Reforming Learning

EDUCATION IN THE ASIA-PACIFIC REGION: ISSUES, CONCERNS AND PROSPECTS

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Reforming Learning

Concepts, Issues and Practice in the Asia-Pacific Region

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Introduction

As an increasing number of countries move from the industrial age to the information age, and in so doing seek to adjust to the demands of globalisation, the new information and communications technologies and changing demands in both the workplace and society, they are exploring ways of reforming their systems of education and schooling to best prepare individuals, communities, and society at large to accommodate such challenges.

As has been argued elsewhere,[1] there is no lack of attempts to reform educational systems to address such changes, including those in the workplace and society. Some reform efforts, however, are based largely on improving existing practice, on efficiency rather than effectiveness, and are aimed at modifying or improving the existing paradigm, rather than coming up with a new paradigm. Thus, for example, some curriculum reforms focus on how to improve the sequencing of teaching specific subject-matter blocks, rather than on questioning whether to teach that subject at all or replace it with new learning content. Another example, this time concerning learning, refers to exploring how to improve the testing of learners through improved paper-and-pencil tests, rather than questioning the value and use of such testing in promoting learning, and exploring the use of collaborative methods of assessment including doing away with formal examinations and other more traditional ways of assessing learning.

The viewpoint of all the contributors to this book of readings is that the primary focus in all education endeavours should be on learning and learners: how to best facilitate learning, in the most effective, enjoyable, relevant and cost-effective ways, whether the learners be children, youth or adults. The emphasis is on what reforms are necessary if learning is to be enhanced.

It is not by chance that the emphasis in this volume is on the reform of learning, rather than teaching. The reason is that the editors and contributors share the view that the purpose of education is to facilitate learning, and so it is desirable (indeed essential) to identify and implement innovations and best practices which promote,

[1] See, e.g., Ordonez and Maclean (2007) 'Seeking a new education paradigm for learning and teaching: Achieving education for sustainable development', in Rupert Maclean (Ed.), *Learning and Teaching for the Twenty-First Century*, Springer.

and result in, improved learning. Although teachers are of central importance with regard to reforming learning, the emphasis should nevertheless be on learners rather than teachers.

The authors indicate that in order to be successful in reforming learning there is a need to examine ways of reforming the numerous variables which influence the effectiveness of learning and learners, such as teacher behaviour; assessment and evaluation methods; teaching modalities and pedagogy; curriculum content in terms of 'what knowledge is of most worth', and most effective ways of organising the curriculum; and how existing and new information and communication technologies can be most effectively utilised to promote learning. It also requires a consideration of a variety of ways of promoting learning including approaches which stress group work and collaborative learning; greater flexibility in how learning is best promoted; and notions such as lifelong learning. In reforming learning there is a need to reform the culture of teachers and teaching.

This volume mainly focuses on the reform of learning in the Asia-Pacific region, with examples being drawn from a wide range of countries including the Philippines, Australia, New Zealand, Singapore, China (including Hong Kong and Macao), and Japan. Despite the emphasis on Asia-Pacific examples, the insights presented are also relevant to many other countries, worldwide.

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Reforming Learning in the Asia-Pacific Region: An Introduction

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Education in the Asia-Pacific region has undergone considerable reform in the past decade. While such reforms can be discussed from various perspectives, in this book we focus on *learning* as the core activity of educational institutions. Research on learning in the region has expanded rapidly as countries have developed economically and have sought to participate more fully in the globalising market for knowledge-workers. Politicians, business executives, community leaders, as well as peak academic and professional bodies have positioned *learning* as a key to the future prosperity of the region and as vital for sustaining social harmony within and between the nations of the region (Renshaw, 2002). Engagement in learning activities is required to identify solutions to both the technical challenges of sustainability, and to the challenges of developing social institutions that are inclusive and equitable for the diversity of peoples in this region. We need to learn – to survive, to live together in diversity, and to provide a sense of hope for our children and for the generations that follow.

Workplaces are increasingly represented as dynamic learning organisations (Senge, 1990) with distinctive cultures and communities of practice (Wenger, McDermott & Synder, 2002). Used in this context 'learning' conveys the sense that organisations and employees should be flexible, adaptive, and capable of responding to rapidly changing environments. Employees need to be problem-solvers, multi-skilled to enable them to work across portfolios, team players, and capable of learning new skills and strategies as required. The anticipated length of employment in any organisation is possibly no longer than 5 years or so, before employees can anticipate entering other learning organisations where new skills, knowledge, and dispositions may need to be acquired (Abernathy, 1999). So adaptability and capacities for ongoing learning are essential. James Gee (2000) captured this sense of ongoing learning when he dubbed the generation of the new millennium the 'portfolio generation', because from early childhood everyone is expected to engage in learning activities.

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Success as an employee or student used to be regarded as a function of fixed personal qualities such as intelligence or acquired knowledge and skills. Now, success is related to dynamic dispositions such as knowing how to learn, knowing how to network with others including experts, and knowing where to seek out information, appropriate it, and communicate it effectively to others. So what counts as worthwhile learning is changing as the social and economic realities of our region are transformed.

We suggest that learning is concerned both with acquiring technical expertise and know-how, and developing capacities for making wise value judgements. To promote learning per se, as an end in itself, is to promote any kind of change as a valuable goal. *Learning* is as much about making individual and collective value judgements and choosing between alternative futures, as it is about technical innovation. By privileging some general notion of *learning* as a universal good, we remove our responsibility to make judgements of what is worthwhile learning, and the kind of future that it is worth 'learning towards'. To research learning, therefore, is to enter into critical reflection about what is being learned, by whom, in what context, and for what purpose, and to reflect on *who* has the opportunity to learn *what*. In this book, therefore, we are advocating a questioning approach to what is worth learning for a sustainable and socially inclusive future for the region.

The history of research on learning in this region has been largely derivative in the sense that it has been characterised by the adoption and application of North American and European models of learning. This trend has been apparent in various fields, including cognitive development, learning approaches and styles, learning environment, problem-solving, motivation, and metacognition (see Part 1, Section 3: Learning and Human Development, in Keeves & Watanabe, 2003). Renshaw and Power (2003) anticipated that educational researchers would draw more from the rich cultural history of the region and develop local models of pedagogy and explore local wisdom and practices with regard to socialisation and educational processes. The chapters in this book can be taken as a collective effort by researchers across different countries in the region to sustain this pattern of educational research in light of the current waves of reform. In examining different reforms from a learning perspective, we can identify and clarify major concepts and theoretical assumptions in these reforms, evaluate their possible impacts on the actual learning and teaching processes, and highlight emerging indigenous theories and models relevant to local educational systems.

In the wake of the 1997 financial crisis, various reformative measures have been carried out in different countries within the Asia-Pacific region. In Thailand, a new national educational bill was passed which promotes learner-centredness, lifelong learning, decentralisation and autonomy in curriculum design. In Hong Kong, a major overhaul of the whole education system has called for reforms in curriculum, pedagogy, and assessment strategies. In Australia, the Queensland Education Department launched the 'New Basics' reform based on new curriculum frameworks, productive pedagogies and rich tasks. In Malaysia, the 'Vision 2020' policy promotes democraticisation, privatisation, and decentralisation of the educational system (Lee, 1999). In Singapore, the 'Thinking Nation' reform promotes the development of creativity and critical thinking among their students. Aside from these official reformative policies and plans, there were countless ‘unofficial reforms’, initiated by reform-minded educators and teachers in their own classrooms. All these reformative efforts aim to restructure different aspects of schooling in order to promote learning and to prepare students to meet the diverse challenges in the future. The expected and unexpected effects of these reformative measures on students’ learning processes outcomes need to be understood.

Paralleling these reforms, a number of progressive theoretical perspectives have also come into play in the current development of education in the Asia-Pacific region. The new ‘-isms’ such as constructivism, post-structuralism, and multiculturalism, have posed new ideas, motives, and challenges for reforming teaching and learning in different educational settings. They challenge traditional practices, established arrangements, and deep-seated assumptions related to different aspects of schooling and learning. In addition, the advancement of new technologies not only provides new ways for learning but also changes how learning is conducted as well as the relation between learners, teachers, and different means of learning.

Exploring educational reforms in the Asia-Pacific region from the perspective of learning is challenging. It is challenging because the Asia-Pacific region is diverse. It contains countries of diverse cultural, political, economic, and religious orientations. To effectively bring about reform, it is necessary to understand the diversity and complexity present in different countries, and the history of their educational systems (Keeves & Watanabe, 2003). In addition, the whole region is experiencing ongoing transformation. Tensions and conflicts abound. Education, and in particular student learning within schools, is affected in a dynamic and complex manner by these tensions and changes. For example, the intermittent political disputes between China, Korea, and Japan over atrocities during the Second World War have influenced the design of school curricula and in particular the content of history textbooks in these countries. Major disastrous events such as the Bali bombing in 2002, and Asian Tsunami in 2004, have contributed to a sense of uncertainty and demanded the development of policies that are proactive, preventive, and forward-looking. The economic crisis in late 1990s galvanised political leaders and educational policy-makers to focus on reforming education.

Also, it is challenging because change is being driven by economic and technological transformations that lie outside the control of both the policy-makers and the broader community of researchers, teachers, parents, and students. The rational sequential model of policy suggests that reform policies and plans can be effectively and efficiently implemented to actually change practice and improve outcomes. What the current discussion on these reforms in the region has failed to capture is what Ball (1990, p. 9) described as ‘messy realities of influence, pressure, dogma, expediency, conflict, compromise, intransigence, resistance, error, opposition and pragmatism in the policy process’. In a similar vein, due attention has not been given to the ‘messy realities’ in daily learning and teaching activities in school. An agenda for change has been introduced into the educational systems in the region without a thorough examination as to whether local systems of learning and teaching at various levels, including national, district, school, classroom, and even individual levels, can accommodate or effectively deal with these calls for changes. We suggest that policies for reform require a more participatory and negotiated approach that involves dialogue among different stakeholders.

The precise genesis of these widespread educational reforms within the region is closely related to factors such as globalisation, economic transformation, and technology advancement. Scholars in the region have been conscientious in discussing how these macro-processes are related to education and concerted efforts have been expended in documenting the structural changes related to these reforms (e.g. Cheng, 1999; Cheng & Townsend, 2000; Mok & Welch, 2003; also see Vol. 10 No.1 of School Effectiveness and School Improvement). However, the discussion of globalisation and its impacts on actual learning and teaching processes has been limited. Our academic imaginations need to be stretched so that we can envision the link between the daily practice of learning and teaching in classrooms and reforms such as school-system restructuring, new school-management schemes, and new systemic goals for education. The authors in this book have taken up this challenge and explored the link between reform and learning in their own educational sites. The data, findings, arguments, and discussions in the chapters in this book collectively invite us to reconsider carefully these reforms and their dynamic impacts on learning and teaching.

In the next section, we shall focus on discussing various major global forces driving the current waves of reforms in the region. Our goal in this discussion is to engage readers in a journey that charts the 'unfamiliar', 'coarse', and 'emerging' link between global forces of change and learning processes in local sites. The discussion below is therefore bound to be exploratory. In writing this introductory chapter, we hope to highlight the importance of understanding reforms from a contextual perspective, emphasising the importance of affordances and constraints of local conditions and embedded sociocultural systems of practice.

1 Economic Trigger for Reform

Globalisation refers to the transfer, adaptation, and development of values, knowledge, technology, and behavioural norms across countries, societies, and different parts of the world (Water, 1995). There is a convergence of academic views that globalisation is associated with knowledge-based economies, which are characterised by networking, information, and innovation. In a knowledge-based economy, workers are required to be adaptive, flexible, innovative, and motivated to learn. The main challenge for education is the extent to which a particular educational system can produce graduates with new skills, knowledge, and dispositions for the new economy. Such an economic or developmental concern has been the common focus of educational reforms in countries such as Hong Kong, Taiwan, Singapore, South Korea, Malaysia, and Australia in the region. Reforming education in these Asia-Pacific countries is characterised by converging themes believed to be driven by the requirements of globalisation – promoting lifelong learning and education, improving qualities of learning, reorganising curriculum into key learning areas, developing critical thinking skills, promoting multiculturalism and global awareness/outlook, and raising level of teacher professionalism. The excerpts below are some of the examples taken from major policy statements in various countries in the region, which demonstrate the significant impact of globalisation on educational reforms.

> Schools will need to help students develop the skills and knowledge for the knowledge economy, lay the foundations for lifelong learning, and ensure that students reach their optimal potential. Initiative is a critical area of skill for the future (Queensland State Education, 2001).
>
> Education nurtures talents for the society and promotes its prosperity and progress. In an ever-changing society, it is imperative that our education system keeps pace with the times and be responsive to the needs of learners. To design an education system for the future, we must envision future changes in the society in order to cater for the needs of learners in the new society and to define the role and functions of education in the new environment (Hong Kong Education Commission, 2000, p. 27).
>
> Looking beyond the immediate future, we must focus on lifelong learning and employability for the long-term. Our future prosperity will be built on a knowledge-based economy. That is why we are revamping our education system to produce thinking students. The future economy will be driven by information technology, knowledge, and global competition (Goh Chok Tong, the Prime Minister of Singapore, 1998; cited in Kumar, 2004, p. 561).

At issue in these excerpts is that educational reforms in the region are focusing overtly on economic functions of education – producing required labour forces to meet the demands in a globalised knowledge-based economy. Sahlberg (2006) called it the Global Education Reform Movement. It is concerned with economic competitiveness as the main motive driving changes in every aspect of a society, including education and educational reforms. Similarly, Cheng (2003a) called this wave of reform in the region as focusing on ‘future effectiveness’. The economic depression experienced by most of the countries in the past decade has heightened the perceived need for a reform. Despite the diversity in the Asia-Pacific region, most of the countries are united in upholding the importance of improving educational quality, effectiveness, and relevance in the era of globalisation (Maclean, 2001).

2 The Focus on Learning

Another striking convergence in the current discourse on educational reforms is the focus on learning. Cheng (2003a) argued that this new wave of reforms should have student learning as its primary focus and schooling should be ‘managed in a way that facilitates transfer and adaptation, drawing on global resources, and exploiting global networks which will contribute to students’ learning and teachers’ teaching’ (p. 430). Learning has been considered as a universal good or solution for future challenges (e.g. Kalantzis & Cope, 2001; Hong Kong Education Commission, 2000). Writers on globalisation (e.g. Daun, 2001; Burbules & Torres, 2000) have argued that globalised, knowledge-driven economies call for a paradigm shift in teaching and learning which involves reforms of goals, content, and practice at all levels of education.

Nevertheless, learning is a value-laden process. To make a judgement that something is worthwhile learning is highly contextual. Spinning off from this central concern about learning are important questions such as: What are we learning for? What are we learning towards (new identities, new communities, and new ways of life)? How should we go about learning (new tools and resources)? Who can access these learning opportunities and who is excluded? Embedded in these questions are important social and political concerns such as equity, multiculturalism, diversity, differential funding, and values.

In relation to what we have discussed is the problem about the conceptualisation of learning in educational reforms. While there is more or less an agreement on the significance of graduate attributes such as problem-solving, creativity, lifelong learning, team work, flexibility and interpersonal skills, willingness to take risks, being innovative, and communication skills, there is no agreed plan as to how these knowledges and skills can be promoted among school students. The question is not about choosing between these attributes, or deciding which is more important than the others. It is more about how we are going to make sure that our students are scaffolded appropriately in the development of these learning attributes. What should be done to reform the daily learning and teaching practices in order to enhance the development of these important attributes?

In response to globalisation, different countries have come up with different reform programmes. One common theme in these reform efforts is that change in classroom practice is assumed. For example, in Queensland, Australia, the New Basics Reform was instituted in 2000. This futuristic reform proposes a curriculum framework that builds on four basic curriculum organisers, which is delivered through productive pedagogies and rich tasks. The alignment of curriculum, pedagogy, and assessment is the main concern in this reform. In Singapore schools, the focus was on the development of critical thinking and creativity. The use of project-based learning was called for to promote higher order engagement for their students. In Hong Kong, a comprehensive reform changed the school curriculum, academic structure, and assessment system. The development of a new teaching culture that values mastery over achievement was considered critical in this reform.

The examples above indicate that to meet the challenge in the new economy, there is a need for new pedagogies or a paradigm shift in teaching and learning. However, the discussion on what exactly is needed for the development of these new pedagogies or new learning is limited and there seems to be no agreement. When discussing the reform of Singapore education, Luke and colleagues (2005, p. 8) stated that 'the policy question is about how to take schooling and education in Singapore to the "next level"'. However, what does the 'next level' involve? What kind of learning and teaching processes should be established in order to take the achieving Singaporean educational system to the 'next level' of performance? Failing to find a satisfactory model to follow, Luke and colleagues resorted to fuel the Singaporean reform by quantitative and qualitative research on classroom teaching and learning, exploring how the practices are grounded in various cultural, familial, and institutional contexts as well as how they mediate the effects of these various contexts and lead to the development of desirable learning outcomes and attributes. There is a need to look closely at the teaching and learning processes, the curriculum, learning activities, and experiences students gathered from their schools. In other words, it is essential to examine the established teaching and learning practices and explore whether they are capable of or appropriate for the development of those learning attributes a globalised economy values.

It is often hard for stakeholders to theorise how learning is related to a particular reform and to analyse how learning should be, or has transformed, during the reform process. One of the important considerations is that effectiveness of these reforms should not be judged narrowly on students' achievement levels. As Luke has argued, the effectiveness of an educational policy should be grounded 'in the power of education in making material and intellectual differences in the pathways and consequences for students, teachers and their communities' (2005, p. 12).

In short, economic concerns have triggered the current wave of educational reforms in different places in the region. Nevertheless, we need to move beyond the positive sounding rhetoric of educational reforms, by considering the following features: reforms need to be examined in relation to their cultural and historical context; in relation to value judgements regarding worthwhile learning; and in relation to changing economic conditions in different countries and the tensions associated with these changes for educators and citizens alike.

The immense diversity of the Asia-Pacific countries adds another level of complexity to what we have discussed. It is inappropriate to assume that globalisation impacts equally and universally on every nation in the region in a similar manner. Each country can be affected differently by globalisation; some may be driving the globalisation process, some may be working along with it, while some may be struggling to catch up or simply being left behind. In this sense, it is inappropriate to assume that the new economy has already been established universally in every part of the region. Even for the more advanced countries such as Australia and Japan, certain forms of the old mode of production are still running parallel with the post-Fordist mode of production in the new economy. In this case, to argue for a paradigm shift of learning and teaching universally applied to every part of the region is not a justifiable position, which may only serve to reveal our lack of understanding of the diverse cultures of the nations in the region. Different forms of learning and teaching may be required for students in different societies in the region given their own specific sociocultural traditions and current concerns (Kemmis, 1998). Learning, pedagogy, and curriculum privileged in a particular place cannot be understood thoroughly without referring to its sociocultural context (Renshaw, 2002). A paradigm shift requires appropriate rules, norms, and values to legitimise its acceptance and enactment. For example, the inquiry project approach adopted in Singapore schools may be out of tune with Indonesian students in the tsunami-affected villages who are still struggling to come to terms with the massive destruction. In the same vein, the stress on the development of an intellectually challenging environment in the Australian state of Queensland, may not work for students in Hong Kong, South Korea, and Japan who learn within the constraints of their local exam-oriented systems. Each nation in the region needs to engage in this challenging process of educational transformation through a close scrutiny of their own cultural practices in education, building on their past achievements, exploring various contextual constraints and affordances, and addressing the new conditions with localised solutions that focus ultimately on improving learning and teaching.

3 Technological Advancement and New Learning

Undoubtedly, the use of information and communication technologies (ICT) is considered vital in the twenty-first century. ICT is a major force that promotes globalisation processes and quickens the development of a knowledge-based and information-rich economy. It enables the creation and development of globalised networks of ideas, finance, commodities, and communities. We can find reforms focusing on incorporating ICT into classroom learning and teaching, benchmarking teachers' ICT skills and knowledge, improving technology infrastructure in schools and communities, for example, in Singapore, Hong Kong, Taiwan, Australia, and Japan (Cheng, 2003b). The consistent message in the policy rhetoric is that ICT holds promise for improving student learning or the development of progressive educational ideas such as collaborative learning, student-centred learning, and problem-based learning.

Nevertheless, the positive impact of ICT does not come automatically. The challenge to education posed by technological advancement is not just a matter of installing computers and connecting them with the World Wide Web. We believe that we still have a long way to go in transforming learning using new technologies in the globalised, knowledge-driven, and information-rich economies. The shift from learning *about* ICT to learning *with* ICT needs to be maintained. Most of the countries in the region have clear policy guidelines regarding the former – focusing on establishing ICT infrastructure, training teachers on essential ICT skills and applications. To capitalise on the strengths of ICT, however, we need to focus on the latter, exploring how learning and teaching can be improved through integrating ICT into the school curriculum as part of the pedagogical content knowledge that informs the design of the curriculum, pedagogy, and assessment. It is important to explore how ICT can be incorporated in the new pedagogical or learning models for different school curriculum, supporting the development of learning and assessment tasks that are authentic, constructive, collaborative, and challenging. For example, ICT can be integrated into project-based learning as a way to promote collaboration, learning engagement, the search for relevant information, and creative report of learning outcomes (cf. Wong et al., 2006).

To learn and to teach with ICT requires the learning of a new set of words, symbols, graphics, images, discourse structures, and practices in the cyberspace. The new media denotes a new form of literacy for both teachers and students. The appropriation of the new tools for teaching and learning also assumes changes in the roles of both teachers and students, their patterns of interaction, and the design of learning activities and assessment. Such a change is essential for the development of a pedagogy that builds on the strengths of new technologies. Implicated in this discussion is the fact that learning *with* ICT will require a discussion of larger questions such as epistemology, identity formation, classroom dynamics, and (in)equity of access.

In relation to our discussion on learning *with* ICT, Kozma (2003) reported some encouraging results. In a number of countries in the region – Singapore, Hong Kong, Japan, Taiwan, and China – he found that integrating technology into school curriculum enhanced collaboration with and between teachers, promoted the design of constructivist learning activities, increased the use of web resources, email and multimedia software to communicate. Another key research finding in Komza's international study was that the use of ICT in pedagogies that demand research work and information management from students resulted in more desirable learning outcomes than did those treating ICT as add-on skills. In other words, it is critical for us to understand how ICT is actually used in the classroom among teachers and students.

In light of globalisation, learning *with* ICT means that there is a need to 'assess directly the impact of ICT on student learning, especially those skills such as information handling, problem solving, communication, and collaboration that are considered important for the 21st century' (Komza, 2003, p. 13). We cannot tell with confidence at this stage if ICT is effective in promoting the development of these important skills for different student groups in the region. Specific sociocultural conditions, such as existing pedagogic practice, social backgrounds, and cultural beliefs may have a profound impact on the use of ICT. The practice, values, and group characteristics may either foster or inhibit the use of ICT (cf. chapters by Goos, and Yuen et al. in this collection). Thomson, Nixon, and Comber (2006) studied the use of ICT in several schools in the low socio-economic suburbs in South Australia. Their study found that the use of ICT was limited by the uneven distribution of the hardware establishments in these schools; their actual use among students was further constrained by factors such as a lack of technical expertise, inadequate understanding of home and community ICT practices, and significant variation of the capacities of schools, and the delayed engagement in examining the implication for pedagogy and curriculum. In short, it is a daunting task for teachers to come up with in-time changes in their classroom practices in order to capitalise on the benefits of ICT.

The digital divide between information-poor and information-rich groups is increasing. In this case, the ICT reform brings to the fore the problem of equity and access. The use of ICT needs to be evaluated in light of the developmental conditions within different countries in the region, as well as between them. Countries in the region are in different stages of development in the use of ICT in education (cf. Hedberg & Lim, 2004). Information-poor countries such as Vietnam and Laos risk being left behind in terms of ICT reform. Students in the information-poor countries are increasingly crippled by a new form of illiteracy posed by the use of ICT. The struggle to provide the necessary hardware and equipment is another round of basic reform that developing countries in the region need to pursue after the provision of basic education.

Information-rich countries face another form of inequity. The challenge for developed countries in the region such as Australia and Japan is how to make sure students from disadvantaged backgrounds or minority groups are not left behind in the digital development in terms of access, use, and mastery of these technological tools. Thomson, Nixon, and Comber (2006, p. 477) argued that when equity is concerned, learning with ICT requires an analysis of the purposes of schooling and 'such a discussion need to connect with situated analysis of their local populations and existing understanding about "curriculum justice" and how it might be developed'. A deterministic approach to the ICT movement, which holds that ICT is beneficial to every student, should therefore be avoided. Instead, the new learning called for in the ICT reforms needs to be evaluated from various contextual considerations, including pedagogical practice, curriculum characteristics, school cultures, and student backgrounds.

4 Systemic Effectiveness

International comparison of educational achievement has attracted much attention from political leaders and educational policy-makers who seek confirmation regarding the competitiveness of their graduates in knowledge-based economies. Educational attainment in terms of mathematics, science, and literacy development is the focal point of interest. In the recent publication of international comparison tests such as TIMSS and PISA, major Asian nations in the region, including Singapore, Korea, Taiwan, Hong Kong, and Japan were ranked high in terms of achievement in mathematics, science, and literacy development. Stakeholders in education are becoming more aware of educational standards and achievement in other countries. Seeking similar educational quality or pursuing competitive achievement has become one of the major concerns for educational policy-makers and politicians in the region (Riley & Torrance, 2003; Sahlberg, 2006).

Teaching and learning effectiveness cannot be understood clearly without a situated and sociocultural analysis. In the past, Asian learners have been criticised for the over-reliance on rote learning, their reluctance to participate in classroom discussion, and the need for tight teacher control and guidance (mostly from a Western perspective). These stereotyped images of Asian students have been challenged (Volet & Renshaw, 1995, 1996; Watkins & Biggs, 1996). The high achievement of Asian students in international comparison tests has forced researchers to abandon such a deficit view of Asian learners and to consider the apparent paradox of Asian teaching/learning strategies and their high level of achievement. Consequently, what can be learnt from the Asian systems has triggered a new wave of research (LeTendre, 1999). In the case of TIMSS, this was achieved through comparative analyses of a series of video-taped lessons among participating countries (Stigler & Hiebert, 1999), which explored the notion of national teaching scripts. Subsequently, the search for and debate on national teaching scripts and their effects has prompted a closer examination of learning and teaching processes in different countries (e.g. Clarke et al., 2006; Lopez-Real & Mok, 2002; Stigler & Hiebert, 1999). For example, Mok (2006), based on data generated from an international video study of teaching in Shanghai classrooms, argued that teacher-dominated pedagogy can promote learning and engagement. This research-based argument warns us against treating teacher dominance as an overtly undesirable teaching practice based on a Western perspective. To extend Mok's analysis, the activities observed in the Shanghai classrooms need to be situated in the sociocultural conditions that have contributed to the development and effectiveness of particular teaching and learning arrangements.

Aside from an increased interest in the teaching and learning processes in Asian classrooms, Asian countries themselves are searching for effective ways to maintain their current level of achievement in the globalised knowledge-based economies. For example, Japanese educational researchers are increasingly concerned about the decline of Japanese students' performance in TIMSS and the internal gap of achievement among students coming from different socio-economic backgrounds (LeTrende, 1999; Sato, this volume; Shimizu, 2001). The Hong Kong government in its current reform has stressed the need to develop a new form of competition, where no child is being left behind. The Singapore government promotes critical thinking skills among their students. The policy imperative in these high-achieving Asian nations is to maintain competitive advantage whilst adapting to new economic and sociocultural conditions. This has led to increasing emphasis on accountability and demonstrable evidence of the usefulness and effectiveness of reforms in order to justify government's funding support (e.g. Luke & Hogan, 2006).

To summarise, our discussion pinpoints the need to explore the link between educational reforms and learning in specific sociocultural contexts in which they operate. Learning in globalised economies is value-laden. Given the diversity among the countries in the region, innovative thinking is required to craft reform agendas and processes that are contextually relevant, culturally appropriate, and developmentally viable. Policy borrowing from the West does not guarantee results. Global dissemination of successful programmes in one place to another is always problematic. The changes in practices are complex, messy, constrained by sociocultural conditions, and can only be partially manipulated by policy mandate. It is time, therefore, for us to go back to the basics and explore educational reforms in the light of teaching and learning in their immediate context with a view to develop indigenous models of learning and teaching that address the current wave of reforms; because 'education innovation for first and last is about teachers and students where they begin, what they experience, and where they end up' (Luke et al., 2005, p. 26).

5 The Aims of this Book

One of the major aims of this book is to document how learning is being affected by the current wave of educational reforms in the region. We have defined the term 'reform' very broadly so as to include both formal and informal projects. This will allow readers to understand that reforms in education will not necessarily be confined to policy initiatives or large-scale reform programmes. Collectively, the chapters in this book argue that successful reform is located in a deep understanding of the local context. We take a sociocultural approach that entails evaluating various reforms in light of the existing systems of learning and teaching, its constraints and affordance, and its historical evolution and current form. The contextual lenses we use in this book are far from static. We discuss reform and learning from past, present, and future perspectives; it also draws the link across multi-levels, from the political system in a country, to the social, familial, school, and classroom operations.

We also hope to start a dialogue among educational researchers within the region on critical and emerging issues and concepts related to reforming learning within the Asia-Pacific region. To facilitate the academic dialogue, the chapters in the book follow a broad structure that requires authors to:

- Situate the reform or change, defined broadly, within the context of student learning; explain its backgrounds, theoretical concerns, and clarify key concepts and issues at stake, and discuss how they are related to or may have an impact on the teaching/learning process
- Consider relevant theories and concepts in the literature
- Explain how learning would be influenced or has been impacted by these reforms or changes
- Discuss issues related to learning that have arisen, and relate them to different contexts of schooling in the Asia-Pacific region

6 Chapter Overview

The first chapter in this collection offers a theoretical model based on the Activity Theory to delineate various possible linkages between reform and learning. One of the most important challenges to understanding educational reforms in such a vast region is how to conceptualise reforms and link them up with various aspects of learning. Activity Theory offers a theoretical framework that can link reform and learning in diverse sociocultural conditions, and across different relational features of a system including relations between subjects and objects, rules, communities, and the division of labour. The chapter ends with a discussion of several critical lenses that we suggest need to be considered to evaluate reform and learning.

Part II, "Focusing on Tools, Transformation and New Learning", contains eight chapters. The theme in this part focuses on the reforms related to the introduction of new cultural tools for learning and teaching. These tools include the effective use of new technology (Bahr & Bahr, Goos, Towndrow et al., and Yuen et al.), the implementation of a new curriculum (Bernardo et al.), the development of new policy on the medium of instruction (Poon), and the introduction of a new pedagogic model (Cheung, and Yeong & Ng).

Part III, "Focusing on Contradiction, Tension and Systemic Change", presents six chapters. The first four chapters discuss various forms of contradictions and tensions associated with the introduction of a new reform. These contradictions and tensions originated from the changes in the norms and goals for learning (Sato and Ng), the needs and characteristics of different student groups (Archer), and views among different stakeholders in education (Liberty). The final two chapters discuss systemic change in education; issues related to transferability and sustainability (Law), and an innovative model for professional development (Timperley et al.).

6.1 Focusing on Tools, Transformation and New Learning

The crucial question addressed here is how this new set of cultural tools will transform learning or lead to the development of new forms of learning. In answering this question, authors in this section focus on the sociocultural context for the development of these new tools (Goos, and Yuen et al.), as well as understanding various micro-level factors that may affect students' engagement in using them (Bahr & Bahr, and Towndrow et al.).

Goos' chapter explores the impact of these technology-related reforms on mathematics learning and teaching in the Australian context by analysing examples of classroom practice and teacher learning drawn from a series of socioculturally oriented research studies. The chapter offers a framework for theorising relationships between pedagogical beliefs, school structures, and other factors that might influence technology use by teachers and students in mathematics classrooms. It extends Vygotsky's concept of the Zone of Proximal Development to incorporate affordances and constraints of the learning environment (Zone of Free Movement) and the nature of the specific activities designed to promote new skills and understanding (Zone of Promoted Action). It also develops a series of metaphors (technology as *master*, *servant*, *partner*, *extension of self*) to describe ways in which teachers and students appropriate technology as a cultural tool. Implications are discussed for technology-related reform of mathematics education in Hong Kong and Singapore.

Yuen and colleagues draw our focus onto the integration of technology into the science curriculum in Hong Kong. It is a government policy in Hong Kong that teachers are expected to incorporate ICT into school curriculum and classroom teaching. This chapter explores the students' and teachers' authentic experiences in a science curriculum innovation, in which students and teachers from five primary schools in Hong Kong engaged in online collaborative knowledge building. Thirty fifth-grade students and eleven teachers from five primary schools were interviewed on their concepts of learning and knowledge building, as well as their personal accounts of this unique pedagogical experience. The results indicate that it is important to understand students' and teachers' conceptions of the new experiences in using the innovative technologies, which to a certain extent, is constrained by various contextual factors. One of the interesting findings derived from the interview data was students' negative responses to the use of internet technology may be related to the exam-oriented learning environment in Hong Kong.

Bahr and Bahr focused on exploring how the design of classroom activities can promote learning with information technology. In Queensland, there have been significant initiatives in the past decade to support the integration of technology in classrooms and to set the conditions for the enhancement of teaching and learning with technology. Recent research and theory into cognitive load, suggests that complex information environments may well impose a barrier on student learning. Further, teachers have the capacity to mitigate the cognitive load through the way they prepare and support students engaging with complex information environments. Bahr and Bahr compared student learning at different levels of cognitive load to show that learning is enhanced when integrating pedagogies are employed to mitigate the high-load information environments. This suggests that a mature policy framework for ICTs in education needs to consider carefully the development of professional capacities to effectively design and integrate technologies for learning.

In Singapore, change is sought urgently in the field of literacy pedagogy where the presence of digital technologies has spawned a vibrant and challenging interest in how teachers and pupils can prepare for the creation and interpretation of multimodal representations of knowledge. Drawing on data from a larger study investigating the use of ICT in contemporary school learning in Singapore, Towndrow and colleagues presented two case studies that illustrate the manner in which pupils engaged in the process of crafting representational artefacts in learning tasks in two lower secondary science classrooms. The discussion that follows includes views on the successes and difficulties faced by the study participants in their work with multimodalities. Some suggestions are also made concerning how these difficulties could be overcome.

Aside from the introduction of new technology, the reforms of new tools also include the development of innovative pedagogical model, change in curriculum, and medium of instruction. Since 1997, the Ministry of Education in Singapore has launched a series of educational initiatives to revise and update the national education system in order to meet the new epistemological challenges of the twenty-first-century global economy. Yeong and Ng in their chapter examined Project Work, one of the educational initiatives introduced under the Singapore government's *Thinking Schools, Learning Nation* vision. This chapter takes a look at the theoretical foundations on which Project Work is based as well as the design of the initiative itself. An analysis of the challenges facing the successful implementation of Project Work is also offered. The authors argue that the most pertinent challenge faced by Singapore's education reform is the deeply ingrained mindsets of the various stakeholders, including students, teachers, school leaders, and parents, regarding the goals of education. These mindsets pose a challenge not only to the Project Work initiative but also to the wider education reform in Singapore. Several fundamental changes in epistemological presuppositions, both within and outside of the classroom, are needed in order for Project Work to fulfil its educational objectives.

Macao is a Special Administrative Region of China where schools enjoy a high degree of autonomy and undertake school-based educational reforms. After the 1999 sovereignty transition, many kindergartens, primary, and secondary schools, as well as special schools attempted to apply Gardner's MI Theory to reform teaching and learning in order to implement an individually configured educational experience for students. Cheung discusses individually configured education in the postmodern era, and proposes a school-based MI-inspired action research paradigm for undertaking reform in instructional design, assessment practices, and the school curriculum. Based on the MI-inspired action research paradigm, research-based examples are presented to showcase how Macao schools are making use of MI Theory to reform schooling towards learning with understanding and liberation of students' potentials and abilities. Cheung ends the chapter with a discussion of how MI as a theory is related to the traditional Confucian ideas of teaching and learning in the Chinese culture.

One of the important elements of the current wave of educational reforms in the region is the restructuring of the school curriculum. Bernado and colleagues discuss the key features of a curriculum reform initiative in Philippine basic education that aims to improve student learning to meet the increasingly complex demands of Philippine society amidst globalisation. These features and goals are crystallised in a new integrated learning area called Makabayan, which integrates the curricular content of several previously existing subjects in order to have more coherent focus on the goal of developing Filipino students' personal and national identity. The chapter discusses the difficulties that related to building consensus among the crucial implementers of the reform (i.e. the teachers) regarding the appropriate curriculum elements that would have realised the improved learning goals. It asserts that a fundamental problem was that although there were well-defined articulations of the improved learning goals of the curriculum, there was a weak conceptualisation of how to reform the various elements of the educational process to improve the learning processes, particularly in a large, resource-limited, and highly centralised educational bureaucracy. However, the chapter ends somewhat optimistically as it suggests that the key learning concepts introduced in the reform initiative come to be appropriated by various stakeholders for their other efforts to reform student learning.

An important tool for learning is the medium of instruction. The policy on medium of instruction is important for nation states such as Malaysia, Singapore, and Hong Kong during the colonial and post-colonial periods. In Hong Kong, the compulsory Chinese-medium teaching policy has been in place in Hong Kong since September 1998, one year after the handover of sovereignty from the UK to China. Though educationally desirable, the use of Chinese as a medium of instruction in Hong Kong has been controversial. To date very few studies have investigated the impact of the compulsory Chinese-medium teaching policy on learning. The public perception is that the English standards of students have further declined. As for the results of content-based subjects, some subjects have improved while others have maintained the same level. In this chapter, Poon examines the reform on medium of instruction and investigated the impact of Chinese-medium teaching policy on learning generally, and specifically on students' attitude and motivation on learning at Chinese-medium schools, on the processes of learning content-based subjects through the mother tongue, on the examination results, and on students' medium of instruction preference. Ten schools have been surveyed. The theoretical underpinning of this article is Cummins' bilingual theories. Poon's chapter explains how the policy on medium of instruction is the result of negation processes embedded in political, cultural, and economic contexts.

6.2 Focusing on Contradictions, Tensions and Systemic Change

Educational reforms inevitably bring contradictions and tensions into educational sites. Different perspectives, views, and theoretical favours abound in relation to issues such as goals, strategies, and content of education. The first four papers in this section discuss these contradictions and tensions in Japan, Hong Kong, Australia, and New Zealand.

Japan has an excellent track record when it comes to international testings in important academic areas like mathematics and science. However, discontent with the drop of achievement levels in the current round of assessment by TIMSS and PISA testings was on the boil in various educational communities in Japan. Sato in his chapter discusses the debate triggered by the concerns of the decline in the academic performance in these international tests. Different strategies have been put forward to rectify the worsening performance, two most important ones being the time on learning and motivational pattern of students. Sato argues in favour of the latter and he ends his chapter with a discussion on how motivated learning can be promoted in some reformative programmes designed from a Vygotskian approach to learning.

Hong Kong students have done well in the international tests. However, the past achievement record of the Hong Kong students was considered not enough to fuel the continuing development of the achieving economy in light of globalisation. One of the main concerns in the current reform in Hong Kong is how to develop a new teaching and learning culture that focuses on construction and mastery of essential knowledge and skills. Ng argues in his chapter that this proposed pedagogical change has not taken into adequate consideration of teachers' and students' striving for performance and its derived pedagogical arrangements. Ng explained the development of this achievement orientation in terms of the evolving political, cultural, and educational contexts in Hong Kong. It is argued that to reform successfully, there is a need to incorporate this orientation with students' other goals for learning.

Students often come to school with different systems of beliefs, values, and goals. Archer draws our attention to the need to examine a reform in light of goals held by different groups of students. The Quality Teaching Model has been designed to improve teachers' pedagogical skills in the Australian State of New South Wales. Archer discusses the motivation implications of this reformative pedagogic model. The model is examined from the perspective of achievement goal theory. Archer argues that the intention of the authors of the model is that its implementation will encourage students' adoption of a mastery achievement goal. However, there is a danger that the model may be less successful with those students who have not been specifically targeted by the authors of the model, namely, under-achieving students from traditionally disadvantaged groups. The model does not take into sufficient account the way in which students' social goals, or even a less conscious need to feel related to others, can work simultaneously with academic goals. Archer ends her discussion highlighting the differential role of social goals operating in the Asian context.

Different stakeholders in education will have different views on students' needs and how to meet them effectively. Hence, disagreement, contradictions, and tensions are inevitable on important educational policies that target on specific groups of students. In New Zealand, children with learning differences had been often excluded from school or educated separately from children seen as typical learners, and have been streamed into different educational paths. New Zealand embarked on a comprehensive revision of the schooling strategy for children with learning differences from 1989. The changes involved radical reform of legislation, the implementation of parent-trustees in partnership with principals and teachers for local school management, parent-choice of schools for their own children, resourcing of children with learning differences at the school level, and a mandate for inclusion of children with learning differences in state school classrooms. By 2006, New Zealand was working towards full inclusion with increasing support from school principals and parents of children with learning differences. The development, implementation, and evaluation of this radial reform of learning is described and critiqued. In her discussion, Liberty highlights the changing roles of parents and how their views, once devalued, have become more salient in the current debates on policies related to the education for students with special needs.

The final two chapters in this section focus on systemic change. A major challenge in education is how to sustain and scale up innovations. Law draws on the case studies of innovative pedagogical practices using technology collected in the Second Information Technology in Education Study Module 2 (SITES M2) to explore whether technology-supported pedagogical innovations pose similar or different challenges to the problems of sustainability or transferability. In particular, it examines the relationship, if any, between the extent of pedagogical innovation and scalability (i.e. sustainability and transferability), as well as contextual and policy impacts on scalability.

Sustainability was found to be more difficult when the extent of innovation was higher and related significantly with leadership style. Sustainability was enhanced in situations where mechanisms were set up to establish a community of practice for teachers as they experimented in bridging the learning gap between established practice and the innovation. Transferability, on the other hand, appeared to be influenced by factors different from those affecting sustainability. First, the extent of innovation had no statistically significant relationship with transferability and appeared to be facilitated by the use of more sophisticated technology. Transferability was also found to be significantly influenced by two contextual factors, the ICT policy at school level and the educational policy at the systems level. Educational policies which encouraged and supported the establishment of multi-site, multiparty collaborative networks for the conceptualisation and implementation of innovations were found to stand a much better chance of transfer.

Undoubtedly, innovations that have a proven record of effectiveness will have a high chance of being transferred. Timperley and colleagues discuss different approaches to innovations in New Zealand. Improving student achievement through school-based innovations has been as challenging for New Zealand as many other countries in the Asia-Pacific region. There are few options for state imposition within the self-managing-schools framework of New Zealand's education administrative structure. After a period of attempting different approaches with limited success, one approach that is described in their chapter has proved highly promising. They call the approach '*evidence-informed collaborative inquiry*'. Rather than persuading or requiring target schools to adopt innovative programmes that have been developed by external experts, the approach involves those experts collaborating with teachers to develop their expertise to diagnose student achievement problems in their schools and to develop solutions to address those problems. Three case studies are described where this approach has been successful in significantly raising student achievement.

Reforming learning within the Asia-Pacific region is an important emerging theme on the education horizon. It is our hope that the collection in this book will attract interest in this topic and draw the attention of policy-makers, educational reformists, and researchers to the need to evaluate reform policies and measures in light of ingrained sociocultural traditions, schooling processes, curriculum change, and evolving classroom practice. This book represents an initial effort in examining educational reforms from this contextual perspective. Chapters in this collection cover important aspects of current reforms in the region from seven nation states in the region, including Australia, New Zealand, Japan, Hong Kong, Singapore, Macau, and the Philippines. There is certainly a need to extend this academic endeavour to discuss educational reforms and learning in other parts of the region.[1]

[1] We would like to thank the authors of this book who have responded to our call and taken on this academic challenge to examine their research from the focus we proposed – reforming learning. We appreciated their initiative, participation, and above all their willingness to revise repeatedly their chapters with a view to clarifying important issues, adding vital information, and sharpening the arguments. We would also like to express our gratitude to the editor of the book series, Rupert Maclean, for his positive response to our proposal and his steadfast support throughout the process. Due gratitude should also be extended to the anonymous reviewers for their favourable comments and to the publisher for publishing this book.

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Exploring the Linkage Between Reforms and Learning in the Asia-Pacific Region: An Activity Theory Perspective

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Abstract This chapter offers a theoretical discussion of the relationship between educational reforms and learning in the Asia-Pacific region. Several reasons are discussed explaining why it is difficult to ascertain the linkage between educational reforms and learning. A consistent theoretical framework is needed to guide the discussion. The chapter argues that Activity Theory is a potential candidate. We discuss how educational reforms are understood from this specific perspective. Two conceptual linkages between educational reforms and learning are discussed. The chapter ends with a discussion of four critical lenses integral to an activity theory perspective that help exploring the linkage between reform and learning.

1 Introduction

In the previous chapter, we described how globalization, economic growth and technological development contributed to the direction and shape of educational reforms in the Asia-Pacific region (e.g. Law, 2004; Lee, 1999; Green, 1999). While the major trends have been mapped (Cheng, 2003; Cheng & Townsend, 2000), there is a dearth of literature exploring the relationship between educational reforms and student learning. The authors in this volume have taken up this challenge and dealt with the linkage between reforms and learning in their own educational sites. Collectively they provide us with rich examples, relevant data and insightful analysis that extend our understanding of reforms and student learning in the Asia-Pacific region.

In this chapter, we offer a theoretical discussion of the complex linkage between reform and learning from an Activity Theory perspective. The use of the term, 'learning', in this chapter also implicates the supporting processes of teaching and curriculum design. We suggest that Activity Theory provides a framework for

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researching and understanding how educational reforms can be related to these processes of curriculum design, teaching and learning. This theoretical perspective draws our attention to processes and aspects of reforms that can be overlooked if school effectiveness or linear cause–effect models of educational improvement are adopted.

From the Activity Theory perspective, educational reforms are framed as planned actions that necessarily have system-wide effects on human relationships, everyday educational practices and outcomes. The reform process itself is described in terms such as: the introduction of new cultural tools and artefacts; the establishment of new rules and norms; the inclusion of new members in the relevant communities; changes in participants' roles; and most importantly, the complex dynamic interaction of these components within an activity system and its neighbouring systems. In this sense, educational reforms are no longer merely understood as policy initiatives designed by policy-makers and subsequently carried out in schools by faithful teachers and school administrators. Instead, they are characterized as interactive and uncertain ventures between participants whose actions are mediated according to rules, norms, roles, tools and artefacts made available to them within the immediate community. Using this specific theoretical lens, educational reforms inherently evoke contradictions and tensions, which nonetheless can be seen as positive forces driving the transformation in the existing system through the development of new practices and redefinition of the objects of activity.

Below we explain the advantages of adopting Activity Theory over other approaches and then we outline how educational reforms are conceptualized from this particular perspective. The linkage between educational reforms and learning is discussed in terms of contradictions within an activity system and across interacting systems. Finally, we highlight four critical lenses we need to focus on when exploring the linkage between educational reforms and learning.

2 The Relationsip Between Reform and Learning

The relationship between educational reforms and learning is a significant issue given that there is a lack of research exploring how learning is being affected by various educational reforms carried out in the Asia-Pacific region in the past decade. Learning and teaching, being the core activities of education should assume a more central role in the design, implementation and evaluation of educational reforms. The difficulties in ascertaining the relationship between reforms and learning can be attributed to the diversity and complexity of reform efforts and the elusiveness of capturing the direct and indirect effects of reforms on student learning.

'Reform' is a rhetorical device deployed by a government to justify various agendas for changing the education system from the top. This model of reform implies that certain aspects of the current system have been diagnosed as inadequate and that a better alternative has been designed and is ready for implementation and dissemination across the system. As Cheng (2003) and others have noted, educational systems in the Asian-Pacific region have embarked on large-scale top-down reforms associated with almost every aspect of education – the fundamental aims of education, curriculum frameworks and restructuring, school management and improvement, teachers' professional development, innovative pedagogical models and new technologies for learning (cf. Cheng, 2003; Cheng, Chow & Tsui, 2001; Luke & Hogan, 2006; Maclean, 2002; Cheng & Townsend 2000; and chapters in this volume).

Below, the major trends and directions in educational reforms in the Asia-Pacific region are specified (see Cheng, 2003):

- Towards re-establishing new national visions and educational aims
- Towards restructuring educational system at different levels
- Towards marketization, privatization and diversifying educational choice
- Towards parental choice and community involvement in education
- Towards ensuring education quality, standards and accountability
- Towards decentralization and school-based management
- Towards enhancement of teacher quality and continuous lifelong professional development of teachers and principals
- Towards using IT and new technologies in education
- Towards paradigm shift in teaching, learning and assessment

This list is not random. It reveals the influence of the neo-liberal paradigm that has shaped the reform of social institutions since the 1980s. The key elements of that agenda can be seen in the trends towards privatization, individual choice, accountability at the local level but strong central control of educational aims linked to national policies and economic imperatives. The effects of these reforms are mediated by how the reforms are appropriated, resisted and transformed in various ways by actors at different levels of an educational system. Thus, we agree with Elmore (1995); when concluding his discussion of the relationship between structural reforms in school and their connection with teaching and learning, he warned researchers of the danger of oversimplifying the relationship between reforming school structure and student outcomes. He suggested that 'researchers should probe underneath the structures to discover, both conceptually and empirically, what changes in teaching practice and student learning are actually entailed in them and what evidence one would accept that changes in structure were actually related to changes in practice and learning' (Elmore, 1995, p. 26). In other words, we need to theorize and research the connection between reforms and learning to take account of complex interactions and unforeseen effects and outcomes. Different paths of direct and indirect influences on learning must be conceptualized and investigated in relation to how a particular educational reform is understood and implemented at a local site.

A general framework is required to guide this complex exploration. One approach to researching educational reforms that came to prominence in the 1980s was based on studies of school effectiveness. Such research suggested that empirical documentation of 'best practice' could provide the basis for developing general principles and guidelines for policy initiatives in curriculum and pedagogy (e.g. Harker & Tymms, 2004; Lo, 1999; Creemers & van der Werf, 2000). In reflecting on this approach, Teddlie Stringfield and Reynolds (2000) noted that context had been ignored in much of the effectiveness research. Their review of effectiveness research included contextual variables (such as SES, community-type, grade level and governance structure), and they found complex first-order and second-order interactions between contextual factors. This suggests that effectiveness research will not yield clear and consistent principles applicable across diverse contexts. Rather, more multi-layered mediated models of teaching and learning appear to be necessary to account for endemic and interacting contextual effects. Similar research on educational implementation sought to identify the generalized principles for effective implementation (e.g. Morris & Scott, 2003; Yu, 2005). Another group of researchers adopted a broader agenda of investigating educational change and focused more on social and political issues that influence policy development and construction (e.g. Law, 2003; Lee, 1999; Tan & Ng, 2007). All in all, these different lines of educational research offer us a better understanding of the processes involved in any educational reform and alert us to the significance of local contextual variables that will facilitate or hinder their implementation. However, we suggest that the major drawback of the extant literature on educational effectiveness, reform and change is the failure to conceptualize the relationship between the processes of change and student learning.

It is a challenge to theorize and research the relationship between educational reforms and learning. This challenge is further complicated when the Asia-Pacific context is being taken into consideration. The Asia-Pacific region includes countries of diverse cultures, religious beliefs, political orientations and peoples. It contains countries that are situated in both ends of the economic spectrum; it contains the richest and poorest countries measured in terms of GDP per capita. Educational systems in countries such as Singapore, Hong Kong, Australia, New Zealand and Japan are considered as more advanced and their students fare well in international tests. In contrast, some of the less developed countries in the region, such as China, are still struggling with the provision of basic education to their children. The marked disparities and diversities of the nation states in the region caution against seeking a one-model solution to educational problems. The meaning of an educational reform hinges on the cultural, economic and political characteristics of the society in which it is being carried out. The differences and diversity in the region make it problematic to directly transfer a reform from one place to another. There is certainly a need for us to examine diverse contextual factors related to reforming learning in different countries within the region (Hallinger & Kantanmara, 2001). At the crux of these complex considerations is how learning and educational reforms should be related in a coherent conceptual manner. The problem is that educational reforms are often seen as structural changes at different levels within an educational system and therefore have seldom been related to individual actions in the classroom. Embedded in this understanding of educational reforms and learning is the conceptual difficulties involved in explaining how social and individual planes are related.

We propose, therefore, that the requirements of an adequate framework for linking education reform and learning should include the following characteristics:

- It should focus primarily on learning outcomes for both students and their teachers.
- It should assess how various educational reforms at different levels in the system are related to everyday practices, in this case, learning and teaching activities in the classroom.
- It should analyse particular educational practices in relation to sociocultural and contextual factors.

We argue that Activity Theory, developed from cultural-historical psychology, fits these requirements. Activity Theory provides conceptual and analytical tools that can be deployed to foreground linkages between educational reforms and learning in the Asia-Pacific context.

3 Activity Theory as a Framework

Activity Theory has its roots in cultural-historical psychology proposed by Vygotsky (1978) and Leont've (1978), and subsequently elaborated by European and North American scholars and encapsulated now as Cultural-Historical Activity Theory or CHAT (Wells & Claxton, 2002; Cole Engeström & Vasquez, 1997). According to Engeström (2000), Activity Theory is a multi-disciplinary theory offering a framework for understanding human activities in their context and provides a set of perspectives for linking social and individual planes, and therefore, it can 'overcome the aged dichotomies between macro and micro, mental and material, quantitative and qualitative, observation and intervention' (Engeström, 2000, p. 961). In recent years, it has been deployed in research on various kinds of socially embedded practices such as the use of technology in higher education (Issroff & Scanlon, 2002), the formation of identities (Roth, 2004), the design of online activities (Barab, Schatz & Scheckler, 2004) and the provision of services for adolescents with emotional and behavioural difficulties (Daniels & Cole, 2002). Limited efforts, however, have been expended by Asia-Pacific researchers in applying the Activity Theory to the study of educational reforms and their impact on learning.

Vygotsky's contribution to the theory was primarily to explicate the social basis of human consciousness. His work demonstrated that cultural tools such as language, sign systems and speech genres (e.g. everyday versus scientific genres) mediate human development and learning. The use of cultural tools is shaped by relevant cultural contexts, which in turn, shape the development of the members in a particular culture. Vygotsky did not show clearly before he died in 1934, how social institutions and the engagement in different activities influence human learning and development. It was his colleague, A.N. Leont'ev, who drew our attention to the close relationship between sociocultural activities and the development of human consciousness.

Leont've (1978) distinguished between operation, action and activity, as three different levels of human practice. Operations are routine or automatized acts and practices that we enact without paying much conscious attention. Actions are goal-directed tasks that we engage in more consciously and intentionally. An activity is a broader sociocultural frame within which actions and operations are nested. Activities are systems of interrelated motives and social practices that become institutionalized over time. Individual operations and actions are subordinate to an activity and related by the same objects and motives. For example, the activity of schooling is more than the acts of individual teachers and students in their classrooms. To understand schooling as an activity, we need to research the overarching sociocultural motives that give meaning and direction to specific local practices. Similarly, the reformative actions of individual teachers need to be understood in relation to the immediate classroom context as well as the wider sociocultural and historical milieu.

So how does Activity Theory frame the relationship between educational reform and learning? We deploy Engeström's triangular representation of the tool-mediated relationship between a subject and an object, situated in a system that contains 'rules', 'community' and 'division of labour'. 'Rules' are principles, values or norms that govern the structure of interaction and mediation. 'Community' refers to the collection of participants who share a common interest on the same object or are involved in the subject–tool–object relationship. 'Division of labour' refers to how different roles, tasks and actions are being shared among members within an activity system. Using this triangular representation, Engeström shows that tools, rules, community and division of labour are different focal points that mediate the relation between different subjects and objects. Consequently, the activity system is 'the minimal meaningful context' for understanding human actions and development (Kuutti, 1996, p. 28). In other words, the basic unit of analysis is expanded from a narrow focus on human action to encompass analysis of interactions within the whole activity system.

Engeström emphasizes that the interaction between various constituent components in an activity system should be understood as involving contradiction, negotiation and interpretation. The active engagement of community members and their different initiatives in taking up and resisting specific practices, discourses and reforms need to be foregrounded. This situates human agency within various constraints and affordances of communities, their practices and their tools.

4 Educational Reforms from Activity Theory Perspective

In this section, our aim is to delineate the conception of educational reforms using Activity Theory. In order to do this effectively, we compare and contrast the conception of educational reforms using Engeström's model of activity system with that derived from a stage conception frequently used among policy-makers and reformers.

In the literature of policy analysis, educational reforms are often conceptualized as involving different stages (e.g. Fullan, 1991; Levin, 2001). The relationship between policy-makers, school administrators and teachers in a stage model of reform can be likened to the operation of a factory production with policy-makers being responsible wholly for the design process, school administrators overseeing the implementation at the operation level, and teachers working faithfully at the chalk face to carry out the reform. The designer–administrator–worker metaphor suggests a power relationship biased towards the policy-makers. School administrators and teachers who hold other views about a reform are often taken as a barrier to successful implementation. The materials used in educational reforms, such as curriculum documents, are often understood as instructions or prescriptions that teachers need to follow. The room for negotiation is limited. As Timperley (this volume) highlights in her chapter, this approach to reform is ineffective and does not ensure either transferability or sustainability of reforms (see Law in this volume). In fact, Fullan (1991) has argued that stage-like reforms often operate as rhetorical devices or public relations campaigns that have little impact on how schools and classrooms are organized. The logic of the reform is also challenged during implementation when the direction and the extent of change are unpredictable or opposed to the intentions of the policy-makers (e.g. Morris, 2002). There is always a pronounced gap between what the educational reformers intended and how it is received and may have impacted on school and classroom practice.

From an Activity Theory perspective, the forms of exchange between policy-makers, school administrators and teachers involve collaboration, negotiation, tensions and conflicts. Similarly, students are not just receivers of the reform but also negotiators of their interests during the reformative process (cf. Corbett & Wilson, 1995). Resistance to the reform within an activity system is assumed and is treated as a positive force for driving changes. The materials used in a reform are often treated as cultural tools to be appropriated. In other words, the implementation of educational reforms is a negotiated process, mediated by various forms of tools, rules and roles among members.

Educational reforms may address existing contradictions. However, they themselves are inherently a source of disturbance that stirs up contradictions and tensions, rendering instability in an activity system. The traditional views consider contradiction or resistance as a barrier to reform, which should be evaded. From an Activity Theory perspective, contradictions are a driving force for change, which should be approached in a positive manner. We have much to learn from Engeström's research, which shows how contradictions can be located through talks, negotiation and collaboration among participants of an activity system. It is through engaging with contradictions that expansive transformation is possible; or to use the notion of the zone of proximal development, it is working with contradiction that participants within an activity system can begin to forge new relationships and practices.

Examining educational reforms in this manner allows us to see educational reforms not just as isolated plans of action or policy documents for solving a particular educational problem, but attempts to transform actions, scripts and practice of a stable system of collective activities as well as the rules, norms and values governing them.

Table 1 Conceptual comparison using stage model and Activity Theory

	Stage Model	Activity Theory
Education reform is defined as…	Systematic programmes of change that involve several stages like policy formulation, implementation and evaluation	Planned actions for transforming existing stable practice that inevitably lead to contradictions, tensions, and calls for new forms of interaction
Teachers…	Implementers of reforms	Participants and actors
Students are…	Receivers of reforms	Participants and actors
Reformative materials	To be acted upon (seldom discuss the anticipated or required changes in relationship and interaction among stakeholders)	As a mediation tool – instil new forms of interaction and relationship
Resistance	Being taken as a barrier to reform	Being taken as positive forces driving changes
Historicity	Education reforms are discrete actions, solving immediate problems or providing new directions	Educational reforms are part of the historical development of an activity system
Policy-makers	Controlling the reforms	One of the members in the community sharing the same object; members from another neighbouring activity system negotiating the object
Research focus	Implementation research and evaluation studies	Focusing on historical analyses of reformative ideas and contextualizing changes.

5 Linking Reforms and Learning: Two Levels of Conceptualization

Following Engeström (2000), the linkage between educational reforms and learning can be conceptualized in two different levels – operating within the same activity system and operating as separate but related neighbouring systems. The difference between these levels of conceptualization lies in the understanding of the object of the system. In the first level of linkage both reform and learning share the same object while the second level of linkage involves a redefinition of the object.

The first level of conceptualization has both educational reforms and learning actions classified as components operating within the same activity system. The reformative action can be taken as congruent to the operation of an existing activity system in that it shares with learning and teaching activities the same set of rules, community and division of labour in its operation. The most important consideration in determining whether a particular reform should be classified as operating in the same activity system is basically determined by the extent to which a particular reformative action and learning engagement share the same object and work towards the shared outcome. In other words, only those reforms aimed directly at changing learning and teaching activities will be qualified for this classification. The introduction of a new curriculum, the use of new technology in learning and teaching and the trial of an innovative pedagogical model are examples of this kind of reformative actions.

To understand the linkage between this type of reform and learning, we need to explore the various forms of contradictions that a particular reformative action will stir up in the activity system and to understand how its construction, development and implementation are mediated through existing rules, and different roles of participation among members in the community. The focus, therefore, is on how students and teachers appropriate the new tools made possible by the reform and to understand the affordances and constraints originating from various nodal components of the existing activity system in promoting or resisting the uptake of the reformative ideas and actions. One point we need to stress is that while both reform and learning share the object and outcome in an existing activity system, the reformative action will inevitably lead to changes in the rules, norms and membership, and their role definitions in the system.

To illustrate the linkage between a reform and learning within the same activity system, we discuss the introduction of life-wide learning strategy in Hong Kong. The educational reform in Hong Kong (Education Commission, 2000) has identified life-wide learning as a guiding principle and pedagogic strategy to promote lifelong learning and whole person development. Life-wide learning is defined as learning in real-life and authentic settings. The main purpose of this pedagogic strategy is to provide enriched learning experiences related to the school curriculum and to extend learning beyond the confines of classroom through tapping the resources in the community. In response to the calls for change, schools began to organize outside-classroom learning activities such as museum visits, trips to the mainland and elsewhere, and participating in international competition.

The extent to which this new pedagogic idea can be implemented effectively depends not just on the goodwill of reform-minded teachers. From an activity perspective, the injection of this innovative pedagogic idea to the existing Hong Kong classrooms requires changes in the norms governing the understanding of effective teaching and learning; the inclusion of new partners; and the role definitions of teachers, students and community partners in the process of schooling. This innovative pedagogic strategy relies much on students' active participation, the resources for learning, and careful planning from teachers and community partners. These requirements are incongruent with the existing pedagogical arrangement commonly found in Hong Kong schools, which are characterized by teacher-centred classrooms, tight curriculum control and textbook-based learning. Without appropriate changes in these aspects of the system, life-wide learning will be reduced to another form of extra-curricular activity or simply a change in the locale of learning without significant impact on students' knowledge acquisition and personal development.

Another concern of this form of pedagogic strategy is to evaluate it from the perspectives of different student groups. To the extent that some of the life-wide learning activities will incur extra costs for parents, students coming from disadvantaged backgrounds may not be able to participate in this reform process. Life-wide learning, which is supposed to provide students with life enrichment experiences, may unintentionally foreground the plight of the disadvantaged groups.

The second conceptualization takes education reforms and learning as two separate but related activity systems within the collective activity of schooling. The linkage between this kind of educational reforms and learning will take the form of indirect disturbance through redefining the object and outcome, and subsequently new requirements or considerations passed over to various nodal components within the learning/teaching activity system from the activity system in which the reformative action originates.

The introduction of new professional standards for teachers in the Australian state of Queensland is a good example of how learning is linked with reformative actions operating in a separate but related activity system. The Queensland College of Teachers published a new set of professional standards in 2007, which spelt out 10 important attributes teachers need to develop in order to gain entry to the teaching profession and maintain their continuing registration (Queensland College of Teachers, 2006). The 10 professional standards are clustered in three areas – teaching and learning, building relationships, and professional reflection and renewal.

These professional standards suggest a vision of learning and teaching that overtly focuses on: (i) creating a challenging learning environment that values diversity; and (ii) effectively developing and assessing students' literacy and numeracy skills. The professional standards also spell out a vision for a school community that builds on the collaboration between professional teachers and the support of families and communities in order to maintain a safe and caring learning environment for students. The commitment to continuous professional reflection and renewal is vital for maintaining these standards, and therefore has been identified as the final standard in the list.

The design, development and implementation of these professional standards involved consultation with representatives from the government, Catholic and independent schools, employing authorities, universities, teacher unions, Queensland Studies Authority and the Board of the Queensland College of Teachers. The professional standards were articulated within the context of the future needs of students in midst of the rapid social, economic, technological and cultural changes. Another consideration was the call for the establishment of explicit standards governing the entry to and continuation of membership in the teaching profession (Queensland College of Teachers, 2006).

It is apparent from what we have described above that these professional standards need to be conceptualized as a distinct activity system in education, which involves a different set of rules or concerns that governs its development, the membership of stakeholders and the construction of their roles. The subject in this activity system is the Queensland College of Teachers and the object is the population of teachers in Queensland and their professional attributes. This system should be distinguished from the activity systems that govern the daily learning and teaching activities in Queensland schools. Nevertheless, these two systems are related, and according to Engeström (2000), the overlap occurs in the definition of teachers' standards and their implications for what counts as effective learning and teaching in Queensland schools.

It is through redefining the object and outcome that these separate activity systems come to share a communal motive that provides 'continuity, coherence and meaning' for reform actions as well as for daily engagement in teaching/learning activities in classroom. The process of redefining the object and outcomes needs to be understood in light of respective rules, participants, role specifications and their complex dynamic interaction in these two overlapping activity systems.

Common to both conceptualizations of the linkage between reform and learning is the notion that the linkage between reformative actions and learning needs to be assessed within the context of either the immediate activity system or overlapping systems. The influence on learning is understood as contradiction and disturbance either from within an activity system or brought across from an interacting activity system. The conceptualization of these two forms of contradictions is in line with a Vygotskian understanding of the relationship between social and individual psychological planes, and the mediated processes that link them together.

6 Four Critical Lenses for Research

To explore effectively the conceptual linkage between reforms and learning that were discussed in the previous section, there is a need to direct our discussion using several critical lenses central to Activity Theory. In the following section, we discuss four lenses that educational researchers should consider when exploring the relationship between educational reforms and learning. These lenses are consistent with the five principles on researching activity systems that Engeström proposed: activity system as a unit of analysis, multivoicedness, historicity, contradiction and expansive transformation (Engeström, 1999, 2001). They are also in tune with major theoretical tenets of sociocultural theories (e.g. Cole, 1998). The four critical lenses are:

1. Educational reforms are reformative actions introduced into an activity system. Their influence on learning and teaching needs to be assessed using both individual and interacting activity systems as a basic unit of analysis.
2. Educational reforms deal with stable cultural practice in the schooling activity that has developed over an extended period of history. To understand how learning and teaching will be affected or how they should relate to a specific reformative action, a historical analysis is required of the continuity of existing practices and the possible assimilation of the new actions into the existing system.
3. Members within an activity system will hold diverse views of a reformative action. An understanding of diverse perspectives held by members within a particular activity system is essential for the design, promotion and implementation of an educational reform.
4. Educational reforms means disturbance to existing practice. Contradictions and tensions will be aroused because of the introduction of an educational reform. Contradiction is seen as a driving force in the successful implementation of an educational reform.

In the section below, we elaborate further on these important lenses. Examples in this volume will be quoted to illustrate the points we have made in the discussion below.

6.1 Lens 1: Basic Unit of Analysis

We need to place a particular reform in the context of either an activity system or interacting systems. This act of contextualizing will lead us to consider a reformative action in light of:

1. The mediated action between subject and object
2. Affordances and constraints originated from the rules, communities and division of labour
3. Contradiction aroused from the redefinition of object between interacting activity systems

We illustrate our discussion of these three forms of contextualized analyses using the reform of ICT in Asia-Pacific context. The use of information technology in education has been one of the most widely pursued areas of educational reform in the Asia-Pacific region. Countries such as Hong Kong, Singapore, Taiwan, Australia and New Zealand have established policies and clear guidelines for integrating ICT into classroom.

To incorporate ICT into classroom learning and teaching means that both teachers and students are able to deploy these tools in their activities and interaction with each other. Micro-analyses need to focus on factors such as students' and teachers' perceptions about ICT and their readiness to adopt it, the effective use of ICT in specific classroom activities, and the interactive skills and strategies ICT requires. For example, Lim and Chai (2004) demonstrated that it is important for teachers to plan and put in place orienting activities such as organizing introductory sessions to ICT tools in order to support students' autonomy in using the new technology. Bahr and Bahr (this volume) provided empirical results to support their claim that the appropriation of informative skills will hinge on the design of learning task. More specifically, their studies showed that cognitive load will be an important factor for teachers to consider when incorporating ICT into their classrooms. In other words, to understand whether the introduction of this new technology will affect learning and teaching, we need to understand different factors that affect its appropriation. Goos (this volume), based on sociocultural perspective, discussed how a sociocultural frame of reference can be used to assess teachers' use of graphic calculators in Australian schools. Such an analytical tool will definitely help improve our understanding of how the use of ICT mediates the relationship between teachers (subject) and students (object).

To place the mediated relationships associated with ICTs in a wider context, various constraints and affordances may originate from different constituent components of an activity system. One of the most important considerations is the rules or norms governing the notion of effective learning and teaching in different places within the region. If the introduction of the new technology does not fit well with existing norms governing how learning or teaching should be delivered in an educational site, contradictions can be expected. For example, Goos (this volume) attributed the failure of a pre-service teacher experimenting with the use of graphic calculators during her practicum to the incongruence between the established model of teaching and learning and that required by the new tools. Goos explained that the prevailing teacher-centred transmissive approach to teaching in the school community was not in tune with some of the requirements for effective use of graphic calculators such as student-centredness and problem-based approach to learning. In addition, Goos pointed out that students were unmotivated to spend time on the new tools because they were more concerned about passing assessment tasks and meeting the requirements of the curriculum. A similar result was reported in Yuen (this volume). Based on interview data, Yuen argued that the demand for achievement and the focus on learning products among Hong Kong students explained why some students were unmotivated to learn with the online platform for science.

The implementation of ICT in the Asia-Pacific region may not be as smooth as originally intended. The technology reform brings to the fore important considerations such as access, availability and capability. Goos discussed important factors such as the training of teachers and institutional characteristics in the implementation of new technology. This discussion suggested the need to evaluate the implementation of the new tool in light of separate but related activity systems, such as those governing the professional development of teachers and the development of school culture. For example, teachers' effectiveness in incorporating the new technology in their classroom depends on the extent to which they are confident and fluent in using it.

6.2 Lens 2: Historicity and Continuity

To widen our discussion of the unit of analysis, we need to acknowledge that all activity systems, including their constituent elements, evolve over an extended period and will probably continue their development into the future. In this sense, it is important to ground the analysis of a particular educational reform in an activity system in different temporal moments – historic, current and future. Activity Theory focuses our understanding on the various mechanisms that sustain the continuity of a specific collective activity and its associated cultural and social practices. From this perspective, various forms of changes can be considered as inherent parts of an evolving activity system. Educational reforms look backward to deal with something that requires modification in the historical development of a practice; they can also be taken as attempts to modify the existing practice in order to deal with emerging challenges in the future. In other words, historicity and continuity are also important considerations for educational reforms using the notion of activity system.

Every reform deals with a problem or an issue that has its own evolution within the context of its own education system. Any reformative action designed without a careful consideration of the evolution of an activity system and its likely future development may end up with rejection. Bernardo and Mendoza (this volume) discussed the current curriculum reform in the Philippines. They pointed out that the lack of consideration on the historical development of the curriculum and teachers' established perceptions about it had caused enormous resistance in the implementation.

Poon's discussion of the medium of instruction policy in Hong Kong is another example that shows the importance of the notion of historicity and continuity. A medium of instruction can be understood as an ideational artefact (in this case the use of English as the medium of instruction in a Chinese society) developed in the cultural past, carrying its meaning across time and influencing the present and the future development of the policy on medium of instruction. Her proposal for a bilingual education can be taken as a way to acknowledge the historical significance of English in Hong Kong, the current renewed interest in Chinese after the political handover and the importance of English as an international language for Hong Kong.

6.3 Lens 3: Multivoicedness

Activity systems are goal-directed. These goals are taken as shared motives within an activity system, which can be represented differently at individual levels. Through interaction enabled by various forms of tools and mediated relationships, human participants in an activity system will develop their skills, knowledge, understanding and identities, as well as redevelop those of others. Strategies for achieving or promoting the shared motive can also vary. If members within an activity system hold different perspectives, beliefs and understanding of the object, then pathways for its promotion may differ. It is critical, therefore, for us to adopt the lens of multivoicedness in our analysis of the linkage between reform and learning.

The notion of multivoicedness involves not only different perspectives but also power and control. One of the important considerations is whose voice is being represented in a particular reform and it is critical for us to understand the various events or factors that have contributed to its dominance. The current educational reforms in most of the nation states in the Asia-Pacific region privileged the economic voice. The notion of 'future effectiveness' (Cheng, 2003) has steered the development of these reforms. This is understandable because these reforms were formulated in the wake of the Asian economic crisis in late 1990s. Promoting learning has been taken as the prime solution for the future economic challenges. The Singaporean government packaged their response through the Thinking Nation reform. The development of creativity and thinking skills was called for as a strategy for promoting future effectiveness. Yeong and Ng (this volume) warned us that we need to take heed to the voices of Singaporean teachers, parents and students in order to implement the reform effectively.

The inclusion experience in New Zealand provides us with another example as to why it is so critical to consider multiple perspectives. Liberty (this volume) described how special education in New Zealand had moved from one based on a deficit-medical model of exclusion to a needs-based model of inclusion. This radical shift in the special education activity system involves a fundamental change in 'the rules' governing the provision of educational services for students with learning differences. Liberty documented resistance from school teachers and principals, parental distress and choice. These different voices were heard and adjustments were made to the reform. Her chapter clearly demonstrated how parents' choice has become more central in the process of reforming the learning of students with special needs in New Zealand. It also revealed in a rather subtle manner that some parents crafted an identity that they too should be accorded an 'expert' status when making decisions about the education of their children with special needs.

6.4 Lens 4: Contradiction and Transformation

Multivoicedness inevitably begets contradictions and tensions. From an Activity Theory perspective, contradictions are important dynamic forces driving the continuous development of an activity system. To instil change through reform actions, contradictions and tensions should not be considered as opposite or negative responses but be seen as inherently positive impulse for change. At the action level, individuals can challenge the system and the tensions aroused between individuals' preferences or intentions and the socially and culturally mediated object of activity may become starting points of change and transformation.

The work of Archer (this volume) highlighted the importance of contradiction when the goals for learning of different groups of students are taking into consideration. In particular, Archer argued that the innovative pedagogical model designed for promoting learning and engagement for students in New South Wales will meet with less success among students coming from traditionally disadvantaged backgrounds. To the extent that students' goals for learning in school contradict or are incongruent with the intended goals specified in the innovative pedagogic model, the journey for this change may be less smooth.

The most apparent contradiction happens when different but related activity systems meet or cross over each other. Engeström (2000) demonstrated this form of interaction in his studies of medical organizations in Finland. He explained that this form of contradiction is 'dangerous' but is a potential force for expansive learning and transformation and development of new or reformed practice. This argument applies well to educational reforms, especially for those reforms that we thought may have more indirect impact on teaching and learning. For example, Timperley and colleagues (this volume) explained in their chapter how a new form of professional development was developed in New Zealand. The new model of professional development is based on professional collaboration involving both teachers and university experts working on significant issues in the school. Timperley argued that this form of collaboration based on equitable interaction, sharing and empirical evidence collected on the site by both parties had been well received in the teaching community in New Zealand. This renewed practice was developed in order to replace the old model in which educational researchers positioned themselves as experts in a teachers' own professional territory– the classroom. Though they did not discuss the conflicts or contradictions between local teachers and university researchers explicitly, some tensions and perhaps conflicts can be assumed. The teachers who worked in their own learning-teaching systems could claim intimate knowledge regarding their students, curriculum in action and school environment. The researchers on the other hand would draw upon their expertise from their own system through access to research and information and theoretical knowledge on curriculum. Working with the shared object for improving learning and teaching, these two groups of 'experts' might have approached their task differently. The renewed practice Timperley described and implemented represents a new approach to teacher development evolved out of the past practice and can be considered as a product of contradiction prompted solution. Future efforts are needed to document the change processes and the contradictions involved in the development of this renewed practice.

7 Conclusion

Recent reforms in Asia-Pacific region have sought to answer educational problems using the development of new technology, formal testings, curriculum change, academic restructuring and new management practice. These strategies are thought to be responsive to future challenges posed by globalization. Nevertheless, educational researchers in the pursuit of responsiveness to future challenges may have overlooked cultural-historical embeddedness of educational practice, resulting in the injection of reform actions without thoughtful consideration of the importance of continuity and contextual considerations In this chapter, we have shown that Activity Theory can be used as a framework for conducting a cultural-historical analysis of the reforms and their possible links with learning.

In conclusion, it is our hope that the design and evaluation of educational reforms in the Asia-Pacific region, will draw upon Activity Theory more frequently to enable analysis of specific aspects of the whole system, taking into account continuity, dialogicality and multivoicedness. Activity Theory takes into account the changing context that gives meaning to individual or collective reformative actions, to the construction of outcomes or the definition of new object, and to the development and appropriation of new tools that mediate the actions and collaborative processes among individual members. The introduction of a reform action that attempts to change existing practice or various social structures that support it needs to be evaluated and analysed within the historic development of associated tools, artefacts, norms, rules, and roles among participants. While the current trend of educational reforms in most of the places within the Asia-Pacific region has been triggered by common forces such as globalization, technological development and economic transformation, we remind our readers that tremendous diversity and difference exist among educational systems within the region. This consideration cautions against the borrowing of reformative ideas from another educational system without analysing the existing cultural systems in which learning activities take place and the dynamic processes that substantiate them.

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Reforming Mathematics Education: Theorising Teachers' and Students' Use of Technology

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Abstract For some time, education researchers and curriculum policy-makers in Australia and elsewhere have recognised the potential for mathematics learning to be transformed by technologies such as computers and graphics calculators, and every Australian State and Territory has now developed mathematics syllabuses that mandate the use of these resources in high stakes assessment at the end of secondary school. This chapter explores the impact of these technology-related reforms on mathematics learning and teaching in the Australian context by analysing examples of classroom practice and teacher learning, and development drawn from a series of socioculturally oriented research studies. Its purpose is to interrogate assumptions about relationships between access to technology, its use by teachers, and the nature of students' technology-aided learning.

1 Introduction

Mathematics, science, and technology education in Australia is currently experiencing major impetus for innovation and reform. The Australian Government's policy statement on educational innovation (Commonwealth of Australia, 2001) and its recent inquiry into the quality of the teaching profession (Commonwealth of Australia, 2003) emphasise that Australia's future lies in its potential as a knowledge-based society built on the intellectual capabilities and creativity of its people. Teachers and students are expected to become partners in a learning society underpinned by science and mathematics, and successful schools are portrayed as those that draw on the resources of technology to facilitate learning.

Throughout Australia there are moves to encourage – and in some cases mandate – the integration of information and communication technologies (ICTs) into school education through curriculum initiatives, funding for infrastructure, and the development of professional standards for teachers. Facility with ICTs is regarded by most

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State and Territory education authorities as one of the essential capabilities that young people should acquire in order to participate successfully in contemporary social, economic, and cultural life (e.g., Department of Education and the Arts, Queensland, 2004; Freebody, 2005; Victorian Curriculum and Assessment Authority, 2004). Frameworks for professional teaching standards that describe what teachers need to know, understand, and be able to do also refer to integration of ICTs as an essential aspect of teachers' professional knowledge and practice (e.g., see the standards frameworks developed by the New South Wales Institute of Teachers, 2005, and the Department of Education and the Arts, Queensland, 2003). Significant funding has also been committed to providing better network infrastructure and access to improve teachers' capacity to manage the curriculum through ICTs (e.g., the *Smart Classrooms* initiative of the Department of Education and the Arts, Queensland, 2005). In the current context of educational policy-making it seems to be assumed that supplying schools with hardware and software will increase teachers' use of technology and encourage more innovative teaching approaches that produce improved learning outcomes for students. Yet internationally there is research evidence that improving teachers' access to educational technologies has not, in general, led to increased use or to movement towards more learner-centred teaching practices (Cuban, Kirkpatrick & Peck, 2001; Wallace, 2004).

Windschitl and Sahl (2002) have identified two factors that appear to be crucial to the ways in which teachers might embrace, ignore, or resist technology. First, teachers' use of technology is mediated by their beliefs about learners, about what counts as good teaching in their institutional culture, and about the role of technology in learning. Second, school structures – especially those related to the organisation of time and resources – often make it difficult for teachers to adopt technology-related innovations. Clearly then, there is a need to interrogate assumptions about relationships between access to technology, its use by teachers, and the nature of students' technology-aided learning. The chapter addresses this task by offering a framework for theorising interactions between pedagogical beliefs, school structures, and other factors that might influence technology use by teachers and students in mathematics classrooms together with analyses of several examples of classroom practice and teacher learning and development drawn from a series of socioculturally oriented research studies carried out in Australian schools.

2 Theoretical Framework

2.1 The Mathematics Classroom as a Site for Technology Integration

For some time education researchers have recognised the potential for mathematics learning to be transformed by the availability of technology resources such as computers, graphics calculators, and the internet (see Arnold, 2004; Forster et al. 2004;

Goos & Cretchley, 2004 for recent reviews of Australasian research). These technologies offer new opportunities for students to communicate and analyse their mathematical thinking by enabling fast, accurate computation, collection and analysis of data, and exploration of the links between numerical, symbolic, and graphical representations (Hennessy, Fung & Scanlon, 2001). In Australia and internationally, teacher organisations recommend giving priority to the use of technologies as natural media for mathematics learning, while recognising that effective support for teachers is a key ingredient in exploiting technology to enhance learning (Morony & Stephens, 2000; National Council of Teachers of Mathematics, 2000).

Although every Australian State and Territory has now developed mathematics syllabuses and assessment regimes that mandate the use of technology (e.g., Queensland Studies Authority, 2008), the support that teachers need for meaningful technology integration is often lacking. A recent survey of Queensland secondary mathematics teachers (Goos & Bennison, 2004) found that while most were convinced of the advantages of technology in performing calculations more quickly and easily, many were unsure whether technology really helped students to understand mathematical concepts or explore unfamiliar problems. This uncertainty was reflected in their expressed desire for professional development on how to plan activities that combine technology with mathematical concepts in order to meaningfully incorporate technology into lessons. One respondent commented that professional development should involve ‘more of why and less of how’ to use technology in mathematics teaching. These findings highlight the need for frameworks to describe, theorise, and interpret the ways that teachers and students engage in technology-enriched learning activities.

2.2 Theorising Technology-Enriched Mathematics Teaching and Learning

Early research in this area examined the effects of technology use on students’ mathematical achievements and attitudes and their understanding of mathematical concepts, often using quasi-experimental designs that compared technology and non-technology users (see Penglase & Arnold, 1996, for a review of ‘first wave’ research on graphics calculators). However these studies were based on the assumption that the same instructional objectives and methods are valid for both pen and paper and technology-enriched tasks, and they did not distinguish between the use of technology and the context of that use. In fact, few studies have investigated how students use technology to learn mathematics in specific classroom contexts, and how their teachers learn to integrate technology into their classroom practice. Those studies that have focused on *students*’ learning have taken contrasting approaches, for example, analysing technology use from a mathematical standpoint (Doerr & Zangor, 2000), in terms of profiles of student behaviour (Guin & Trouche, 1999), or from the perspective of classroom interactions (Farrell, 1996). Little attention has been given to issues of pedagogy and the nature of *teachers*' professional learning within and beyond the school environment (Windschitl & Sahl, 2002).

To address some of the issues raised above, my colleagues and I have carried out over several years a series of studies informed by sociocultural theories of learning and involving teachers and students in Australian secondary school mathematics classrooms (see Galbraith & Goos, 2003; Goos, 2005; Goos et al., 2000, 2003). Sociocultural theories view learning as the product of interactions with other people and with material and representational tools offered by the learning environment. Because it acknowledges the complex, dynamic, and contextualised nature of learning in social situations, this perspective can offer rich insights into conditions affecting innovative use of technology in school mathematics.

In our research programme Valsiner's (1997) zone theory, originally designed as an explanatory structure in the field of child development, was adapted to apply to interactions between teachers, students, technology, and the teaching-learning environment. This framework extends Vygotsky's concept of the Zone of Proximal Development (ZPD) – often defined as the gap between a learner's present capabilities and the higher level of performance that could be achieved with appropriate assistance – to incorporate the social setting and the goals and actions of participants. Valsiner describes two additional zones: the Zone of Free Movement (ZFM) and Zone of Promoted Action (ZPA). The ZFM structures an individual's access to different areas of the environment, the availability of different objects within an accessible area, and the ways the individual is permitted or enabled to act with accessible objects in accessible areas. The ZPA represents the efforts of a more experienced or knowledgeable person to promote the development of new skills. For learning to be possible the ZPA must be consistent with the individual's potential (ZPD) and must promote actions that are feasible within a given ZFM.

In the case of *student* learning the ZFM is fashioned by environmental constraints such as the particular learning experiences provided and the types of resources these incorporate, and the 'rules' by which the classroom is run. The ZPA is designed by the teacher to provide access to sets of activities, objects, or areas in the environment in respect of which students' learning is being promoted. When we consider *teachers*' professional learning, the ZFM can be interpreted as constraints within the school environment, such as students (their behaviour, motivation, perceived abilities), access to resources and teaching materials, and curriculum and assessment requirements, while the ZPA represents opportunities to learn from pre-service teacher education, colleagues in the school setting, and professional development.

Previous research on technology use by mathematics teachers has identified a range of factors influencing uptake and implementation. These include: skill and previous experience in using technology; time and opportunities to learn (pre-service education, professional development); access to hardware and software; availability of appropriate teaching materials; technical support; institutional culture; knowledge of how to integrate technology into mathematics teaching; and beliefs about mathematics and how it is learned (Fine & Fleener, 1994; Manoucherhri, 1999; Simonsen & Dick, 1997; Walen, Williams & Garner, 2003). In terms of the theoretical framework outlined above, these different types of knowledge and experience represent elements of a teacher's ZPD, ZFM, and ZPA, as shown in Table 1. However, in simply listing these factors, previous research has not necessarily considered possible relationships between the teacher's setting, actions, and beliefs, and how these might change over time or across school contexts. Zone theory provides a framework for analysing these dynamic relationships.

From a sociocultural perspective, technologies such as computers and graphics calculators are cultural tools that not only reorganise the way that students think but also transform classroom social practices (Berger, 1998). Our previous research (Goos et al., 2003) developed metaphors to describe various modes of working with technology. Teachers and students can see technology as a master if their knowledge and competence are limited to a narrow range of operations. In the case of students, subservience may become dependence if lack of mathematical understanding prevents them from evaluating the accuracy of the output generated by the calculator or computer. For teachers, lack of knowledge and experience can make them reluctant to allow students to use technology to explore new mathematical concepts.

Technology is a *servant* if used by students or teachers only as a fast, reliable replacement for pen-and-paper calculations. That is, technology is a supplementary tool that amplifies cognitive processes but is not used in creative ways to change the nature of activities. However, when teachers develop an affinity for technology as a *partner*, there is potential for increasing the power that students exercise over their learning by providing access to new kinds of tasks or new ways of approaching existing tasks. For students, this cognitive reorganisation effect may involve using technology to facilitate understanding, explore different perspectives, or mediate mathematical discussion in the classroom. Technology becomes an *extension of self* when seamlessly incorporated into the user's pedagogical or mathematical repertoire, such as through the integration of a variety of technology resources into course planning and the everyday practices of the mathematics classroom. These metaphors can be used to gauge the effectiveness of technology integration within mathematics classrooms in terms of qualitative differences in the nature of students' technology-mediated learning experiences and in the pedagogical approaches taken by their teachers.

Table 1 Factors affecting technology usage

Valsiner's Zones	Elements of the Zones
Zone of Proximal Development	Skill/experience in working with technology
	Pedagogical knowledge (technology integration)
	General pedagogical beliefs
Zone of Free Movement	Access to hardware, software, teaching materials
	Support from colleagues (including technical support)
	Curriculum and assessment requirements
	Students (perceived abilities, motivation, behaviour)
Zone of Promoted Action	Pre-service education (university programme)
	Practicum and beginning teaching experience
	Professional development

3 The Research Programme

The research programme referred to above has investigated relationships between factors influencing how teachers use technology in the mathematics classroom, and relationships between teacher use of, and student learning with, technology. Examples from three separate studies are analysed later in the chapter. An outline of the research design and methods for each study is provided below.

3.1 Study A: Technology, Pedagogy, and Student Learning

This study examined how technology enters into the mathematical and pedagogical practices of students and teachers (Goos et al., 2000, 2003). Data collection over 3 years from 1998 to 2000 involved five senior secondary mathematics classrooms from three schools in a large Australian city. Students participating in the study were in either Grade 11 or Grade 12, the final 2 years of secondary schooling, and were 15–17 years old. While at the time of the study the approved mathematics syllabuses did not yet mandate the use of graphics calculators and computers, teachers were strongly encouraged to make use of these technologies wherever appropriate. All classes had ready access to graphics calculators as well as desktop or laptop computers equipped with generic and mathematical software.

Since the aim of the study was to investigate students' and teachers' use of technology in specific classroom environments, research methods drew on ethnographic techniques such as participant observation, interviews, survey instruments, and collection of video- and audio-taped records. At least one lesson every week was video-taped and observed for each participating classroom, and selected segments of the tapes were transcribed for later analysis. Field notes of each lesson were also kept to record details of classroom tasks, teacher actions, and student actions involving technology usage. Audio-taped interviews were conducted with individuals and groups of students to examine the extent to which they thought technology contributed to their understanding of mathematics, and their perceptions of how technology changed the teacher's role in the classroom. At the beginning and end of Grade 11 and the end of Grade 12 students also completed a questionnaire on their attitudes towards technology and its role in learning mathematics (see Geiger, 2005, for details of questionnaire instruments and findings).

As we intended to inductively derive theory from data, classroom observation was initially exploratory in nature but became increasingly focused and selective as patterns emerged in the data. A consequence of this process was the testing and progressive refinement of the categories used to interpret the data in the light of further observations, interviews, and students' questionnaire responses. From this process emerged the four metaphors of technology as *master*, *servant*, *partner*, and *extension of self* that were used to frame analysis of classroom interactions. Following the adaptation of Valsiner's zone theory for use in the later studies described below, some of this classroom data were re-analysed using zone concepts.

3.2 Study B: Technology-Focused Professional Development

The second study, conducted in 2001, aimed to analyse processes through which mathematics teachers learned to use technology as an educational resource (Galbraith & Goos, 2003). Participants were a group of ten experienced teachers who volunteered for a training programme that prepared them to deliver professional development workshops on the use of graphics calculators. The training programme, conducted intensively over a single weekend, drew on the findings of Study A in emphasising teaching roles that treated technology as a *partner* that facilitates classroom discussion rather than a *servant* that simply replaces pen-and-paper calculations. These sessions engaged participants as learners in technology-rich activities that could be used in secondary school classrooms, and in discussion of associated teaching and learning issues. Many of these activities had been observed in the classrooms participating in Study A, and one of the teachers in this earlier study helped to present the training programme. All sessions were recorded on video-tape.

During the year we then followed the progress of three of the teachers who subsequently delivered professional development workshops at conferences or in their own schools, and interviewed them on how their views about technology had been affected by the training programme. In December 2001, we observed several sessions of a two day technology workshop organised and presented by one of these teachers in her role as Mathematics Head of Department for the benefit of mathematics teaching staff in her school. We interpreted this teacher's professional learning experiences using Valsiner's zone concepts as well as the technology metaphors developed in Study A.

3.3 Study C: Technology and Beginning Teachers

The main aims of the third study were to identify factors that influence how beginning teachers integrate computers and graphics calculators into their mathematics teaching practice, and to identify the modes of working with technology they adopt (Goos, 2005). The longitudinal design followed successive cohorts of pre-service students into their first years of teaching from 2000 to 2004. Participants in each year comprised the full cohort of Bachelor of Education students specialising in secondary mathematics education at a university in a large Australian city (typically $n = 20$ students per year). A feature of this course is the regular and intensive use of the internet, graphics calculators, and computer software, and exploration of the possibilities offered by these technologies for mathematics teaching.

The research design had two components: a cohort study of the group as a whole; and individual case studies of selected participants. In the cohort study all participants completed (a) a survey of their practicum schools to record information on the availability of technology resources, how often these were used in mathematics lessons, and for what purposes; and (b) a questionnaire administered at the start and end of the course that investigated their beliefs about the nature of mathematics, mathematics teaching, and mathematics learning.

Case studies captured developmental snapshots of experience during the final practice teaching session and towards the end of the first and second years of full-time teaching. Four to six cases were selected from the new pre-service cohort each year to sample practicum school settings that differed in terms of the ZFM (institutional context) and ZPA (supervising teacher approaches) they offered. These participants were also chosen because of the interest and skills they demonstrated in using technology and the beliefs they expressed about student-centred, inquiry-based approaches to teaching mathematics (ZPD). It was anticipated that their experiences in schools could provide insights into how they dealt with obstacles or took advantage of opportunities in incorporating technology into their pedagogical repertoire. They were visited in their schools at the times described for lesson observations, collection of teaching materials, and audio-taped interviews. Interviews had both a specific focus on the pedagogical beliefs that influenced the goals and methods of the observed lessons, and a more general focus on the opportunities participants had to use technology in mathematics lessons, their perceptions of constraints and opportunities affecting their use of technology, and their views on the influence of technology on mathematics curricula, learning, teaching, and assessment.

Analysis of classroom observations and teaching materials was guided by the *master*, *servant*, *partner*, and *extension of self* metaphors to describe modes of working with technology, while responses to surveys, questionnaires, and interviews were categorised as representing elements of participants' ZPDs, ZFMs, and ZPAs. This approach enabled exploration of how personal, contextual, and instructional factors came together to shape novice teachers' pedagogical identities as users of technology.

4 Selected Findings: Technology Access, Teacher Use, and Student Learning

4.1 How Is Teachers' Use of Technology Related to Students' Learning?

Study A provided contrasting examples of how teachers used technology in mathematics classrooms and the implications this has for students' learning. Valsiner's zone theory and metaphors for modes of working with technology were applied to interpret these relationships.

4.1.1 Teacher Use of Technology Constrains Student Learning

Jack was Head of the Mathematics Department in a large suburban secondary school participating in Study A. He was active in organising professional development seminars for his staff and teachers from neighbouring schools, and had equipped his own department with a range of technology resources including computers, software, and graphics calculators. However, he admitted limited expertise in using technology himself for teaching mathematics. He often countered his own lack of confidence by calling on a recognised student 'expert' to demonstrate graphics calculator procedures via the overhead projection unit. While the teacher lacked personal autonomy in the use of technology (suggesting that technology had the role of *master*), he nevertheless retained tight control of the lesson through the medium of the student presenter (thus technology was used as a *servant*) – often to the extent of providing the mathematical commentary and explanations accompanying the student's silent display. Even when the student instructed the class on calculator keystrokes, Jack's voice could still be heard in the student's articulation of carefully controlled, step-by-step procedures consistent with his preferred methods. Ultimate authority rested with the teacher, who remained reluctant to allow students to use technology to explore mathematical territory that was unfamiliar or outside the immediate lesson topic.

The edited excerpt below illustrates how Jack introduced his students to the use of graphics calculators in order to learn about some features of quadratic functions. Figure 1 provides sample screen pictures from the graphics calculator display.

> **Jack:** Do not turn on the calculator until directed to do so and do only what I ask you to. If you get lost following the OHP demonstration unit raise your hand immediately.
> (Demonstrates procedure for clearing calculator screen)
> **Jack:** Is your screen the same as mine? Hands up, 'yes'. (Students raise hands) Hands up, 'no'. (Students raise hands) Hands up, 'I haven't done it yet'?
> (Demonstrates successive keystrokes needed to draw the graph of $y = x^2$ which students copy. There is some discussion of outcome.)
> **Student:** Yeah, but you can zoom in … and find stuff (referring to calculator Zoom function that allows inspection of different parts of the graph).
> **Jack:** But to zoom in wasn't part of what we were supposed to be doing.

Effectively the ZPA that Jack designed has caused him to constrain the scope of the students' ZFM by demanding that they reproduce the demonstrated keystrokes. Forbidding them to explore the Zoom function of their graphics calculators thus restricted students' capacity to address the mathematical topic. It is arguable that the students' ZPDs in this classroom were not fully exploited, and students itching to explore were precluded from doing so.

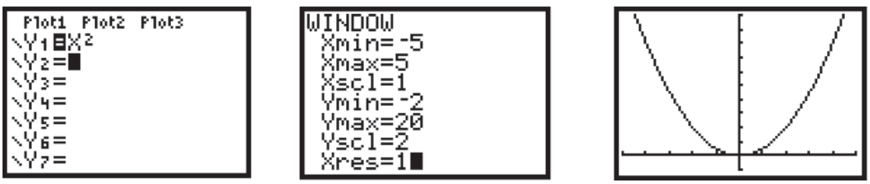

Fig. 1 Sample calculator screens for graphing $y = x^2$

4.1.2 Teacher Use of Technology Facilitates Student Learning

In another school participating in Study A, Steve was Head of the Mathematics Department and an expert and innovative user of technology. He wanted to foster similar expertise in his students – not through detailed instruction on keystrokes, but by providing tasks that required students to use technology as an intelligent *partner*. A brief vignette involving graphics calculator programming illustrates this point.

The students were asked to program their calculators to find the angle between two three-dimensional vectors $\mathrm{r}_1 = \begin{pmatrix} a \\ b \\ c \end{pmatrix}$ and $\mathrm{r}_2 = \begin{pmatrix} d \\ e \\ f \end{pmatrix}$, which is given by the formula

$$\vartheta = \cos^{-1}\left(\frac{\mathrm{r}_1 \quad \mathrm{r}_2}{|\mathrm{r}_1||\mathrm{r}_2|}\right) = \cos^{-1}\left(\frac{ad + be + cf}{\sqrt{a^2 + b^2 + c^2}\sqrt{d^2 + e^2 + f^2}}\right)$$

The teacher provided only minimal instruction in basic programming techniques, and expected individual students to consult more knowledgeable peers for assistance. Volunteers then demonstrated their programs via the overhead projection unit, and examined the wide variation in command lines that peers had produced (see Fig. 2 for examples).

This public inspection of student work also revealed programming errors that were subsequently corrected by other members of the class. For example, the class disputed the answer obtained by executing the programme shown in the first screen of Fig. 3.

Following the instructions of fellow students, the presenter scrolled down through the programme and replaced the plus sign with a multiplication sign between the two bracketed terms in the denominator (Fig. 3, second screen). The output of this amended programme was again challenged by his audience, one of whom located the offending element of the programme where multiplication instead of addition signs had been entered in the second term of the denominator. The presenter made this correction (Fig. 3, third screen) and executed the programme once more, with the appearance of the correct answer being greeted with cheers and applause from his classmates. When interviewed after the lesson, students commented that programming not only saved time with calculations (technology as *servant*), but also

Fig. 2 Different student programmes for finding angle between vectors

Fig. 3 Correcting errors in a student programme

helped develop a more thorough understanding of the underlying mathematical concepts, especially when there were opportunities to compare the efficacy of programmes written by different people (technology as *partner*).

In this classroom students were free to collaborate with peers in pursuit of solutions to problems for which technology was of material assistance in the mathematical processing required. A more public forum for interaction occurred when students were invited to present their calculator work to the whole class via the overhead projection unit. Thus the ZPA was designed by the teacher to engage with students' ZPDs by enabling them to form and defend mathematical conjectures. This ZPA is also consistent with the ZFM representing the classroom learning environment in the sense that there were no restrictions on the technology resources available, or on students' access to the knowledge resources of their peers.

4.2 What Factors Interact to Influence Teachers' Use of Technology?

The classroom examples presented above demonstrate that teachers' approaches to using technology for mathematics education are not dependent on 'access' in any simple or straightforward way. Jack and Steve had easy access to technology resources; yet technology-aided teaching and learning were enacted quite differently in their respective classrooms. Further examples from Studies B and C involving experienced and novice teachers illustrate multifaceted relationships between teachers' access to technology and other factors influencing use. How they learn to integrate technology into their practice can be conceptualised in terms of changing relationships between their ZPDs, ZFMs, and ZPAs, while their learning trajectories can be traced by identifying changing modes of technology usage.

4.2.1 Case Study of a Novice Teacher

Sandra was one of the pre-service participants in Study C selected for individual case study. Her practicum placement was in a large school in the State capital city. At this time the mathematics syllabuses merely encouraged teachers to use computers and graphics calculators, although new syllabuses to be introduced the following year would make technology use mandatory. The school was well equipped with computer laboratories and had recently purchased its first class set of graphics calculators. However, none of the teachers had yet found time to learn how to use the calculators. Sandra was very familiar with computer applications such as Excel and regularly searched the internet for teaching ideas and resources. She used both these technology resources in her mathematics teaching during her practice teaching sessions, although she had not observed other teachers in the school use any kind of technology with their classes. Before starting the pre-service course Sandra had no experience with graphics calculators but she was now keen to explore the possibilities this technology might offer for developing students' understanding of mathematical concepts.

Sandra was teaching linear programming, a topic that deals with the kind of optimisation problems commonly encountered in engineering and economics. A typical example would be maximising the profit in a factory that manufactures a number of different products from the same raw materials using the same resources. As graphical methods are usually used to solve linear programming problems in secondary school treatments of this topic, Sandra decided this presented an ideal opportunity for students to use the graphics calculators instead of drawing graphs by hand. Here she envisaged using technology as a *servant* to save time and improve the accuracy of solutions. She adapted an activity from the internet that asked students to work out the optimal quantities to be produced of two different kinds of pasta, using three different varieties of cheeses, so as to ensure maximum profit for the manufacturer. Part of the graphical solution is shown in Fig. 4. (The enclosed region contains values for the number of batches of each type of pasta that can be made from the amount of cheeses in stock. The profit function, represented by equation Y4, has its maximum value at a vertex of this region.) Because the students had never used graphics calculators before, she also devised a worksheet with keystroke instructions and encouraged students to work and help each other in groups.

Unexpectedly, Sandra encountered strong resistance from the students, which seemed to stem from their previous experiences of mathematics lessons. Other mathematics teachers in the school tended to take a very transmissive approach and focused on covering the content in preparation for pen-and-paper tests, so the students were not interested in learning how to use technology if this would be disallowed in assessment situations. According to Sandra, the students' attitudes could be summed up as: 'Just give me enough to pass … I don't want to know how to do group work, I don't want to know how to use technology.'

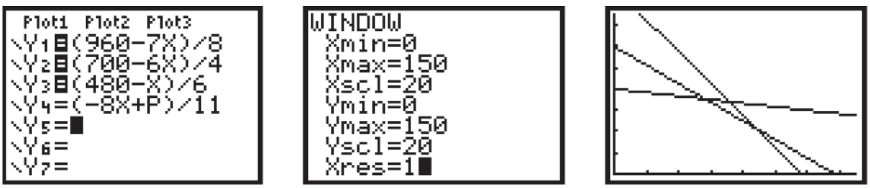

Fig. 4 Calculator screens for graphical solution of a linear programming problem

In theoretical terms, the ZPA offered by the teachers in the school was not a good match with the ZPD defined by Sandra's pedagogical beliefs and her knowledge and skills in using technology to teach mathematics. Neither did her supervising teacher's ZPA provide a pedagogical model consistent with the technology emphasis of the pre-service course. Some elements of Sandra's ZFM, such as her easy access to calculators that no other teacher knew how to use, presented favourable opportunities to use technology. However, most other aspects of her ZFM – students' attitudes and lack of motivation, curriculum and assessment requirements that excluded technology – represented constraints. Yet Sandra was not discouraged by this experience and remained committed to enacting her pedagogical beliefs about using technology.

After graduation Sandra moved from the city to a smaller rural school that was much better resourced with respect to graphics calculators but lacking in experienced teachers who knew how to use them effectively. All Grade 11 and 12 mathematics students had continuous personal access to graphics calculators via a hiring scheme operated by the school, and there were two additional class sets available for teachers to use with other classes – although Sandra was the only teacher to use these with younger students. She was also beginning to incorporate into her teaching data-logging equipment such as temperature probes and motion detectors which could be used in conjunction with graphics calculators to collect and analyse data from experiments. This equipment gives students access to new kinds of tasks that develop deeper understanding of mathematical concepts, suggesting a shift on Sandra's part towards viewing technology as a *partner*.

Compared with her practicum experience, Sandra's first year of teaching offered a more expansive ZFM: motivated and cooperative students, good access to technology resources, and new syllabuses that mandated use of computers and graphics calculators in Grades 11 and 12. Yet there was no ZPA within her school environment, and geographical isolation, compounded by a very slow internet connection, made it difficult for her to access professional development and teaching materials (an external ZPA). While she was still able to draw on the knowledge gained during her university programme (the pre-service ZPA), Sandra recognised her need to gain new ideas via collaboration with other more experienced teachers beyond the school in order to further develop her identity as a teacher for whom technology was an important pedagogical resource.

4.2.2 Case Study of an Experienced Teacher

Teachers who completed their pre-service education before computers and graphics calculators were introduced into school classrooms rely on formal or informal professional development to learn how to use technology. By comparison with Sandra, Lisa was an experienced teacher but a relative novice in the use of technology when she participated in the graphics calculator training programme described in Study B. When reflecting on her initial professional development experiences in this field, her comments suggest that, for her, technology was her *master*, since she 'got lost in the first ten seconds, and was really turned off so didn't touch them again for a while'. After several more workshops she felt confident enough to use graphics calculators in her teaching, but only in *servant* mode:

> I was [using graphics calculators], but not confidently and not proficiently. Not really realising how much they improved the thinking. More just as a tool to do graphs and things.

The training programme offered as part of this research study proved to be a turning point for Lisa as it emphasised the impact of technology as a *partner* in pedagogy rather than focusing on 'pushing buttons'. In the interview excerpt below she refers to an activity that investigated the periodic, oscillating motion of an object suspended from a spring. A data-logging instrument was used to record the motion of the object. This information was downloaded to graphics calculators and a plot produced of the object's vertical distance from the ground against time (as in Fig. 5). Participants then had to fit a mathematical function to the data and present their work to the group using the overhead projection unit.

> It was out of that week-end that I really understood the impact that [graphics calculators] had on the pedagogy. Up to then I saw it as a tool to draw graphs and analyse statistics. But at that workshop, just one little thing from that workshop, how we were working in groups, and they explained to use how kids start trying to help. So when we were doing that we were grabbing somebody else's calculator and sharing our data, so it made the group work thing a whole lot better. And I really valued the part where we, as groups, we went out and used the overhead projector and we presented our information back to the group. So I just, I really started to see different ways of using it that I hadn't thought of before. So it really enhanced group work, it really showed me that you could do a lot more hands on stuff, the practical activity with the motion detectors. That graphics calculators are good for inspiring all those other good things in teaching, like the hands on, the group work, and really starting to think when we were fitting functions to the data. Really having to think and understand what the intercept and the gradient mean. We weren't just *doing*, we were really *understanding* at a higher level. I found that really powerful. Because I had thought that all they do is save you that boring part of maths.

Environmental constraints and affordances (ZFM) seemed to play little part in Lisa's learning, possibly because as Head of her school's Mathematics Department she had considerable autonomy in obtaining desired resources and in managing curriculum and assessment programmes. Instead, the reconstruction of her identity as a teacher can be understood in terms of the changing relationship between her

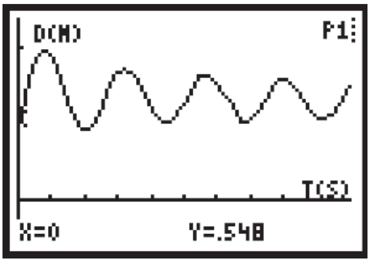

Fig. 5 Graphics calculator graph of object suspended from a spring (vertical distance from ground vs time)

goals and interests (ZPD) and the ZPAs offered by the professional development and training she experienced. The early workshops she attended were described as 'off-putting', because the emphasis was on procedural aspects of operating the calculators and the mathematics presented was too difficult for participants to engage meaningfully with the technology. She contrasted this with the approach taken in the week-end workshops offered as part of this research project:

> I didn't really feel super confident until I went to the workshop (…) And I think it was then, understanding the bigger concepts, rather than just pushing buttons. Because at the pushing buttons level you never really understand how they operate. And after that I was just so inspired. It was just tremendous to meet teachers that came from all over the State to share with them, and the fact that (…) the real gurus of technology and maths were there, prepared to give up their week-end … it was just the way we were treated … It was just that whole valuing and that sharing and learning from each other, and just to realise that other people are out there. So that was really the turning point for me to say that this is really exciting stuff.

Thus Lisa seemed to find a professional development ZPA that matched her need to focus on pedagogical, rather than procedural, aspects of using technology, and acknowledged the potential for experienced teachers to teach and learn from each other.

5 Implications for Technology-Enriched Reform of Mathematics Learning and Teaching

This chapter has considered key questions in analysing relationships between mathematics teachers' access to technology resources, the ways in which they incorporate these resources into their pedagogical practices, and the nature of student learning that results. In doing so it has examined assumptions that appear to underpin current education policies concerning integration of ICTs into curricula and teaching (Fig. 6). Evidence from research studies carried out in Australian classrooms suggests that simple notions of 'access' and 'use' are inadequate for understanding the roles that technology plays in mathematics teaching and learning. The case studies of Sandra and Lisa showed that teachers interpret access to technology in relation to what they believe is beneficial for students and feasible in the light of their own expertise and institutional context. Teachers can also use technology in

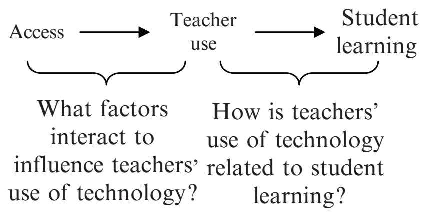

Fig. 6 Questioning assumptions about technology access, use, and learning

ways that either hinder or facilitate students' mathematics learning, as illustrated by episodes from the classrooms of Jack and Steve.

Early recommendations about preparation for teaching with technology assumed that teachers needed only general technological literacy. It is now recognised that knowing how to use computers and other forms of technology is not the same as knowing how to teach effectively with technology (Wallace, 2004), since pedagogical content knowledge (Shulman, 1987) is required to integrate technology into the curriculum in specific subject domains. Pedagogical content knowledge, which enables teachers to create mathematical representations that connect students with the subject matter, is at the heart of teaching effectively with technology and is embodied in the metaphors for technology as *master*, *servant*, *partner*, and *extension of self* described in this chapter.

The opportunities that teachers provide for technology-enriched student learning are also affected by ways in which they interpret and analyse problems of practice. How do teachers justify and enact decisions about using technology in their classrooms? How do they negotiate potential contradictions between their own knowledge and beliefs about the role of technology in mathematics education and the knowledge and beliefs of their colleagues? How do they interpret aspects of their teaching environments that support or inhibit their use of technology? These questions, when framed within a sociocultural perspective, allow us to systematically investigate conditions affecting teachers' and students' use of technology in mathematics classrooms through the application of Valsiner's zone theory – where the ZPD represents an individual's potential for learning, the ZFM environmental constraints, and the ZPA the nature of the specific activities designed to promote new skills and understanding.

Different ZPD/ZFM/ZPA configurations produce quite different learning opportunities for students, and for teachers. Consider first the implications for students' learning. While teachers construct activities (ZPAs) consistent with their pedagogical beliefs and learning goals for students, these planned activities may or may not be consistent with the learning resources accessible to students (ZFMs). For example, students may lack access to technology resources, the range of such resources may be restricted, or ways in which students are permitted to exploit the potential of available resources may be curtailed. The episode from Jack's classroom underlined the frustration experienced by students who wanted to use a graphics calculator function (zooming) that was outside the teacher's prescription. The teacher imposed actions (restricted the ZFM) to conform to a limited ZPA that excluded other calculator functions and other students. By contrast, Steve's pedagogical approach (ZPA) of encouraging students to propose conjectures, defend solutions, and suggest alternatives was consistent with a classroom ZFM that gave unrestricted access to various types of technology and permitted students to share material and intellectual resources.

Teachers' learning can also be conceptualised in terms of ZPD/ZFM/ZPA relationships, and this provides a useful way of analysing teachers' responses to reform and the extent to which they adopt innovative practices involving technology. For teachers, the ZFM can be interpreted as their institutional context, the ZPA represents their experiences in learning about teaching with technology, and the ZPD is influenced by their knowledge of how to integrate technology into their teaching and their pedagogical beliefs. As with students, learning is only possible if the ZPA is consistent with the individual's need and potential (ZPD) and promotes teaching actions believed to be feasible, that is, within the effective ZFM. The case study of Lisa illuminated issues facing experienced teachers who are unfamiliar with new technologies such as graphics calculators. While her ZFM presented few constraints, she had to search for professional development (ZPA) that would extend, rather than only accommodate, her existing ideas about teaching with technology (her ZPD). On the other hand, teachers like Sandra who are knowledgeable and enthusiastic about using technology may encounter obstacles in their professional environment (ZFM) that hinder implementation of preferred teaching approaches.

6 Implications for Reforming Learning Within the Asia-Pacific Region

Although the arguments presented in this chapter are based on research carried out in Australian classrooms, many other countries in the Asia-Pacific region are grappling with similar issues concerning integration of ICTs into mathematics teaching and learning. For example, commentaries by researchers in Hong Kong and Singapore highlight discrepancies between the potential value of ICTs and their limited use in secondary school mathematics classrooms, despite generous government resourcing of schools and extensive teacher professional development programmes (Jones, Ng, & Tang, 2006; A. Leung, 2006; F. Leung, 2006). They suggest that teacher knowledge and beliefs, curriculum and assessment policies, and local cultural values are the key factors influencing technology integration in these countries. This final section of the chapter applies the theoretical frameworks developed earlier to discuss implications of technology-based reform of mathematics education in the light of local conditions in Hong Kong and Singapore.

6.1 Technology-Related Mathematics Education Reform in Hong Kong

The former British colony of Hong Kong returned to the People's Republic of China in 1997 under a 'one country, two systems' governing structure. One of the aims of the newly established government of the Hong Kong Special Administrative Region (SAR) was to transform schools into technology-rich educational environments to meet the needs of a rapidly changing society. In 1998, the government announced an ICT education strategy, with a 5-year target for teaching in at least 25% of the curriculum to be supported through ICTs (Education and Manpower Bureau, The Government of the Hong Kong SAR, 1998). The government committed extensive resources to meeting this target and now claims that most schools are well equipped with computer laboratories, data projectors, intranet and internet access (A. Leung, 2006). Specific support for integrating technology into mathematics education is provided by the government, professional associations, and textbook publishers in the form of exemplary teaching materials and professional development seminars (e.g., Education and Manpower Bureau, The Government of the Hong Kong SAR, 2002, 2006).

While this brief summary suggests that mathematics teachers in Hong Kong should enjoy a ZFM with few constraints in terms of access to resources, local curriculum and assessment requirements are the significant elements of the ZFM that work against technology integration in mathematics classrooms. The TIMSS 2003 study (Mullis et al., 2004) reported that the Hong Kong national curriculum does not contain a statement supporting the use of calculators or computers. In contrast to the optimistic picture presented by the government policy initiatives outlined above, Hong Kong teachers participating in the TIMSS study stated that computers were not available for 61% of their Grade 8 mathematics students (compared with 46% of Australian Grade 8 students of teachers in the same study), and that computer use as often as in half of Grade 8 mathematics lessons was almost non-existent (similar to the Australian TIMSS findings). In addition, the high stakes public examination in mathematics at the end of secondary school does not permit students to use graphics calculators. Not surprisingly in the light of these conditions, local mathematics education researchers report negligible use of graphics calculators in secondary schools (Jones, Ng & Tang, 2006).

Analysis of the Hong Kong context in terms of contradictions between the ZFM and ZPA demonstrates that no amount of resourcing and professional development will persuade large numbers of teachers to embrace technology if the curriculum and assessment regime do not require it. Another contradiction emerges from research that has studied Hong Kong teachers' pedagogical strategies when introducing technology into the mathematics classroom. In one of the few studies of this kind, Mok and colleagues (2000) carried out a teaching intervention in a Hong Kong classroom where 15-year-old students used graphics calculators to study algebra and functions. The intervention drew on research from Western countries linking effective technology integration with student-centred teaching approaches and exploratory or investigative tasks (technology as *partner* or *extension of self*). However, implementation of this approach created difficulties for the teacher because it did not fit with the procedural emphasis of the existing Hong Kong mathematics curriculum and the traditional expository style of teaching common to most Hong Kong mathematics classrooms (favouring use of technology as *servant*). While the tensions experienced by the teacher could be conceptualised as a mismatch between the efforts of the researchers to develop new teaching actions (ZPA) and the teacher's pedagogical knowledge and beliefs (Zone of Proximal Development), Mok and colleagues, and other Hong Kong researchers (e.g., F. Leung, 2006) additionally invoke the mediating influence of local cultural values on teacher beliefs and practices. Within Confucian Heritage Cultures (CHC) – such as in Hong Kong and Singapore – the teacher is regarded as the respected source of knowledge and there is a commitment to helping students master fundamental techniques and knowledge as a strong foundation for further conceptual development. To an uninformed Western observer, teaching in CHC classrooms appears to emphasise memorisation of content and repeated practice of skills; nevertheless, teaching and learning interactions in such classrooms are founded on a deep cultural belief that skilfulness (knowing and doing something well) can bring about cleverness and creativity (Watkins & Biggs, 1996). Perhaps, in these circumstances, there needs to be a re-conceptualisation of role of technology as a cultural tool that transforms the nature of mathematics and how it is taught and learned, and further investigation of 'culture' as bridge between teachers' personal knowledge and beliefs (ZPD), and the contexts in which they practise (ZFM).

6.2 Technology-Related Mathematics Education Reform in Singapore

As in Hong Kong, the government of Singapore has developed policies supporting use of ICTs in school education (Ministry of Education, Singapore, 2002). According to the TIMSS 2003 study (Mullis et al., 2004), the Singapore national curriculum does embody a policy regarding use of computers in mathematics, and Singapore teachers participating in this study stated that computers were unavailable for only 33% of their Grade 8 mathematics students. The percentage of Grade 8 students whose teachers reported using computers in at least half of Grade 8 mathematics lessons was still very low (3–4%), but above the international average (2%) and higher than that reported in Australia and Hong Kong. Of more interest from the perspective of mathematics education is the move to mandate use of graphics calculators in the senior secondary years (Ministry of Education, Singapore, 2005). Since 2002, the small group of mathematically able students taking advanced mathematics in senior secondary school has been permitted to use graphics calculators in the public examination, but the examination questions were written in 'calculator neutral' form so as not to disadvantage those students who did not use them. The new advanced mathematics curriculum implemented in 2006 assumes all students will have access to graphics calculators when sitting the public examination from 2007, and development of 'calculator active' examination questions is now a priority (Ng, 2006). For this reason, teachers are most interested in how graphics calculators will affect their assessment practices, and little attention seems to have been given to the potential for this new technology to change the nature of the school mathematics curriculum and how mathematics is taught.

Integration of calculators is supported by extensive professional development programmes (e.g., Ministry of Education, Singapore, 2006), and students generally have continuous personal access to a graphics calculator via ownership or hire schemes. In terms of Valsiner's zone theory, there is a degree of consistency between the ZFM (professional environment: access to graphics calculators, curriculum, and assessment requirements) and the ZPA (professional development)

30399 Use of Graphing Calculators in the Learning of Mathematics (Sec)
Design and develop learning activities using Graphing Calculators to handle mechanical computation efficiently, thus allowing students to focus on the concepts and problem-solving skills.
Duration: 9 hours
Target Audience: Sec Teachers
Workshop Dates: 18 Apr, 25 Apr & 2 May 2007

Fig. 7 Synopsis of a professional development workshop on graphics calculators offered by the Singapore Ministry of Education (Source: http://www.moe.gov.sg/edumall/pro_develop/maths.htm)

that is lacking in Hong Kong. However, the tenor of at least some professional development workshops offered by the Singapore Ministry of Education suggests that technology is viewed only as a *servant* for relieving computational burden (see Fig. 7).

The current situation in Singapore has some parallels with the introduction of graphics calculators in the Australian state of Victoria in the late 1990s. A recent study comparing Singapore and Victorian secondary mathematics teachers' use of and beliefs about graphics calculators is illuminating in this regard (Tan & Forgasz, 2006). Conducted before the implementation of the new Singapore advanced mathematics curriculum, the study found that Singapore teachers, compared with their Victorian counterparts, were less experienced and less proficient in using the calculators, and less certain that they helped students to understand mathematics better. These findings highlight the need to address teachers' knowledge and beliefs about the role of technology in learning mathematics (their ZPD) as part of any ICT related reform initiative.

7 Conclusion

Researchers and policy-makers in Hong Kong and Singapore have looked to Western countries for models of curriculum and pedagogical reform to guide integration of technology into mathematics education. However, there are risks in simply transplanting models from one country and culture to another, and the lessons learned from the West need to be re-evaluated in local contexts through local, classroom-based research. The theoretical approach outlined in this chapter provides a way of interpreting teachers' and students' actions in mathematics classrooms that goes beyond comparisons of 'with-technology' and 'without-technology' lessons or simple assumptions that 'access' to technology will guarantee use and improve student learning. It may also generate informed discussion about conditions that support or inhibit teachers' learning and adoption of new technologies across different cultures.

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Reforming Learning and Teaching Through Online Collaborative Knowledge Building

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Abstract In the past decade, educational innovations using information and communication technologies have been increasingly embedded within a broader framework of educational reforms in different parts of the world. It is within such a reform context that this chapter explores students' and teachers' authentic experiences in a science curriculum innovation, in which students and teachers from five primary schools in Hong Kong engaged in online collaborative knowledge building. Thirty students and eleven teachers from five primary schools were interviewed. Their conceptions of the new experiences were built on cross-case analyses of their personal accounts of this unique pedagogical experience. A total of six student categories of descriptions and six teacher categories of descriptions emerged out of their views and experiences of using the new technologies for learning and teaching science. The findings alert us to the importance of understanding students' and teachers' conceptions of experiences in integrating ICTs in the school curriculum.

1 Introduction

The call for integrating information and communication technologies (ICTs) in education coincides with the emergence of globalised knowledge-based economies that require their knowledge workers to develop critical attributes such as lifelong learning, sustained motivation and autonomy (Drucker, 1999). Sharing this frame of mind, some researchers have argued that it is critical for our school systems to produce graduates capable of creating new knowledge and knowing how to gain advantages from learning, using and reflecting on it (Bereiter, 2002). ICTs are among the essential knowledge and skills privileged in a globalised economy. It is therefore unsurprising that educational reforms in many countries have adopted the integration

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of ICTs in education as a way to promote learning (Anderson, 2003; Pelgrum & Anderson, 1999). For example, the Singapore Government announced a master plan for the development of ICTs in 1997 (Ministry of Education, Singapore, 1997). Like its Asia-Pacific partners, Hong Kong has put in place policy initiatives regarding the use of ICTs in education. Following the 1997 Policy Address by the former Chief Executive Tung Chee Wah, the Hong Kong Government published its policy statement on ICTs in education in the *Information Technology for Learning in New Era – Five Year Strategy* (Education & Manpower Bureau, Hong Kong, 1998). This policy statement promoted the use of ICTs across the school curriculum and highlighted the significance of abilities to seek, evaluate and organise information using new technologies. To integrate ICTs into the school curriculum effectively, this policy envisioned significant pedagogic change in schools.

> To respond to these new requirements, our school education needs to see a paradigm shift—from a largely textbook-based teacher centred approach to a more interactive and learner-centred approach. (Education & Manpower Bureau, Hong Kong, 1998, p. 1)

Enormous resources have been devoted to the school system in Hong Kong to integrate ICTs into the teaching and learning processes. Nevertheless, the major progress in the use of new technologies for teaching and learning in the local schools has been largely confined to the development of infrastructure and treating ICTs as add-on resources. Thus far, limited evidence on how the use of ICTs has contributed to reforming learning and teaching in Hong Kong classroom has been reported (e.g. see Lee, 2005, 2006). This lack of development in terms of change in pedagogy, curriculum and learning associated with the use of ICTs, however, is not confined to Hong Kong. Other places in the world have also experienced problems associated with sustaining changes in classroom teaching and learning practice. Richards (2006) pointed out that 'yet too often in practice the actual use of ICTs reflects the very "transmission" and reproduction' paradigms of teacher-centered face-to-face learning (rather than) the new theories of pedagogy which emphasize the learner-centered implications of new learning technologies' (p. 240).

In this chapter, we argue that changes associated with the integration of ICTs into the school curriculum have to be evaluated in terms of students' and teachers' conceptions of their experiences in using the new technologies, which in turn are constrained by various contextual considerations. The research on conceptions of learning provides theoretical support for our current study. Saljo, Marton and colleagues (Saljo, 1979; Marton, 1994; Marton & Booth, 1997; Marton, Dall'Alba & Beaty, 1993) maintain that there is a need to understand how individuals experience learning, and hence develop different conceptions of learning. Students will respond to learning using different approaches or strategies depending on their own conceptions. In addition, their perceptions and attitudes towards the learning activities will also be affected by their conceptions of learning. It is argued, therefore, that an understanding of students' and teachers' conceptions of their experiences in using the new technologies may help us understand how pedagogic reform should be arranged to promote the use of ICTs in our school curriculum. In this chapter, we report qualitative findings derived from a study on the implementation of an ICT innovation, called Knowledge Building (KB) project, in the primary science curriculum in Hong Kong. The chapter ends with a discussion on the implications of the findings on promoting science education within the Asia-Pacific region.

2 Knowledge Building Project

The online Knowledge Building (KB) project described in this chapter is an example of an innovation capitalising on the use of ICTs. Knowledge Forum (KF), a second generation product of the Computer-Supported Intentional Learning Environment (CSILE) project, is an online discussion platform designed to facilitate collaborative and progressive knowledge building (Scardamalia & Bereiter, 1991, 1996). The basic idea of knowledge building in the KF environment is that knowledge is brought into the online platform through students' contributions of ideas, and as students work collaboratively on improving ideas and putting their knowledge together, new knowledge can be generated to benefit the whole community (Scardamalia & Bereiter, 2002). This technology-based pedagogic innovation is in line with the comprehensive education reform currently underway in Hong Kong (Education Commission, 2000), which emphasises on the importance of learning how to learn.

About 700 fifth-grade students and 20 teachers from 5 primary schools in Hong Kong participated in this online collaborative knowledge building project within the science curriculum. All the students and teachers were new to the KF platform and also new to this form of inter-school collaborative discussion. Knowledge Forum Client version 3.4 was used throughout the project implementation. The central learning activity required students to contribute to group-threaded discussions on three assigned topics: (1) energy form in a well-planned city, (2) environment in a well-planned city, and (3) traffic in a well-planned city. Students from individual schools were divided into groups according to the topics assigned. Groups from various schools sharing the same topic collaborated with each other through online discussion. Students' contributions to the Knowledge Forum can take the following forms: (1) individual notes by which students put forward ideas, information or questions; (2) build-on, which allows students to reply to others' messages; and (3) rise-above, which allows students to summarise and synthesise a group of related notes. Figure 1 shows the online discussion platform. The little squares represent the KF 'notes' contributed by the participants.

From a theoretical perspective, learning in the KF environment is designed to promote a progressive view on learning that focuses on student-centredness and community involvement (Scardamalia & Bereiter, 1999; Rose & Winterfeldt, 1998; Glaser & Poole, 1999; Howard & England-Kennedy, 2001; Caverly & MacDonald, 2002; Yuen, 2003). In particular, the use of Internet technologies has revolutionised the teaching and learning processes (Jonassen, Peck & Wilson, 1999), and one of the most promising applications of the Internet is the creation of powerful online learning communities (Bielaczyc & Collins, 1999; Brown, 1999). However, we

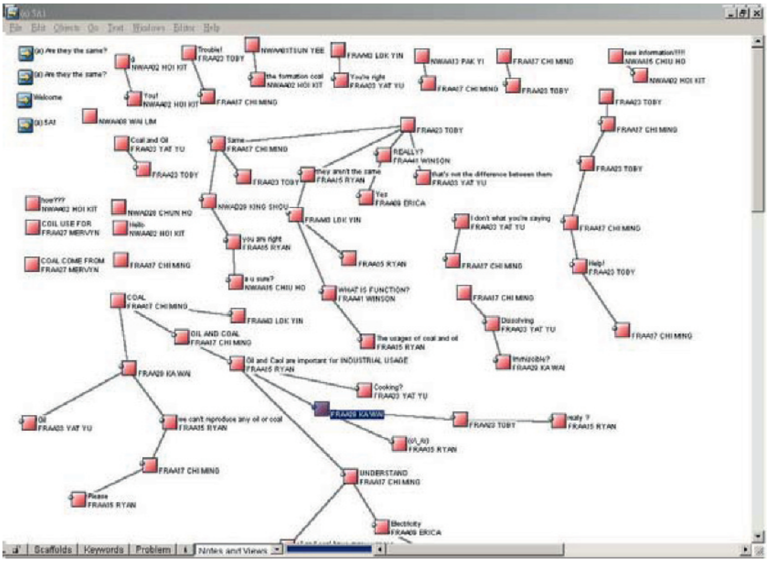

Fig. 1 An example of KF threaded discussion

cannot assume that ICT applications are wizards that can bring instant change to learning and teaching, especially when specific contextual considerations, such as indigenous beliefs about teaching and learning, are taken into account.

Saljo (1979) argued that ‘learning [or teaching] does not exist as general phenomenon. To learn [or to teach] is to act within man-made institutions and to adapt to the particular definitions of learning [or teaching] that are valid in the education environment in which one finds oneself’ (p. 106). The KB online learning environment is a specific ‘man-made institution’ within which teachers and students are expected to act significantly different to those confined to a physical face-to-face classroom setting. Given that students and teachers in Hong Kong are predominantly operating in a learning environment that is teacher-centred, textbook-based and classroom-confined, it is not known how students and teachers would experience the new technologies which promote student-centred collaboration and exploratory learning in a virtual environment.

3 Method

Thirty students and eleven teachers from the five schools were selected for semi-structured group interviews after the completion of the project. Students selected for the interview were both active and less active participants in the online discussion. The 11 teachers had varied experiences in teaching the science curriculum. The interviewees were encouraged to speak freely about their new experiences involving the use of online technologies. In terms of the number of participants in the group interviews, student groups normally consisted of 5–6 whilst teacher groups were made up of 2–3 teachers.

The analytical processes involved several rounds of reading and coding of the transcripts. During the analytical processes, we focused on understanding interviewees' perceptions of their new learning and teaching experiences in using KF. The aim of this study was to unfold students' and teachers' experiences, and therefore we focused on searching for analytical categories representing their unique understanding and experiences in using the new technologies in their classroom. This involved a constant comparison process in order to establish meaningful cross-case analytical categories. In the following section, we describe these findings.

4 Results and Analysis

A quick scan of the interview data showed that both students and teachers discussed various kinds of benefits arising from participating in the online Knowledge Forum. The major benefits include the development of deep understanding of the topics, collaboration with students from other schools, and autonomy. Nevertheless, they also mentioned various challenges and problems they encountered. In particular, the interviewees discussed the extra time they needed to spend on acquiring essential skills such as ICT skills and other researching skills. Some of them highlighted problems associated with the quality of discussion. It is not appropriate, therefore, for us to jump to the conclusion that KF is overtly beneficial to learning and teaching the primary science curriculum. To understand students' and teachers' unique experiences in using the new technologies, we took a cross-case analytical approach and sorted their responses into different categories. The focus of this analytical process was not on the views of individual interviewees but on checking if a substantive category of descriptions of their experiences in learning or teaching with the new technologies in the science curriculum could be established.

Through constant comparison, we grouped and regrouped the responses until we were satisfied that the resulting categories of description were mutually exclusive, that is, no regrouping was required. In describing these categories, we labelled each with a descriptive statement in order to highlight their main concerns. These analytical categories should not be read as representing any individuals. In fact, individuals may hold conflicting views on their own experiences or hold more than one type of conceptions we described below. These categories of description were higher-order analytical dimensions representing several major types of learning/teaching experiences we identified from the responses of these students and teachers during the interviews.

4.1 Students' Categories of Descriptions

Six categories of descriptions were identified according to the students' personal accounts of their online learning experiences. The researchers' comments under each category explicate the characteristics of each category. Note that 'I' represents interviewer, 'S' represents student, and 'T' represents teacher in the sample excerpts reported below.

4.1.1 Showing Indifference Towards the New Experience

The first category of learning experiences in using KF identified from the interview data embodies an 'indifferent attitude'. Some students showed limited interest in talking about their online learning experiences. They often remained silent and were reluctant or slow to respond to a question or others' comments during the group discussion. When they responded, their answers were often short and seldom revealed their personal experiences or views about online collaborative learning. The following excerpt is an example of this form of indifferent attitude towards the innovation:

> **I:** Someone said that we didn't need to type everything; we could just copy and paste. What about you, any comment?
> **S:** No comments.
> **I:** Other than the point that we don't need to type every word, why are we doing this?
> **S:** No use, it's a waste of time.
> [------]
> **I:** What you meant was we could put our views in the 'Notes', is that what you mean, Sam? What about Jason? Why don't you tell me?
> **S:** (Silence)
> **I:** What I mean is do we have to be really good at computers to play with KF?
> **S:** Know how to type.
> **I:** Second question, what's good about KF?
> **S:** Could use computers.

As shown in the interview excerpt above, this particular student was reluctant to respond to the interviewer; s/he spoke very little, answered in incomplete sentences, and showed no particular interest in the discussion. Some of her/his responses, like 'it's a waste of time', imply a negative attitude towards the use of online technologies in the science curriculum. Judging from the responses grouped in this category, it can be interpreted that the introduction of new learning tools and pedagogy might have minimal or almost no effect on the learning of students who held this type of conception.

4.1.2 Feeling the Loss of the Teacher in Online Learning

Most of the students we interviewed showed a great interest in various forms of collaborative activities such as playing games, chats and storytelling. They valued having a teacher who could teach in a playful manner and mix with them in interesting activities.

I: We talked about the issue of teacher earlier. Is teacher important in terms of teaching and learning?
S1: Yes.
S2: Especially teacher Wung, he's very important.
I: What about him?
S1: We can totally disagree with him.
I: So that's good.
S1: He can really make you laugh.
S2: Even though he can be nuts sometimes, like pulling at my shirt, but he doesn't hurt you really.
S3: He can really let go like when he's having fun.
[------]
I: But in KF, I'm all alone, learning in front of the computer screen, is the two … (intercepted by the student).
S1: Isn't that boring?
S2: Yeah.
I: You think it's boring?
S2: It's like you just sit there while others do all the talking.

This conception of learning experiences places the teacher at the centre. Students holding this conception consider that it is the teachers' responsibility to stimulate students to learn and make learning fun. Students found the online experiences 'boring' because this particular computer program lacked the essential elements that they considered important, i.e. a likeable teacher interacting with them in interesting activities.

I: What I meant was what if we used KF on all subjects, and worked without the teachers. What do you think?
S: That's not good.
I: Why is it not good?
S: At least the teacher will make sure you learn something, right?
I: Does that mean you'd prefer traditional teaching? How about Ricky?
S2: It'd be so boring.
I: You mean traditional teaching is boring? How about the new one?
S2: No, I mean traditional teaching is very good.
I: Why?
S2: Someone teaches you.
I: So you don't have to think for yourself?
S1: Yeah, that's it.
S2: Teacher will make you laugh.

In the excerpt above, students relied on their teachers to teach them. Their negative responses to the use of the new technologies were related to the fear of losing the teacher.

4.1.3 Seeing the New Experience as an Obstacle for Learning

The third category of conception derived from the interview data views the use of the new technologies as an obstacle to effective learning. This conception was often held by students who were concerned more about their learning outcomes measured in terms of the grades they achieved.

S: If we use KF all the time, and it takes months, it's a bit waste of time and we learn less.
I: Does it slow down your learning?
S: Yeah.
I: But other student said that KF broadened the learning spectrum, that learning was not limited to what normal school taught you. Do you agree?
S: No, I don't agree.
I: Why
S: It is because we focus on only one topic at a time instead of a variety of topics.

In the excerpt, this student doubted the effectiveness of using KF for learning. He or she considered that using KF to learn required more time spent on one topic and was therefore less effective than traditional face-to-face classroom learning, which can cover more topics in a quick manner. When prompted to comment if the use of KF broadened their learning experiences, this respondent interpreted it in terms of the number of topics that could be covered, and therefore disagreed that his/her learning experience was broadened. This instrumental view on the use of KF focuses mainly on the quantity aspect of learning and tends to downplay other benefits of using this new innovation, such as promoting collaboration and creativity.

4.1.4 Seeing the Online Technologies as a Tool

The fourth category of conception takes KF as a tool for learning. It focuses on one of the basic functions of KF – communicating with others. The student in the following excerpt explained how KF can be used as a communication tool during the learning processes.

S: So constructing knowledge is like, urhmm … knowledge construction is like … I don't have any comments cos I don't know what it is.
I: Then what is 'Knowledge Forum'?
S: KF? KF is only something we use to communicate, first of all, communication, and secondly, we can learn something from it because you can learn something by asking a question and getting an answer. For example, when you ask a question, and someone answers you, and you go, 'So this is how it works!' then you know something.

S: KF is more important. After all, KF is about communication. For example, when you are in a foreign country, and you don't know how to communicate, to share the information, it's like when you have a new invention, really high tech stuff, and if you don't know how to explain it to the world, then all the efforts will go to waste.

4.1.5 Enjoying New Learning that Online Experience Provides

The fifth conception takes the online technologies as a means for promoting learning through collaboration, dialogue and discussion among the participants. What is important for this conception is that learning is no longer conceptualised as being led by a teacher. The student in the excerpt below challenged the common belief that teachers are always correct. He or she realised that a piece of knowledge can be challenged no matter how plausible it looks.

S: The teacher generally thinks he/she is right about certain things …
[------]
S: The teacher said it should be this or that. And we would have to disprove him/her by showing stuff we found on the Internet. …
[------]
S: It's like what the teacher tells us is always right, whereas you can talk about your own ideas in KF.
I: How do you know if the things you said are correct?
S: Let the others prove you wrong.

In the following excerpt, students demonstrated their sophisticated understanding of their new learning experiences using the new innovation. Embedded in their responses are important ideas related to the design of the Knowledge Forum, which include collaboration, self-pacing, and active construction in the learning processes.

S1: I think Knowledge Construction is like when you put many people's ideas together and form a more complicated thing.
S2: I think it is to learn on your own, it's like you figure it out piece by piece, slowly.
S3: It's like everyone is telling their ideas, and we collect these ideas, and we try to figure out what it is, and then something comes out of it.
S1: Knowledge Construction is like putting up a building on your own. We have to look for the materials, and then start constructing. In other words, to make you really understand how it works.

4.1.6 Seeing Computer as Complementary to the Teacher's Role

The sixth conception holds that the use of the new innovation is complementary to teacher-led learning in classroom. This view considers the benefits of using both online and face-to-face modes of learning together. In the excerpt below, the student was aware of the constraints of conventional classroom-based learning and found that the use of KF could overcome some of these constraints. He/she also discussed the changing role of the teacher in using the new innovation.

S: With KF, we can learn from many schools, across the world. Whereas in a school, we can't afford to ask too many questions because that will interfere with the normal teaching, you know? Sometimes we ask questions in the class, but we have more space for questions and answers in KF.

[------]

S: I think both are good. There are advantages learning with teachers, and there are advantages learning with computers.

I: So we should include both kinds of learning?

S: Yeah. It's like combing the two. It's best if we combine the two.

I: How do we do that?

S: Well, it's like some people think computers are better, and some think teachers are better, so we'll have to combine the two. It's like the teachers will have to watch over us when we learn with computers, and tell us if we did something wrong.

I: Like a judge?

S: With more freedom. And give us room to think what we did wrong. The teacher is like a team leader. Like a person who leads a team.

4.2 Teachers' Categories of Descriptions

Using the same analytical approach, teachers' responses were organised into six meaningful categories. The results reported here represent analytical categories of experiences using the new technologies and therefore should not be taken as representing experiences of individual teachers.

4.2.1 'Change Is Irreversible, and I Don't Have a Choice'

The first category of experiences describes a conception that considers the use of the new technologies an imposition. Teachers' responses in this category often discussed external constraints on teaching. These teachers reluctantly accepted the change and rarely took the initiative to implement the new technologies. Though they were able to see some changes in the way students learn after using the new technologies, they did not see the need for change in their own practices.

T: Of course, there are existing constraints. Generally speaking, we have too many students, with limited facilities, and a very tight curriculum. I've thought about it over and over, and there seems to be one problem which is there's simply not enough room and time for student based inquiry. For example, we are now using KF in general education subjects, and it is actually an additional thing we have to do on top of the existing curriculum, so we have even less time.

T: We let the kids do the experiments once in a while. It's of course doable, I mean within the limits of classroom setting. In other words, we do what the circumstances would allow.

T: No problem, I'm the oldest here. It's not a problem at all, change is absolute, no doubt about it. But I would never deny the role of a teacher. Teacher is not someone up there, but teachers undeniably play a strong part in all this. Imagine, without the teachers guidance, and students are free to do anything, it would be a mess.

4.2.2 'I'm Only Starting, Give me Some More Time'

This category of experiences represents teachers who are at the beginning stage learning how to use the new technologies in their teaching. What they thought important was for them to have some more time and exposure in using the new technologies.

T: After all, there are differences. When we were young, we learnt by rote. Now they want you to do a bit more thinking. But I agree with John that it's usually half and half. Memorization is necessary because you have to learn the basic concepts at first.

T: Maybe it's because there are so many new practices. For example, today you have KF, and tomorrow there's something else. Like John said earlier, it's difficult for us to adjust to something that's ever changing … perhaps.

The teacher in the excerpt above was in his first year of his teaching career. He was rather reserved in expressing his views but tended to agree with another more experienced teacher. In general, the teacher in the above excerpt is an example representing those who still need more exposure to the use of KF before they can form their views.

4.2.3 'Give Me Some Good Reasons Why We Are Doing This'

The third category represents teachers who hold a sceptical view on the use of the new technologies in the science curriculum. Teachers often doubted if there were adequate and observable benefits derived from using the new technologies in their classroom. They tended to focus on the problems and difficulties related to the use of these new technologies, such as the problems associated with assessing students' learning online.

T: The marking process is very subjective. Teachers can be subjective too. Like what counts as good and what doesn't. What are the criteria? For example, if I logon to KF for a hundred times, but all I give is yes and no answers. What if the student comes up with a fabulous insight or suddenly comes up with this really wonderful new idea, how am I going to grade them? It is actually very difficult.

T: Personally, I think we have to keep the old theories, to force the students to memorize, and to recite the material. After all, it is still part of the teaching, I would say half of it. It is because you have to learn the basic stuff. For example, if you compare students now with students twenty years ago, you can see a huge difference in terms of academic achievements resulting from all the reforms, educational reforms and all. And you should know that the old ideas and practices are there for a reason. Besides that, there are simply too many things that we are trying, and the teachers don't know which one to follow. Today you may have KF, and then you have something else, I have no idea, I really don't know all these things. All I know is that there are so many theories, and I have trouble figuring out which one to follow.

The following excerpt shows that the teacher had a problem reconciling his or her role as a teacher in using the new technologies. He or she clung onto a transmission mode of teaching and therefore considered the use of KP might marginalise or trivialise the role of a teacher.

T: Teachers will certainly have less work to do if KF becomes the common practice. It is because teacher is no longer required to provide answers, but to raise questions, and let the students think for themselves. Teachers will take up the role of a helper. We may help the students with technical problems, and perhaps be a living dictionary when students can't spell a word right.

I: So the role of a teacher will become relatively unimportant?

T: Yes.

4.2.4 'This Is Something Worth Trying, and I'll Do What I Think Is Suitable'

This category of description generally treats the new technologies positively. Teachers' responses in this category showed that teachers often consciously evaluated the new experiences against their own teaching practice and flexibly incorporated them into their own practice.

T: Now I would give the kids more chance to look for the answers instead of me providing the answers. Now, when I teach science, I would ask a few more questions and ask them to think for themselves, and come up with an answer.

I: What about before this, was the process more important than the result, in terms of the way you teach?

T: Personally, when I teach the language subjects, I place more importance on the learning outcomes.

T: For general education subjects, it's half and half.

T: In terms of language, it depends on the proficiency level. For example, it is slightly more difficult for primary school students which depend on how well

> they can master the language. Whereas for the senior classes, we have literature studies and appreciation.

The teacher in the excerpt above was able to recognise the benefits of using KF and made some changes in his or her own pedagogical practice accordingly. However, he/she did not think that a general shift to a new practice was warranted for all the subjects or could be applied to all levels of schooling. This rational view shows that this teacher had given careful consideration to applying the new technologies and did not feel obliged to change for the sake of change.

4.2.5 'I Love My Students, and I'll Do What's Good for Them'

The fifth category of description sees the use of new technologies as embedded in the caring relationship between the teacher and student. Teachers in this category valued a warm and supportive teacher–student relationship. Therefore, they would try their best to help students cope with new experiences of using KF, and derive satisfaction from seeing their students learn and grow using the new technologies. The teacher in the excerpt below described his close relationship with the students and explained how the use of the new technologies had become a routine in his/her class.

> **T:** We get along very well. It's like being a big sister who is followed by a bunch of younger siblings.
> **I:** Why do the two of you feel that you are being a big sister instead of someone more senior?
> **T:** I think it's mainly because the kids feel comfortable talking to us about anything, including school and life in general.
> **T:** First thing in the morning, before I even set foot on the campus, little Allan would come to me and help me to carry the stuff back to the classroom so that I can go and sign the roaster. And then, there were times when they reported to me about what was happening on KF such as what they saw and read, like some of the rude things that kids from another school had said on KF.

4.2.6 'A New Method Is Provided, and We Can All Try Harder to Make It Work'

The final category of description embraces the use of the new technologies. Teachers valued the new technologies and expected appropriate changes in existing practice eventually if teachers could 'work together'. They also asserted their significant role in driving pedagogical change using the new technologies.

T: My evaluation would be, 'we need to work harder still'. The project is a rather new experience for all of us. For such a new thing, we'd certainly encounter lots of difficulties and problems, but I think we can over come that if we work together. Well, students need the stimulation and excitement from a new learning experience, and if you always do the same old stuff, they'll become bored, and lose interest.

This is a new methodology, and it's stimulating for the students. I think it'd be able to help them learn not only from books, but things beyond the textbooks.

T: In terms of the change in teacher's role, I think it's more like we are teaching at a higher level. It's like traditionally, you tell the students straight whatever you want them to know. But with the new model, you need to think of ways, perhaps asking the questions more skilfully, such as how to ask a question so that you can guide the students to work at a problem. So, I think it's not that teacher's role has become less important, but rather teachers are doing things at a higher level.

5 Discussion

Our analyses of the interview data produced a total of 12 categories of descriptions from students and teachers who used an online collaboration platform in their science curriculum. These categories represent students' and teachers' varied learning and teaching experiences in using the new technologies. According to Marton (1994), these categories can be taken as 'outcome space' and logical relations can be found between them.

A notable relation between the students' categories of descriptions is that they can be collapsed into two global views –positive and negative conceptions of experiences (see Table 1). SCD1, 2 and 3 contain students' interview responses that are inimical to the integration of ICTs in the science curriculum. Students in these categories showed limited interest in using the new technologies, felt uncomfortable with the physical absence of the teacher in the online platform and considered ICTs as less effective in achieving desirable learning outcomes. In contrast, SCD4, 5 and 6 are congenial to the use of new technologies for learning. Students' responses grouped in these three categories discussed the benefits in using the new technologies and how ICTs can complement classroom learning. The question is then why some students embraced the new technologies while others might have developed a sceptical view about it.

A close examination of the student categories has drawn our attention to two important antecedent considerations which may have affected students' learning

Table 1 Student categories of descriptions

Code	Six student categories of descriptions	Nature
SCD1	Showing indifference towards the new experience	Negative
SCD2	Feeling the loss of the teacher in online learning	Negative
SCD3	Seeing the new experience as an obstacle to learning	Negative
SCD4	Seeing computer as a communication tool	Positive
SCD5	Enjoying new learning that new opportunities provide	Positive
SCD6	Seeing online collaboration as complementary to teacher-led classroom learning	Positive

experiences in KF – teacher dependence and goal orientation. How students respond to the use of the new technologies or make sense of their new learning experiences is to a great extent a function of their conceptions of the teachers' role (and hence, their role as a learner) and their achievement (versus learning) orientation.

Students' learning experience in SCD2 can be described as 'teacher-dependent'. In other words, the effectiveness of their learning is dependent on the physical presence of a teacher. In an extreme case, as demonstrated in the sample excerpt, students holding this conception of their new experience will lose interest in learning altogether when the physical presence of a teacher is missing or is kept at a minimum level. The importance of teacher dependence can also be found in SD6 but it was displayed in a rather reflective and flexible manner. These students have begun to see how both online learning and traditional teacher-led learning can complement each other. In other words, they have negotiated successfully among themselves and integrated the new experience into their teacher-dependent conception of learning.

The notion of teacher dependence may, to a large extent, be related to the traditional Chinese cultural practice of learning and teaching. Students are taught to show respect for their teachers and to complete the tasks their teachers have assigned them diligently. In other words, Chinese students have been socialised to develop obedience, diligence and respect for authority (Salili, 1997). The KF learning experiences to a certain extent has physically removed the teacher from the learning scene. Therefore, the Chinese students will definitely need some time to adjust to the change before they can appreciate the benefits of shifting from a teacher-led classroom to a student-centred learning arrangement. To facilitate such a change, the design of the KF platform should consider retaining a 'teacher element', for example, by creating a teacher's chat room where students can take their ideas to their teachers for advice.

Another priori factor we identified from students' categories of description is students' goal orientation on learning. Students holding different goal orientations may approach their learning differently (Ng & Renshaw, 2003). Students' responses in SCD4 can be taken as a representation of achievement-oriented learning, which involves the setting of an achievement target or grade. The new learning experience was taken rather negatively because it was considered as a threat or challenge to the attainment of students' achievement targets. In contrast, SCD5 shows an orientation focusing on learning, understanding and development. The use of KP was considered favourably for it provides students a chance to explore ideas collaboratively, develop them and to verify them. In other words, to those holding views like SCD5 or holding a learning orientation, the use of new technologies is seen as an opportunity for realising his/her learning goals. Further research is needed to verify our observation regarding students' goal orientations and their differential learning patterns in the technology-rich environment.

The achievement orientation as shown in SCD4 may be to a certain extent related to the competition, demand for achievement and examination pressure which characterise the Hong Kong education system. To compete for high achievement and to gain entry to the next level of education are always the main concerns shared among all the stakeholders in Hong Kong. To cater for students oriented towards high achievement, some efforts are needed to help students and teachers to understand how the use of the new technologies promotes learning that results in high achievement. Without such an understanding, seeing online discussion as 'a waste of time' is no doubt a legitimate response among students who compete to survive the pressure for achievement in the Hong Kong school system. Equally significant is for us to understand why some students focus overtly on learning and understanding in using the new technologies despite the competitive nature of schooling in Hong Kong.

As for the teachers' outcome space, we noticed that their conceptions of learning showed varying degrees of focus from being self-aware in terms of their own teaching practices, to being object-aware in terms of student's learning. As shown in Table 2, TCD1, 2, and 3 focus more on problems and difficulties associated with *teaching* whilst TCD4, 5, 6 take the new technologies as opening up new opportunities for promoting *learning* among their students.

Teachers' interview responses in TCD1, 2 and 3 revealed teachers' reluctance, uncertainty and scepticism about the use of ICTs in their science curriculum. In particular, teachers felt that they were forced to implement the ICTs and did not have sufficient training and exposure in using the new technologies. They were also confused about their role in the online discussion platform. These conceptions are consistent with the findings derived from a research assessing the level of use of ICTs in Hong Kong schools (Education & Manpower Bureau, 2005). In particular, over 85% of teachers reported that they had experienced restriction in the use of ICTs as a result of heavy workload, resource limitation and examination pressure. This may have been the case for many teachers who have experienced 'burn out' in the past decade adapting to successive waves of educational reforms in Hong Kong. Our data caution us to rethink if teachers are ready to take in yet another piece of innovation (cf. Fullan, 1991).

Table 2 Teacher categories of descriptions

Code	Six teacher categories of descriptions	Focus
TCD1	'Change is irreversible, and I don't have many choices'	Problems and difficulties (teaching)
TCD2	'I'm only starting, give me some more time'	Problems and difficulties (teaching)
TCD3	'Give me some good reasons why we are doing this'	Problems and difficulties (teaching)
TCD4	'This is something worth trying, and I'll do what I think is suitable'	Opportunities (promoting learning)
TCD5	'I love my students, and I'll do what's good for them'	Opportunities (promoting learning)
TCD6	'A new method is provided, and we can all try harder to make it work'	Opportunities (promoting learning)

In contrast, teachers who were aware of student's learning in addition to their own teaching, or focused on promoting learning generally, expressed greater confidence and ease of manner, when they talked about their experiences in the new situation. For example, in the case of TCD5, the goal for teaching is the development of a moral responsibility for the well-being of one's students. This consideration has led these teachers to take the new technologies favourably as a chance to maintain the relationship and to further this moral goal of teaching. This conception can be related to the emphasis on teachers' moral responsibility within the Chinese culture. More research is needed to explore how teaching is moulded by Chinese traditional values. Teachers' responses grouped in TCD4 demonstrated a subject-based view on effective learning. In other words, the successful use of new technologies needs to take into consideration the nature of knowledge in different school disciplines. The development of this elaborated view will certainly require teachers' professional reflection.

Our data did not provide clear indication as to why some teachers focused more on problems and difficulties in using ICTs while others embraced the opportunities provided by these new technologies to promote student learning. Nevertheless, teachers' differential focuses on 'teaching' versus 'learning' may provide some clues as to how ICTs should be integrated effectively into our school curriculum. Future research needs to explore further the effects of differential conceptions.

To conclude, the use of ICTs cannot be seen as a panacea to educational challenges posed by globalisation. The implementation of new technologies in classroom does not guarantee automatic change in learning and teaching. Our findings show that students' and teachers' conceptions of experiences to a certain extent influence the effective integration of these new technologies in the primary science classrooms.

6 Implication for Reforming Science Learning in the Asia-Pacific Region

The current effort in reforming science education in many parts of the world including the Asia-Pacific region has increasingly focused on the importance of knowledge construction. For example, Lunetta and Lederman (1998) portrayed science education reform in Taiwan using contemporary pedagogical ideas like constructivism, interdisciplinary integration, collaborative inquiry and problem-solving, critical thinking and authentic assessment. Conventional science instructional activities discourage the sharing of knowledge, and the goal is to transmit the textbook's or teacher's knowledge to students (Bielaczyc & Collins, 1999). In contrast is the notion of learning communities and knowledge construction that seems to challenge such assumptions. The knowledge-building discourse suggests that learning science is to develop bases for shared understanding (Bereiter, Cassells & Hewitt, 1997), and that the practices of the learning community and processes of knowledge building help students to deal with new situations and to think critically (Curriculum Development Council, 2001; NSES, 1996). Integrating ICTs in the science curriculum can be an effective way for promoting collaborative and constructive forms of learning and teaching in science education.

It is evident in this chapter that KF can help establish a collaborative learning network to construct knowledge in science education. In general, ICT tools can help achieve the work of community and facilitate communication (Gilbert & Driscoll, 2002). The KF is not only an ICT tool fostering communication and community building, but used effectively, it can shift the focus of classroom instruction to a communal approach and create an environment to engage students in collaborative knowledge building. Nevertheless, the integration of ICTs into existing pedagogic practice of science teaching and learning does not come automatically. Lee and colleagues (2000) reported a survey of 348 teachers in 36 Singapore elementary schools to examine the science teachers' views about their use of pedagogical techniques. The pedagogical activities most emphasised by teachers were completion of science workbooks, teachers' explanation of concepts, and hands-on activities. The least emphasised activities were computer-based learning and activities beyond the textbook and workbook (also see Law in this book). Our findings in this exploratory study draw our attention to the need to evaluate students' and teachers' conceptions of experiences in the adoption and use of new technologies in the science curriculum and how these conceptions may affect the processes of reforming learning and teaching in science education. The pedagogical challenge is to enable teachers and students to become aware of their deep-seated and unchallenged beliefs and to see the need for change. It is suggested that the implementation of reforming learning in science curriculum needs further attention from policy-makers, and informed by critical research (Aoki, 2005) of students' and teachers' experiences.

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Technological Barriers to Learning: Designing Hybrid Pedagogy To Minimise Cognitive Load and Maximise Understanding

Mark Bahr and Nan Bahr

Abstract Information and Communication Technologies (ICTs) provide great promise for the future of education. In the Asia-Pacific region, many nations have started working towards the comprehensive development of infrastructure to enable the development of strong networked educational systems. In Queensland there have been significant initiatives in the past decade to support the integration of technology in classrooms and to set the conditions for the enhancement of teaching and learning with technology. One of the great challenges is to develop our classrooms to make the most of these technologies for the benefit of student learning. Recent research and theory into cognitive load, suggests that complex information environments may well impose a barrier on student learning. Further, it suggests that teachers have the capacity to mitigate against cognitive load through the way they prepare and support students engaging with complex information environments. This chapter compares student learning at different levels of cognitive load to show that learning is enhanced when integrating pedagogies are employed to mitigate against high-load information environments. This suggests that a mature policy framework for ICTs in education needs to consider carefully the development of professional capacities to effectively design and integrate technologies for learning.

1 Introduction

At this point, initiatives around technology in education in the Asia-Pacific region, do not fully consider how we should respond to the way people learn with computers (United Nations Educational, Scientific and Cultural Organisation, 2007). In regions where more than simple access to technology is considered, there tends to be a potent focus on the teacher rather than the learner. In most regions, technology in

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education could indeed be termed ‘teachnology’ given the indelible focus on teacher skills, support for teaching, and general infrastructure. When the learner is discussed it is generally in terms of learner access, numbers of computers in classrooms, and pathways for learning about technology rather than learning through technology (United Nations Educational, Scientific and Cultural Organisation, 2007).

This chapter investigates a key aspect of the learning environment provided by ICTs and specifically computer/online contexts, that is, the effectiveness of learning frameworks provided by software. We consider the load imposed on users by the complexity of the visual frame and interactive protocols and the resultant clarity of learning tasks. That is, cognitive load. This is considered alongside the integration of technology into the pedagogies used by teachers to promote engagement and understanding of concepts in a middle school social science unit. Cognitive load has not been examined by ICT for learning theorists in any great depth. There has not yet been comprehensive examination of the impact of ICT environment complexity on the development of conceptual understandings for students. Education systems are clamouring to establish infrastructures, access, technical support, and enhancement of computer-based productivity skills. Yet there seems to be limited concurrent development of a theoretical framework for the design of information environments alongside the pedagogical approach.

2 Background

For more than a decade, educators have been trying to come to grips with the perplexing puzzle of how to integrate technology into student learning (e.g. Galliher et al., 1995; Hill & Hannafin, 1995). In the early days much of the debate about the use of technology was not so much about how one should integrate technology but centred more on the dual issues of the value of technology in educational settings, and implementing technologies in classrooms. In the case of the former equivocal positions emerged lambasting technology and praising its potential for change. In retrospect, the evidence for either position appears rather scant. Where arguments were made on the basis of evidence, the studies cited divergent outcomes to idiosyncratic applications of one or more technologies.

Many papers seem to have done little more than test the technical capabilities of particular technologies. For example, in the Proceedings of the SITE 2002: Society for Information Technology & Teacher Education International conference the principal emergent themes of the 142 papers were professional development for students and teachers, standards for implementation, implementation packages, specific applications of technologies, attitudes to technology, and consequences of technological change. There is scant evidence of thinking through the characteristics of technological change and mapping those to a particular pedagogic or theoretical framework.

In Australia, Queensland is a good example where there has been some hearty development towards a more principled incorporation of technologies for learning.

The Queensland Government's ICTs for Learning Strategy (2002–2005) did more than simply provide 5,000 more computers for schools, and an effective supporting infrastructure. Although the strategy had a focus on access, key elements were the objectives to reward and recognise teacher excellence through new learning technology awards, engagement of teachers in professional development programmes, and providing support for programmes that extended teachers to grasp learning opportunities provided by technology and effective integration in the classroom.

More recently in Queensland, the Smart Classrooms strategy was launched with the charter to make 'ICTs integral to learning' (Bligh, 2005). The stated Smart Classrooms goals include the goal to:

- Take full advantage of the possibilities of ICT to enhance student learning, create efficiencies in delivering education, and advance lifelong learning
- Empower schools, teachers, and students to make the most of new technologies to create new learning pathways
- Connect teachers with professional learning so that they can create and employ meaningful and engaging strategies where ICT is integral to learning

In 2006, the Queensland Department of Education and the Arts completed an exploration of the ICT needs and challenges for schools. They created the Smart Classrooms Strategy and published an ICT index, which presented benchmarks for 2006 and beyond. While this strategy is a huge step forward, the detail remains bounded by access and utilisation issues. The strategy does not strive to interrogate the potential of ICTs for cognitive development nor the impact of human cognitive factors on the utilisation of technology.

The Queensland Education and Training Reforms for the Future (ETRF) White paper (2002) provided a context for development of online formats. Action 10 of the paper called for systems to 'enhance distance, online and virtual education provision'. A key element of this reform has been the development of the Virtual Schooling Service (VSS) in Education Queensland. This initiative has not really aimed to assist in the development of hybrid pedagogies that effectively integrate online learning tasks with classroom activity and teacher direction. Rather it has focused on evaluation of the efficacy of online delivery of learning materials, and the development of productivity skills for students and teachers. The literature review that supported the development of VSS and its initial reports provide an international overview of the virtues of 'Virtual' education as well as a benchmarking tool for the skill bases and uses of technology by students. Even so, the VSS work has not yet considered the human factors involved in learning with computers.

To effectively assess how we can use information technologies in educational settings we need to take a somewhat different approach and consider what the technologies have to offer pedagogically and to map the particular characteristics of new technologies against specific pedagogic purposes. Such an approach goes someway towards preventing pointless comparisons between a substitution approach to implementation of technology as is often seen in the comparison of 'face-to-face' and 'virtual' classrooms. Moreover, it leads to the perception of new technologies as part of the effective teacher's repertoire of practice rather than as a new or replacement pedagogic framework. To begin the task of mapping technologies to pedagogy first we need to consider the attributes of learning in the classroom, and having identified those, consider the extent to which technologies can contribute towards satisfying those attributes.

2.1 Learning in the Classroom

New technologies and particularly computer-based technologies are often perceived as a panacea for productive educational reform. Terms such as 'e-learning' and 'learning technologies' have emerged in pedagogical discourse and the general thrust of instructional design has been the pursuit of technologies that allow students to learn at their own pace, more efficiently, and largely without other warm body/ies engaged with them in the process.

Social constructivist research highlights the crucial import of social context for knowledge construction (e.g. Vygotsky, 1986; Vygotsky & Vygotsky, 1980), and educational technology design has responded by creating possibilities for online communities (e.g. bulletin boards, discussion lists, chat rooms) in conjunction with instructional packages. The underlying assumption though is that the technological devices are sufficient for the scaffolding of understanding, and that the development of the right technological bells and whistles will liberate students from face-to-face classroom-based learning. That learning will become temporally and geographically independent. Social constructivism clearly constrains that perspective; learning can only be seen as being capable of temporal and geographical independence to the extent that they can be divorced from the need for the social construction of knowledge.

Another widely claimed benefit of new technologies is that the provision of virtual interactions potentially allows greater freedom for students to experience authentic learning. This claim is often associated with the notion that the availability of great quantities of information allows the student greater opportunities for discovery learning. At the moment, existing technology does not provide the necessary bandwidth to allow the fidelity of virtual experience that such a position assumes.

Recent research suggests that effective learning technologies require supporting pedagogies that integrate classroom-based experiences with the possibilities of online technology (Hayes & Harriman, 2001). Classroom-based pedagogies might promote student learning if they draw student attention to key concepts being explored online and reflect on the online experiences of the students. An approach that pre-empts the online material, supports and builds upon it might be termed 'integrating'. An integrating pedagogical approach would be characterised by the full integration of online material into the learning matrix of the programme. That is, computer-based technologies would be much more than elaborate worksheets.

Hayes and Harriman (2001) report that computer-based resources used in conjunction with other classroom approaches are not often effectively integrated and instead act as extension activities taking the place of in-class pen-and-paper worksheets. They report that the result has been a reduced opportunity for higher order thinking, deep knowledge, and substantive conversation than in classrooms where technology is not used at all. For computer-based technologies to enhance the learning experience, then, it seems imperative that they be conceptualised within the total pedagogical framework; that they should transform fundamental pedagogical approaches; and that classroom-based approaches should act as integrating agents for student experience.

3 It in the Classroom: The Limitations of IT

There are significant limitations to the employment of technology in classrooms. Information environments have not yet attained a level of simplicity conducive to their seamless inclusion in classroom activities. Fahy (2000, p. 7) has argued that new technologies make unreasonable demands on users due to their complexity: 'What has happened has been the equivalent of requiring every owner of a phone or car to become a practicing mechanic and working telephone technician.'

As a result, people become lost in what he calls the 'Futz factor', that is, they become consumed by a range of obligatory sideline actions that amount to computer janitor work, interfering with productivity. Until technology is simple, intuitive, with a capacity to truly value-add to a teacher's work and student learning, its adoption and integration in the classroom is challenged.

Many arguments for the uses of technology in classrooms arise from the observation that information technologies are engrossing. The classic work of Bloom (1984) identifies time on task as a key factor in enhanced learning. However, Fahy asserts that engrossing elements are not necessarily the educational ones that we desire. Students may well work with new technologies for extended periods of time, but they may be lost in the site rather than learning the task. That is, online time cannot be equated with time on task.

Information environments present users with an extensive range of options. There is evidence though, that novices are not particularly good at deciding which choices are worth exploring. The net is particularly attractive for teachers who are planning learning experiences for their students. The net assumedly connects the classroom to the world. The Library Journal makes some fairly caustic observations about the Internet as an information source:

> The net is like a huge vandalized library. Someone has destroyed the catalogue and removed the front matter, indexes etc., from hundreds of thousands of books and torn and scattered what remains … and the walls are covered with graffiti. The Net is even worse than a vandalised library because thousands of additional unorganised fragments are added daily by the myriad cranks, sages, and persons with time on their hands who launch their unfiltered messages into cyberspace. (Fahy, 2000, p. 13)

This means that the job of a teacher is harder. Good teachers would never assume that letting a class into the school library would link to predictable learning outcomes. Good teachers organise and arrange the learning resources and conditions carefully to match the needs of their students. A good teacher then is faced with an incredible task to navigate to and select appropriate online materials for their classes. Selecting appropriate materials depends on an understanding of not just how students learn concepts but how they behave in information environments. Added to this virtual treasure-hunt task, teachers are then confronted with issues of functionality in their classroom contexts. Teachers need to be convinced that technologies will enhance their teaching and the learning of their students, and yet comprehensive research into the interface between information environments and learning is not yet mature.

3.1 Cognitive Factors: Task Load and Problem Representation

Over the past decade there has been an increasing interest in the cognitive aspects of learning in information environments. Several issues have emerged which have direct bearing on the design and development of instructional materials and associated integrating pedagogies that contribute to better learning, predominant amongst these is cognitive load (e.g. Sweller, 1994, 1996, 1999). Cognitive load is a term Sweller has coined to describe the load placed on working memory when a person engages in a learning task or problem-solving. The theory suggests that people learn best if the demand on working memory is kept to a minimum. If learning tasks have low cognitive load, then people will have more cognitive resources available for encoding information into long-term memory. Put simply, if we eliminate distracting and complicating elements when we present information to people, they will have a better chance of actually learning and remembering the key concepts.

It is clear that whilst long-term memory is expansive (some even claim unlimited), processing of information in Working Memory (WM) relies on much more limited resources. WM is limited both in duration and information capacity (Miller, 1956). Since ongoing processing of information, and hence much of learning takes place through explicit representation in WM, its limited capacity represents a bottleneck in information flow, which must be considered in designing learning environments. As a result, tasks with high cognitive load impede learning. However, task load can be mitigated by instructional design (Chandler & Sweller, 1996).

Research suggests that computer-based instructional resources must be well designed from an information structure and transparency perspective, but that this clarity of design is necessary but not sufficient in effecting positive learning outcomes for students working with technologies (Alexander & McKenzie, 1998; Hayes et al., 2000). Integrating pedagogies that envelope educational technologies within a constellation of learning experiences make the difference. These integrating pedagogies include classroom-based non-technological approaches that target preparation for and reflection on work with online materials.

This study examines the influence of task automaticity, consistent usage of instructional templates, and worked examples and how these can be used to reduce cognitive load within an integrating pedagogical framework, and assist in student learning.

The declining cost and increasing accessibility of Information Technology in society along with simpler software and a change-imperative culture have seen increasing use of new technologies in the classroom. The computer offers substantial opportunities to create information environments in which student learning is enhanced due to the ease of access to information from diverse sources. However, it is often very difficult to identify strong theoretical rationales for how computers are used to provide information environments. Moreover, it is clear that information environments are potentially very demanding and can impose high cognitive loads on students (Chandler & Sweller, 1994). Given that performance and learning are impeded when cognitive load is high, there exists an urgent imperative to develop techniques for reducing the cognitive load in information environments.

Sweller and Chandler (1994) identified two sources of cognitive load, intrinsic and extrinsic. Intrinsic sources are those that are characterised by the nature of the problem or the information content of the problem, whereas extrinsic sources are those that are imposed by the instructional media. Sound instructional design must consider the implications of both intrinsic and extrinsic sources of cognitive load.

4 Intrinsic Load and Instructional Design

Mayberry, Bain, and Halford (1986) characterised load in terms of the number of elements involved in a task. The greater the number of elements and the more complex the interactions between elements, the greater the cognitive load associated with a given task. As a simple example, a child learning early algebra facing a problem such as ‘5 = a – 3’ and asked to find ‘a’, can solve the task by an element level mapping to an arithmetic analog ‘5 = 8 – 3’. In this case, a single element mapping may be made between the pro-numeral ‘a’ and the numeric quantity ‘8’. However, a much greater load is imposed by the equation ‘5 = a – b’, which requires at least a system level mapping of two elements and a relation to allow understanding of the expression.

Quantification of intrinsic load is complicated by the lack of unambiguous definitions of what constitutes an ‘element’, how to weight the complexity of interactions between elements, and the interaction between user experience and task factors (Chandler & Sweller, 1996). The constitution of a high task load for a novice may impose little load to a more skilled student.

While it may be possible for the educational designer to provide for intrinsic load in development of materials by using staged delivery, and taking the user’s prior experience into account, extrinsic sources of task load may be of greater interest. Principles for mitigation of extrinsic load should be more content-independent than intrinsic load, which must by definition consider the parameters of the task (i.e. the number of learning elements involved in a specific task).

5 Extrinsic Load and Instructional Design

As early as 1994, Sweller and Chandler noted that instruction in information environments often used procedures that imposed unnecessary extrinsic load. In particular, they noted that students were often asked to divide their attention between several different redundant information sources. For example, students learning to use a computer application usually have to attend to the application manual, the computer screen, the keyboard, and other sources of information across a range of modalities. It has been repeatedly demonstrated in dichotic listening and other dual-task paradigms that such conditions result in performance trade-offs (Kahneman, 1973; Mowbray, 1953).

Kalyuga, Chandler, and Sweller (1999) demonstrated that thoughtful instructional design can lessen the extrinsic load resulting from split-attention instruction, and that learning can be enhanced with respect to conventional split-attention designs. This approach to the reduction of extrinsic load was based on well-established research into the acquisition of cognitive skill. However, more can be done. Further load reduction may be accomplished by incorporating a range of additional measures. Second, Kalyuga, Chandler, and Sweller (1999), and Chandler and Sweller (1996) essentially address a deficit in instructional technique such that reduction of extrinsic load makes the use of instructional media 'less bad' than it might otherwise be.

Since the 1960s, research into the acquisition of cognitive skill (de Groot, 1965) has characterised expert performance as being based on high levels of base domain knowledge (often associated with task automaticity), and the ability to identify the underlying deep structure of problems (Chi & Glaser, 1985). Novices on the other hand are characterised by a lack of domain knowledge and an inability to identify underlying structural similarities between problems (Gentner, 1983). Chandler and Sweller (1996) argue that schemata are valuable tools for the reduction of cognitive load, and that expert performance may in part be explained by their use of schemata to reduce cognitive load. He argues that this is why worked examples are more effective in instructional design than discovery learning. He sees worked examples as potential sources of schemata. However, it might be argued that worked examples offer more than simple reduction of cognitive load.

From a structure mapping theory perspective (Gentner, 1983) in addition to reducing load, worked examples and the use of multiple representations of problems (Moreno & Mayer, 1999) may provide a strong foundation for learning. Processes such as these, present a diverse range of exemplars, which contribute to base domain of knowledge. Further, these may have high systematicity between exemplars and with planning, high transparency, which should enhance novices' representation of knowledge.

We propose that the inherent cognitive load of a particular learning technology can be mitigated by pedagogy. The way a teacher works with students to frame their engagement with online material can eliminate confusion. By explicitly identifying key elements of the information environment for students, teachers can help them to focus attention on the desired attributes of the learning task. This reduces the complexity for them, and effectively reduces the cognitive load imposed by the online environment. Additionally, pedagogies that work to integrate classroom knowledge with the online materials and concepts also help to reduce cognitive load for students as they engage in the online environment. These 'integrating pedagogies' serve to link the student's prior knowledge with the concepts presented in the online materials. This helps students to focus on key conceptual elements contained in the online materials again reducing cognitive load.

6 Method

6.1 Participants

One hundred and ten middle school students from two Queensland schools participated in this study. The first group comprised 54 children from two classes in the final semester of year 8 (the introductory year of secondary school in Queensland). The second group included 56 children from three classes in their first semester of year 9.

Students were aged between 13 and 14 years. The two schools differed markedly from each other in their sex distribution ($\chi^2(1) = 8.91$, $p < .01$), but within each school the distribution for each class was relatively consistent as shown in Table 1 ($\chi^2(2) = 5.73$, *n.s.*). Students were randomly allocated to classes in both schools at the start of the school year. Both schools were metropolitan schools. The first school was located in an area of high socio-economic status (SES Factor = 0.44) and had high retention rates (M = 73.4% retention over a 4-year period), whilst the second school was located in an area of substantially lower socio-economic status (SESFactor = 0.80) and was characterised by low retention rates (M = 43.4% retention over a 4-year period). Both schools were of a similar size.

6.2 Design

A quasi-experimental design was used in which instructional type varied between classes such that students could reasonably be expected to experience high, medium, or low cognitive load when they engaged with the online materials resulting from the nature of the integrating pedagogy they experienced (see Table 2).

The first level of instruction was designed to reduce cognitive load and was labelled as an *Enhanced information environment* (low cognitive load) class. These classes used online materials and associated integrating pedagogies intended to reduce cognitive load and identify knowledge structure. The students were led through the online materials. The teacher demonstrated site navigation, worked through similar examples of tasks presented online, and gave explicit instruction

Table 1 Gender distribution by school and level of cognitive load

School	Load	Gender	Frequency	Percentage
School 1	Low	Female	5	20
		Male	20	80
	High	Female	6	24
		Male	19	76
School 2	Low	Female	11	44
		Male	14	56
	Medium	Female	12	60
		Male	8	40
	High	Female	5	45.5
		Male	6	54.5

Note: Gender data were not available for four students in School 1.

Table 2 Design matrix

				Integrating pedagogies	
Groups	School	Cognitive load	Online exposure	Cognitive load mechanisms	Conceptually pre-emptive, supportive and reflective
Enhanced	1&2	Low	High	Explicit transparency	Yes
Medium	2	Medium	High	Available non explicit transparency	No
Conservative	1&2	High	Low	No explicit transparency	No

about the key concepts the students would find online and how they would be presented. In this classroom teacher's work was conceptually pre-emptive, supportive, and reflective of the learning experiences presented online. The teacher worked to highlight the features of the site that students were to notice, and so effected a reduction in cognitive load for the students as they engaged with the site. Additionally, in this condition students were shown how to navigate their way through the materials presented on the site. They were given ample opportunity and high level, frequent, exposure to the online environment to practise their site navigation and familiarise themselves with the key features of the site prior to online assessment. This 'transparency' of the online environment was key to the mitigation of cognitive load for the students.

The second level represented *Medium cognitive load*. These classes used online materials without integrating pedagogies. That is, the teacher did not demonstrate the site to the students, nor explicitly describe how the information provided online, or the tasks presented linked with their prior understandings or class work. In this class the teacher's work was not conceptually pre-emptive, supportive, and reflective of the students learning experiences online. Additionally, in this condition students were required to navigate their own way through the materials presented on the site without guidance. They were given ample opportunity and high level, frequent, opportunity to practise their site navigation or familiarise themselves with the key features of the site prior to online assessment. There were limited 'transparency' mechanisms for mitigation of the cognitive load of the online environment.

The third level of instruction was identified as a *Conservative class* (*high load*). These classes used the online materials only for summative assessment of their conceptual understanding. They had limited exposure to worked examples of problems similar to those they would experience online, or associated integrating pedagogies. As for the medium-load condition, in this class the teacher's work was not conceptually pre-emptive, supportive, and reflective of the students' learning experiences online. However, in this condition students were required to navigate their own way through the materials presented on the site without guidance and were given no opportunity to practise their site navigation or familiarise themselves with the key features of the site prior to online assessment. There was no explicit 'transparency' mechanism for the mitigation of cognitive load of the online environment. When students worked with the online environment, they were labouring under high cognitive load as they were faced with deciphering visual elements, deciding between distracting and feature options, and navigating through the site by trial and error.

Since type of training is potentially confounded by class differences classes were matched prior to testing, and a number of indicators of prior performance were used as covariates to statistically control for differences between classes. Comparable time on task was used for all three groups.

In School 1 there were two classes, one for each of the low- and high-load conditions. In School 2 there were three classes, one for each of the load conditions (high, medium, and low).

The content domain for the study was dictated by the curriculum requirements of the schools, and the particular units being taught at the time of testing. Consequently, materials were developed which related to the relevant areas of the Studies of Society and Environment (SOSE) Key Learning Area syllabus (i.e. middle school guidelines). The students were learning about jungles, the climate of jungles including the construction of climographs, the morphology of jungles, and ecological issues associated with the use of natural resources

Students' performance in each group was assessed at the end of semester with a combination of online tasks and pen-and-paper assessment. The online assessment tasks were of three types; concept knowledge, performance of a task that required the application of concept knowledge, and file management. Concept knowledge tasks involved the completion of tables and crosswords from online stimulus material in Microsoft WORD. The application task consisted of the creation of a climograph using Microsoft EXCEL. The file management task required the students to save their work appropriately onto their own disk. (Note: Their work was automatically saved to the school server so it was not lost if the student was unable to save their work appropriately to disk.)

It was anticipated that the students in the low cognitive load condition, who experienced effective integrating pedagogies, would show better understanding and knowledge of key concepts when tested using the online assessment, than the students in the higher cognitive load conditions.

6.3 Materials and Procedure

A number of basic principles were adopted in constructing the online teaching materials for these classes, which arise from general principles of cognitive psychology and the literature on effective online materials. Given the assumption that participants in this age group would be interacting with the online materials as novices, memory loads associated with site navigation were reduced throughout the materials to no more than four links (Shneiderman, 1992). Moreover, navigation throughout the web site was constrained to forward links nested no more than two levels deep and navigation to the home page was simply instantiated through the use of the browser back button rather than adopting more elaborate navigation options (Fig. 1). The intent of this structure was to limit the amount of information required to successfully navigate the site to within the bounds of normal working memory limitations.

In accordance with contemporary web style guide literature (e.g. Apple Computer, Inc., 1992; Lynch & Horton, 2002), familiarisation with consistent templates in the presentation of online materials was used to reduce extrinsic task load for a second semester SOSE subject. Since split attention has been identified as a source of extrinsic load, mixed modality designs were avoided in the resource materials. Expanding on Sweller and Chandler's (1994) use of integrated information, clarifying information was presented in the same modality as the problems through the incorporation of rollover functionality. Rollover events (also called mouse-over events) are explanatory notes that appear in response to movement of a computer cursor over images.

Figure 2 shows a screen grab of the main navigation page. As can be seen in the figure the navigation structure is intentionally simple and the information content low. Jungle noises are played on site entry and on selecting a link to further pages on the site. This device was used to assist student engagement, and incidentally became a useful classroom management device. Whilst the use of the auditory modality is used in a context, which is low in information content and does add to the task load during processing of the content of the various instructional materials.

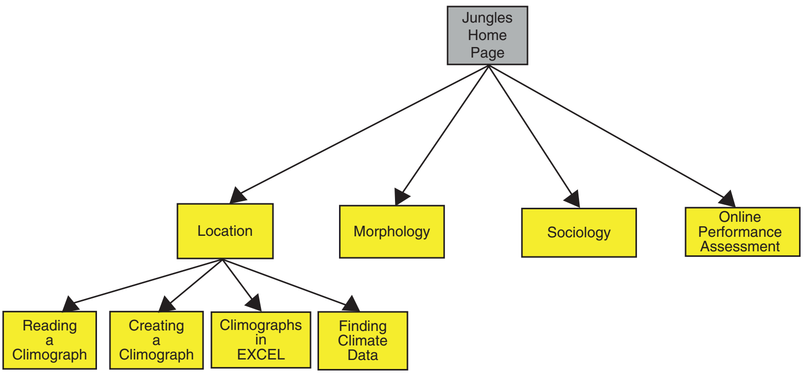

Fig. 1 Schematic representation of navigation structure for online materials

Fig. 2 Main navigation page of the Jungles module

To take advantage of the potential benefits of explicit structure in problem materials, online materials included worked examples and multiple representations of problems. The materials represented three domains of knowledge; climate, jungle morphology, and sociological perspectives of jungle life.

6.3.1 Climate Task

The first domain involved students' conceptual understanding of the effects of climatology of jungles. The domain was explored by having students construct climographs of climates, which would be consistent with the presence of jungles or inconsistent with jungle formation. The climate task involved both pen-and-paper construction of climographs and the use of a computer package (Microsoft EXCEL) for the construction of climographs.

The climate task involved four steps. In the first phase students received traditional classroom instruction in the construction of a pen-and-paper climograph and associated instruction as to the use of climographs to interpret climate patterns in a particular location. In the second phase students first reviewed some general principles about reading climographs and then constructed a pen-and-paper climograph from instructions delivered onscreen in the computer lab. This step reinforced the traditional exercise and provided further opportunities for students to engage with worked examples, and familiarised students with working from onscreen instructions.

In the third phase students were required to construct a climograph using Microsoft EXCEL from onscreen instructions. In this phase onscreen rollovers were introduced to help make students concept mappings more transparent. The rollovers make explicit the relationship between icons and applications and between data placement on the spreadsheet and its conceptual meaning. In the final phase, students interpreted data from climographs accessed through a number of international climate databases. This provided students with further opportunities to reinforce their understanding of the mental models they had constructed both of climographs structure and the typical climate patterns associated with jungles.

6.3.2 Jungle Morphology

The physical structure of jungles was the second domain of knowledge covered by the Jungles module. In this module students were expected to become familiar with the terminology associated with the physical features of jungles such as the taxonomy of jungle layers (canopy and understorey) and the various characteristic features of each layer. Jungle morphology instruction followed the same form as the climate instruction. First students received traditional face-to-face instruction that was aligned to the computer instruction to follow. The second phase involved students performing a task online that reinforced the traditional classroom instruction, and involved using basic computer skills that imposed little instructional load. Reading text and using the information in that text to find elements of the jungle represented graphically in a diagram on the web page. In this task rollovers were used to reinforce students' conceptual representation of location of jungle features. As students rolled their mouse over a feature (such as a vine) an associated text label appeared. In the third phase students conducted a pen-and-paper exercise that provided a further worked example of the jungle structure in a more abstract form and then used a computer package (Microsoft WORD) to repeat the exercise. In the final phase students worked independently on finding further jungle topology information from online data sources.

6.3.3 Sociological Perspectives

The final domain covered by the Jungles module examined the sociological issues associated with human use of rainforests. Students were presented with some information about societies living in jungles, and some ecological and industrial developments in jungle regions. The site included a brief video showing industrial destruction of jungles and a short text article about the lifestyles of people living in jungles. The content of the unit allowed fewer opportunities to use rollovers to define terms for the students.

At the end of the semester, the online assessment presented problems similar in form and content to those presented in the online modules. It included the creation of a climograph using EXCEL from a data table presented online (Climograph), questions relating to concepts covered in the unit (Questions), completion of a table describing the features of each layer in a jungle's ecology (Layers table), completion of a crossword using terms and concepts presented in the unit (Crossword), and the requirement to appropriately save the test responses to a floppy disk (File management). The problems were presented to the students and completed by the students online.

It was anticipated that the students who had been working in the low cognitive load condition would perform better in the assessment as they would be able to demonstrate their understanding of jungle concepts more easily given their familiarity with the online context. It was anticipated that those students who had been working in the high cognitive load condition would not perform as well in the online assessment, because they would be labouring to decipher the features of the site, to work through navigation of the site, and to identify key features from distracters. This would impact negatively on their capacity to demonstrate their conceptual understandings via the online assessment.

6.4 Results

Table 3 shows the means of performance in different domains by cognitive load and gender. To investigate the relationship between school (School 1 and School 2), cognitive load level (low, medium, high), and students' gender on performance an unbalanced three-way MANOVA ($2 \times 3 \times 2$) was conducted of students performance on each of the domains (Climograph performance, Questions, Layers table, Crossword, and File handling). The Wilks Lambda approximation to F is reported for all analyses. Initial diagnostics revealed no significant violations of test assumptions.

Initial analysis revealed no significant three-way interaction (**F** (5,92) = 0.405, *n. s.*). There were also no significant two-way interactions between Load and Gender (**F** (10,186) = 1.89, *n.s.*), School and Gender (**F** (5,92) = 0.404, *n.s.*) and School and Load (F (5,92) = 1.152, *n.s*). There was no significant main effect for School (F (5,92) = 2.15, *n.s.*). However, significant main effects were observed for both cognitive load level (**F** (10,186) = 2.919, $p < 0.01$) and Gender (**F** (5,92) = 4.208, $p < 0.01$). Initial analysis showed the predicted pattern of results with means indicating highest performance in the low-load conditions across all measures of performance.

However, given that the initial analysis suggested a potential interaction between Load and Gender, and suggested that the observed effects were robust across schools the data were reanalysed collapsing across schools to increase test power.

The reanalysis revealed a significant Load–Gender interaction (**F** (10,192) = 1.94, $p < 0.05$, $\eta^2 = 0.09$, power = 0.86). Significant main effects were revealed for both Load (**F** (10,192) = 3.67, p < 0.001, $\eta^2 = 0.16$, power = 0.99) and Gender (**F** (5,96) = 3.06, p < 0.001, $\eta^2 = 0.14$, power = 0.83).

Univariate analysis revealed significant load by sex interactions on only the Questions domain **F** (2, 100) = 3.80, $p < 0.05$. All other measures showed no significant interaction effect between Load and Gender. Examination of Table 3 suggests that males' concept knowledge (as measured by the questions domain) was higher than females under both low and medium load levels. However, under high load

Table 3 Mean sub-domain performance by cognitive load level and gender

		Cognitive load level					
		Low		Medium		High	
Sub-test		Female	Male	Female	Male	Female	Male
Climograph	Mean	7.97	7.59	6.75	8.00	5.57	6.26
	s.d.	2.72	2.34	2.42	1.20	3.30	3.03
Questions	Mean	3.50	6.59	4.75	5.13	4.23	3.04
	s.d.	3.29	3.28	2.53	3.27	3.22	3.88
Layers table	Mean	8.50	7.88	7.83	8.25	6.64	6.76
	s.d.	1.67	2.79	2.79	1.04	3.32	3.54
Crossword	Mean	7.19	8.03	7.75	9.88	2.91	7.32
	s.d.	3.80	3.18	3.82	.35	2.77	2.98
File handling	Mean	3.69	3.18	2.08	2.88	1.64	2.28
skills	s.d.	1.35	1.66	1.62	1.46	1.75	1.14

Note: Climograph, Questions, Layers-table, and the Crossword were all scored out of 10. File handling skills were scored out of 5.

Table 4 Performance on performance sub-domains by gender

		Female	Male
Climograph	Mean	7.28	6.66
	s.d.	2.81	2.19
Questions	Mean	4.92	4.16
	s.d.	3.01	3.48
Layers table	Mean	7.63	7.66
	s.d.	2.59	2.46
Crossword	Mean	5.95	8.41
	s.d.	3.46	2.17
File Handling	Mean	2.78	2.47
skills	s.d.	1.57	1.42

levels girls' performance was better than boys on this domain. This result is suggestive of greater negative impact of high-load conditions on boys than girls.

The only significant main effect for Gender was on the Crossword task where males scored significantly higher than females (**F** $(1,100) = 12.61$, $p < 0.01$, $\eta^2 = 0.11$, power = 0.94, refer to Table 4). Performance on three assessment items significantly differed with cognitive load level; Climograph construction (**F** $(2,100) = 5.42$, $p < 0.01$, $\eta^2 = 0.10$, power = 0.84), Crossword completion (**F** $(2,100) = 9.38$, $p < 0.001$, $\eta^2 = 0.16$, power = 0.98), and File Handling (**F** $(2,100) = 9.12$, $p < 0.001$, $\eta^2 = 0.15$, power = 0.97). Tukey HSD tests ($\alpha = 0.05$) revealed Climograph construction performance scores to be significantly lower in the high-load condition than the low load (refer to Table 5). The medium-load condition did not significantly differ from either high- or low-load conditions.

Post hoc tests also revealed significantly better crossword completion scores at medium levels of load than high load. There was no significant difference in performance

Table 5 Mean scores on performance measures by cognitive load level

Measure	Load	Mean	SEM
Climograph	Low	7.78	0.40
	Medium	7.38	0.60
	High	5.77	0.48
Questions	Low	5.04	0.51
	Medium	4.94	0.77
	High	3.63	0.61
Layers table	Low	8.19	0.43
	Medium	8.04	0.65
	High	6.70	0.51
Crossword	Low	7.61	0.48
	Medium	8.81	0.72
	High	5.12	0.57
File handling skills	Low	3.43	0.23
	Medium	2.48	0.34
	High	1.96	0.27

between medium and low load performance. Nor was the difference between high and low load performance significant. Post hoc tests also revealed file handling scores to be significantly higher in the low-load condition than in any other condition.

7 Discussion

As expected we observed significantly better online performance in the low load (Enhanced information environment) group than the high cognitive load (Conservative). This finding is consistent with the notion that the strategies used in the enhanced information environment group decreased cognitive load during instruction and problem-solving. That is, the integrating pedagogies employed to reduce cognitive load actually worked to enhance the conceptual understandings of students developed while working online through the learning materials. We would also expect performance of online tasks by the second two groups to be associated with high cognitive load. They lacked the benefit of integrating pedagogies to mitigate against cognitive load. The students in these groups would have experienced higher intrinsic load associated with unfamiliar materials and contexts and so would have experienced greater difficulty in engaging with and learning the concepts and also with demonstrating their understandings online.

Future directions derived from this research include the investigation of paper test performance following the learning programme. We would expect to see better paper test performance in the enhanced learning classes than in the conservative class, as the teaching materials are designed to decrease extrinsic load and emphasise problem structure which jointly should contribute to better learning. The surprise finding that boys suffered more in high-load environments also warrants further investigation.

It is clear that ICTs have great potential for promoting effective teaching and learning. However, it is not sufficient to simply improve access, or the productivity skills of students and teachers to ensure that learning is improved when technology is used. The design of online sites, the nature of the learning tasks presented online, and how these are framed by integrating technologies are absolutely key to the potency of technologies to enhance learning. Without careful attention to the design of environments and associated pedagogies, students are exposed to high cognitive load that acts as a barrier to their learning. They may well be excited and motivated by the medium, but if students are unable to effectively direct their attention to the salient learning points of material presented online, if they are distracted by their efforts to navigate through learning materials by trial and error, and/or if they are left to fend for themselves as they attempt problem solutions without the benefit of worked examples, then they will not learn as well as they otherwise might.

We need to carefully consider the potential for effective integrating pedagogies that support student engagement with technology and the concepts they are learning. ICTs need to be integrated as part of the teaching processes. Materials must be designed simply both visually and in the ways people are required to engage with online environments. This is necessary but not sufficient. Their use in the classroom must also be woven into the teaching and learning experience with teachers carefully managing and leading the learning by employing pedagogies that integrate all the resources that they draw on to support learning. Reducing cognitive load is one of the many ways that we can use to go about making the integration work.

In Queensland we are poised for this next step in maturity of ICTs in education. We have teachers who know their way around a computer. We have greatly improved the numbers of computers in schools and we have resourced school communities with technological support. It is time now to more carefully consider the preparation of teachers to cater for student learning using technology. Teachers need to be able to integrate technology into their design for learning, and a significant part of this will be their development to understand the human factors that impact on the development of conceptual understandings in information environments.

Whilst it is clear that there is a change-imperative associated with the widespread availability of new technologies responding to that change-imperative, needs to be done in an informed and critical manner. Research into implications of applied cognitive theories to information environments has drawn attention to both the costs of implementing new technologies in the form of extrinsic cognitive load, and the potential of new technologies to improve learning outcomes over more traditional techniques. However, considerable work remains to be done in this area, particularly in terms of developing approaches to instruction that foster students' ability to represent the underlying structure of knowledge in a given domain. It is this underlying structure, which is most likely to equip students to engage successfully with novel but related problems to those that they have previously experienced. The current study addresses this issue and suggests alternative interpretations of prior results based entirely on a cognitive-load argument.

Key issues emerging from this study include the benefits of carefully selecting online resources for low-load design, and the avoidance of technological distracters in information environments. Further study to more closely focus on the effects of integrating pedagogies is indicated.

7.1 Implications for Reforming Learning Within Asia-Pacific Region

In the Asia-Pacific region there are 17 countries (of 34) that have started to use ICT in education. These fall into four broad groups:

1. Those countries where ICT is already integrated into education systems (Australia, South Korea, Singapore)
2. Those countries where there has been initial teacher training in ICT and where schools are rapidly going online
3. Those countries where they are beginning to go beyond basic computer literacy and where they have begun to integrate of ICT into curriculum
4. Those countries that have not started with ICTs at all

Some common challenges are emerging. In every case there is a desire to strengthen learning with ICTs. However, coherent strategies to do so are still lacking even in the most integrated contexts. There are difficulties being experienced in integrating ICT across disciplines, with most regions focusing predominantly on the uses of technology for productivity purposes and for computer studies. The development of software has attracted attention, but much of the materials has been designed by software engineers rather than educationalists and tends to impose high implicit cognitive load due to dense and complicated visual environments and complex interaction protocols. Across the region it is time to work towards envisioning technology as a effective learning platform in classrooms with efficacy bound by the educational design of the materials (designing for lower cognitive load), and by the nature of the integrating pedagogies employed by teachers. South Korea is working well towards this goal with 10–20% of ICT usage in every subject aimed at enhancing higher-order thinking skills (United Nations Educational, Scientific and Cultural Organisation, 2007), and they are starting to apply and test strategies to check on the efficacy of these approaches.

Several countries in the region have established Master plans for ICTs, but have not yet fully integrated ICT within their education systems (e.g. China, Thailand, Japan, Malaysia, Philippines, and India). These Master plans describe their goals and objectives. At this point, however, there have only been isolated efforts to integrate ICT into education across subjects. ICTs are mainly used for productivity, and ICT is normally taught as a separate subject. In these countries online learning is still in its infancy (United Nations Educational, Scientific and Cultural Organisation, 2007). The challenges are teacher fears – ‘technophobia’, the closed mindsets of school principals, and a general lack of appreciation of ICT in education. The ICT plans have not really addressed teacher training and use of ICT in the classrooms, but instead have been limited to concerns for infrastructure and connectivity (e.g. Cambodia).

The present chapter provides evidence to support the need for comprehensive development of teaching skills around the development of pedagogies that enhance learning using technology. Teachers need the critical skills to evaluate information environments for their potential as learning resources, and these critical skills need to include a capacity to evaluate the implicit cognitive load level of software they may be considering for their classrooms. Finally, software designers need to work closely with educational designers to ensure sites are supportive of learners and learning. As countries in the region work to develop their plans for ICTs in education, they need to look beyond foundational infrastructure and access issues towards holistic educational systems that effectively draw on and incorporate technologies.

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An Examination of Project Work: A Reflection on Singapore's Education Reform

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Abstract This chapter examines the Project Work initiative in Singapore and the challenges to its success. The most pertinent challenge is the deeply ingrained mindsets of the various stakeholders, including students, teachers, school leaders and parents, regarding the goals of education. These mindsets pose a challenge not only to the Project Work initiative but also to the wider education reform in Singapore under the umbrella vision of 'Thinking Schools, Learning Nation'.

1 Introduction

Since independence in 1965, Singapore has managed to develop a quality workforce through a rigorous and traditional education system, one that emphasized textbook learning and examination. However, the government has come to recognize that for Singapore to remain competitive in the economy of the twenty-first century, far more diverse talents, knowledge and skills are required of its citizens and workforce. In 1998, the 'Committee on Singapore Competitiveness' suggested that in order for Singapore to retain its long-term competitiveness, Singapore should 'refine our education system to help foster creative thinking and entrepreneurial spirit among the young' (Ministry of Education, 1998, p. 86). Singapore needs people with creative and critical thinking skills, social awareness and confidence – people with the ability and willingness to adapt and thrive in an increasingly unpredictable and challenging world. Therefore, the government in recent years has launched a series of educational initiatives aimed at adapting the education experience to match the new economic and social challenges that Singapore is now facing.

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The umbrella vision for these initiatives is encapsulated in four words: *Thinking Schools, Learning Nation* (TSLN). Introduced by former Prime Minister Goh Chok Tong in 1997, TSLN is a vision for a total learning environment in which every Singaporean continually develops his or her dynamic learning capabilities to meet the challenges of the new global economy. The starting point is the school, where curriculum and pedagogy will be modified to promote a national culture of independent learning, creativity and resourcefulness. The call is to bring 'real world learning' to students, as well as promoting pedagogical practices that would engage students in self-regulatory and meta-cognitive activities (Tan & Ee, 2004). One initiative that forms a critical part of the overall strategy to achieve TSLN is Project Work, an initiative that is being carried out at the primary, secondary and pre-university levels of education.

This chapter reviews the Project Work initiative in Singapore. It examines its objectives, design and implementation, and reviews some preliminary evaluations of the initiative. Through an analysis of the challenges that Project Work faces in its implementation, this chapter also reflects on the challenges that educators and education officials face in the wider education reform that are underway to achieve the *Thinking Schools, Learning Nation* vision.

2 What Is Project Work?

2.1 Project-Based Learning

Adderley and colleagues (1975) provided the following definition for the project-based method of learning:

1. [Projects] involve the solution of a problem; often, though not necessarily, set by the student himself [or herself].
2. They involve initiative by the student or group of students, and necessitate a variety of educational activities.
3. They commonly result in an end product (e.g. thesis, report, design plans, computer program and model).
4. Work often goes on for a considerable length of time.
5. Teaching staff are involved in an advisory, rather than authoritarian, role at any or all of the stages – initiation, conduct and conclusion.

Helle and colleagues (2006) considered points (1) and (3) to be crucial aspects of project-based learning. Similarly, according to Blumenfeld and colleagues (1991), the essence of project-based learning is a question or problem that serves to organize and drive activities; and these activities culminate in a final product that addresses the driving question.

Although these characteristics describe project work in general, the actual practice of project-based learning varies according to the pedagogical, political and ethical reasons for its adoption (Helle et al., 2006). Morgan (1983), for example, described three general models of Project Work for educational purposes:

1. *Project exercise*: The aim of this type of project is to allow students to apply knowledge and techniques already acquired to an academic issue in a subject area familiar to them. This represents the most traditional kind of project-based learning.
2. *Project component*: In this type of Project Work, the aims are broader and the scope is larger. The project is more interdisciplinary in nature and often related to 'real-world' issues. The objectives include developing problem-solving abilities and a capacity for independent work. Often, traditionally taught courses are conducted in parallel with the project. Project Work in Singapore adopts this model.
3. *Project orientation*: In this case, projects form the basis of the curriculum and indeed the whole education approach. Direct instruction is provided only to supplement the requirements of the projects. The subject material studied is determined by the demands of the projects.

Advocates of the project approach suggest that project work be seen as complementary to the more formal, systematic parts of the curriculum. It provides a context for students to apply the concepts and skills they pick up from various lessons, allows students to develop their proficiencies, stresses intrinsic motivation and encourages children to determine their learning progress (Katz, 1994; 'Project Based Learning', 2004; Wolk, 1994).

Among the common benefits that been found in project-based learning are increased student involvement, persistence and motivation (Chen & McGrath, 2004); greater retention of learning and application to real-world problems, greater motivation among weaker students and fewer disciplinary problems (Curtis, 2002); and increased problem-solving ability as well as research, communication and resource-management skills (International Society for Technology in Education, 1997). The benefits for project-based learning are not limited to students. Research as well as anecdotal reports have indicated that teachers involved in project work develop greater meta-cognitive awareness, creativity and critical reflection in their teaching (McGrath, 2003).

2.2 The Epistemological Lenses of Project Work

While there is no singular definition to project-based learning, there are several fundamental epistemological assumptions that most project-based learning models, including Singapore's Project Work, rest on. Costa (2004) refers to these epistemological assumptions as 'mind-shifts' that educators need to make away from 'traditional and obsolescent thinking'. These mind-shifts include:

1. Intelligence: innate versus growing
2. Meaning: transmission versus construction
3. Knowledge: static versus expanding

4. Teacher-directed versus student-directed learning
5. External evaluation versus self-evaluation
6. Compartmentalization versus trans-disciplinary learning

2.2.1 Intelligence: Innate Versus Growing

Most traditional educational paradigms view students' intelligence as fixed and unchangeable. Innate ability is assumed to be negatively correlated with effort, and intelligence is measured in terms of how much one knows, where knowledge is assumed to be a static entity that one either has or does not have.

Project-based learning presupposes a new definition of intelligence. Intelligence is defined as robust habits of mind and problem-solving skills that grow incrementally with effort. Intelligence is no longer measured by how much content knowledge one possesses, but by how well one practises and enhances those habits of mind.

2.2.2 Meaning: Transmission Versus Construction

The famous Brazilian educational theorist and activist Paulo Freire coined the term 'banking education' to refer to traditional educational paradigms which focus on the transmission of pre-determined meaning into students (Freire, 1972). In contrast to 'banking education', project-based learning presupposes that meaning must be actively constructed rather than transmitted. Knowledge is not a fixed entity that needs to be 'deposited' into passively receptive minds. Learners are active epistemic agents who reflect and construct understanding from their experiences.

2.2.3 Knowledge: Static Versus Expanding

In project-based learning, knowledge is not pre-defined as a set of dogmatic content that learners must ingest. Because knowledge is constructed and based on experiences, knowledge itself is seen to be fluid, dynamic and open to revision. Because of this new definition of knowledge, *what* we know is no longer the focus. Rather, the meta-cognitive awareness of *how* we know what we know and the ability to revise and expand our cognitive horizons are considered more vital.

2.2.4 Teacher-Directed Versus Student-Directed Learning

Following the new perspectives and definitions on intelligence, meaning and knowledge, Project Work is distinct from transmission models of learning in terms of student control over learning (Helle et al., 2006). In project-based learning, teachers do not provide answers or content-heavy knowledge as in transmission models of learning, but provide guidance in terms of equipping students with the skills necessary to pursue the questions framed by their projects.

Wolk (1994) argues that it is critical to the project having purpose that the project emanates from the student's interest. While the construction of knowledge is a collaborative effort between students and their teachers, project-based learning puts the learner in the driver seat while the teachers act as facilitators and coaches.

2.2.5 External Evaluation Vs. Self-Evaluation

The shift from teacher-centred to student-centred learning encompasses the shift from external evaluation to self-evaluation. In Project Work, evaluation has the purpose of providing ongoing feedback to the learner as a part of the continuous cycle of critical reflection and the processes of self-managing, self-monitoring and self-modifying (Costa, 2004). Therefore, evaluation in project-based learning is neither summative nor punitive. It is feedback to facilitate further learning. But beyond external feedback, the ultimate purpose of evaluation here is to have students learn the lifelong learning skills of self-evaluation.

As learning the skills of self-evaluation is such a vital part of project-based learning, it is not uncommon for students to be actively involved in their own formal assessment. According to McGrath (2003), assessment in project-based learning really consists of tracking what students are doing, and helping them to intermittently assess their own progress as they go along. USA's National Science Education Standards document also advocates greater student involvement in assessment as it helps students to become part of the community of learners, to learn to assess and take responsibility for their own work, and to constructively critique the work of other students (National Research Council, 1995).

2.2.6 Compartmentalization Vs. Trans-Disciplinary Learning

Since knowledge is no longer defined as disciplinary content prized 'for its own sake', trans-disciplinary learning becomes an educational priority for project-based learning. This is especially relevant to the contemporary challenge we face to keep our education systems relevant in a world where traditional domain boundaries are being demolished rapidly and 'the separate disciplines are being replaced by human activities that draw upon vast, generalised, and trans-disciplinary bodies of knowledge and relationships applied to unique, domain-specific settings … careers of the future will live at the intersection of the disciplines' (Costa, 2004).

A defining pedagogical goal in project-based learning is for students to learn knowledge application and transference. That is, students learn to tackle diverse and novel situations, drawing knowledge from different sources. This interdisciplinary focus is a major component of Singapore's Project Work.

Project Work emphasizes the student's role in acquiring and applying knowledge and broadens the domains of learning beyond traditional content-centric subjects. Our discussion will now turn to Project Work and some early reactions to it from the education community in Singapore.

3 Project Work in Singapore

In June 1999, the Singapore Government accepted in principle the recommendation of the Committee on University Admission to include Project Work as a criterion for admission into the local universities alongside GCE 'A'-level scores, scheduled in 2004–2005 (Ministry of Education, 2001). In 2000, Project Work was implemented on a trial basis in all non-examination years in Singapore schools (Primary 3, 4, 5, and Secondary 1, 2, and 3, and Junior College year 1). In 2002, Project Work was integrated into the formal curriculum of Junior Colleges, and by 2005, Project Work constituted 10% of the University Admission Scores (Ho, Netto-Shek & Chang, 2004).

3.1 Objectives

In line with the TSLN vision, Project Work aims to allow students to develop the skills and aptitudes that would put them in good stead to flourish in a dynamic and rapidly evolving environment. The Ministry of Education (MOE) states the aims of Project Work in this way:

> Project Work is an integrated learning experience that encourages students to break away from the compartmentalization of the different disciplines. It aims to provide students with opportunities to explore the inter-relationships and inter-connectedness of subject-specific knowledge. The objectives of Project Work are to allow students to (1) apply creative and critical thinking skills, (2) improve communication skills (both oral and written), (3) foster collaborative learning skills and (4) develop self-directed inquiry and life-long learning skills. (Ministry of Education, 2005)

The MOE defines four domains of learning outcomes which Project Work is meant to help students develop:

1. *Knowledge Application* – Students are to learn basic research skills, apply and transfer knowledge and skills learnt across disciplines and to make connections between them.
2. *Communication* – Students are to improve their ability to communicate ideas clearly and effectively in both written and oral modes.
3. *Collaboration* – Students are to develop and improve social skills in collaborating with others towards a common goal.
4. *Independent learning* – Students are to learn to take charge of and monitor their own learning as well as to develop a positive attitude and responsibility towards their work (Ministry of Education, 2005).

The MOE provides a concise set of guidelines for Project Work in which it is emphasized that Project Work has the following key features (Ministry of Education, 1999):

- Is interdisciplinary
- Involves collaborative learning (students work in groups of 4–5)
- Requires an oral presentation
- Focuses on collaborative learning
- Focuses on both the process and the product
- Builds just-in-time skills instruction for students
- Is carried out during curriculum time
- Standards of assessment are made transparent

3.2 Design

The way Project Work is carried out at different levels and different schools varies in methodology, especially at the primary and secondary levels where Project Work does not form part of the formal assessment. In a typical Project Work classroom, students form groups of 4–5 members to work on a project task. Group members meet face to face during classroom time dedicated to Project Work as well as outside curriculum time to discuss strategies and work on their projects. At the end of the period of time assigned for the project, the project groups are required to present their work in written and/or oral form to their supervising teacher and their peers (Wong et al., 2006).

The assessment built into Project Work aims to assess both the process and the product of knowledge construction, and, among other things (Chang, 2004):

- Ability to gather relevant information from a variety of sources and to apply knowledge across different academic subjects
- Analysis of data and creative organization and presentation of information
- Oral communication skills
- Team work and
- Ability to monitor and evaluate one's learning

However, at Junior College level, Project Work is an official examination paper that constitutes 10% of local university admission criteria. The GCE 'A' Level Project Work spans over 8 months and consists of a group written report of 2,000–2,500 words, oral presentation, and a project file (Chang, 2004). Assessments are carried out for both group and individual work and evaluated for both process and product according to the four learning outcomes (Knowledge Application, Communication, Collaboration and Independent Learning) (Chang, 2004).

For each section in the GCE 'A' Level Project Work paper, marking is guided by four bands of rubrics rather than traditional grades (Chang, 2004):

- No mark (criterion has not been met)
- Approaching expectation (below expectation)

- Meeting expectation (satisfactory)
- Exceeding expectations (good)

There is greater flexibility in the evaluation of Project Work in the secondary and primary schools, compared to the junior colleges, as it is considered to be an introductory learning experience for students rather than a formal assessment.

4 A New Education Paradigm

Following the introduction of TSLN in 1997, the Singapore education system shifted away from an Efficiency Driven Education to an Ability Driven Education (ADE) paradigm. The former focuses on producing skilled workers for the economy in the most efficient way. In contrast, the latter aims to identify and develop the talents and abilities of every child to the maximum.

During the 1999 Ministry of Education Work Plan Seminar, RAdm (NS) Teo Chee Hean, then Education Minister, emphasized the need for parents and the public to 're-orientate their gaze' in order to recognize the value of a new way of looking at education using 'ADE Vision'. The new focus was on holistic development rather than merely academic achievement (Teo, 1999, p. 5). He also stressed that it was vital for every educator to understand the rationale and strategic intent of each educational initiative or policy. To do so, the MOE would be putting in greater effort to the schools in order to 'inform, explain, listen and interact' (Teo, 1999, p. 6).

The significance of the minister's address is that Singaporeans have to recognize that the goals of education are now different. In the past, changes in educational policy did not constitute a qualitatively different way of understanding education. Most people perceived education as knowledge assimilating, and academic achievement as regurgitating content knowledge during paper examinations. Under the ADE paradigm, the understanding of education has changed. Education is holistic. It goes beyond academic achievement. Even more fundamentally, the traditional concept of academic achievement has to be challenged and re-evaluated.

Prior to the reforms introduced under the umbrella vision of TSLN, lessons in Singapore's classrooms were geared primarily towards examination preparation. Subjects were taught in order to cover examination syllabi, and there was heavy emphasis on memorization and drilling through the frequent practice of previous years' and trial examination questions. The transmission model of learning defined traditional Singapore classrooms, with students expected to absorb subject content that was lectured by the teachers or printed in textbooks or notes. Assessments carried high stakes and students were highly pressurized by them. Students were tested on how much content knowledge they could regurgitate and their success in such examinations heavily influenced their future academic paths.

Project Work exhibits features that break away from the traditional drill-and-practice, examination-oriented, teaching approach. Firstly, Project Work is interdisciplinary in its approach instead of focusing on only one subject area. This allows students to integrate their learning from various subjects in creative and meaningful ways

Secondly, in Project Work, students are evaluated both on the process as well as the product of their work. Where traditional examinations only allow students to demonstrate their academic abilities through relatively narrow avenues and rigid methods, the comparatively open-ended Project Work is meant to provide students with an opportunity to develop their written and oral skills as well as discover their hidden talents in a variety of ways. Also, it stresses knowledge application and not just knowledge acquisition.

Thirdly, because Project Work is specifically designed to involve group work, it helps to develop communication and collaborative skills among students. Yet, because teachers are facilitating students' learning instead of teaching the content directly, students will have to learn to take charge of, and monitor, their own learning. They have to be responsible independent and interdependent learners.

Creating Thinking Schools and a Learning Nation is not a task that a few well-written policies will accomplish. Furthermore, it is not a mere matter of communicating those policies effectively to schools so that they can be executed accurately. Project Work typifies education initiatives that rest on dramatically different epistemological assumptions and cognitive attitudes towards knowing, learning and assessing. These assumptions and attitudes are deeply rooted in societal culture. If these fundamental assumptions and attitudes are not successfully challenged and altered, educational initiatives aimed at promoting creativity or independent learning would not effectively transform students from one-dimensional paper scholars to reflective, intelligent and adaptable global citizens. It is at this fundamental level that the government has to work for many of its education initiatives to come. In discussing the challenges of Project Work to the various stakeholders, in particular the students, teachers, school leaders and parents, the deeper challenges to TSLN will also be addressed.

5 Challenges of Project Work to the Stakeholders

5.1 Students

Early studies on students' reflections about Project Work have suggested that Project Work has generally been received positively. However, there were also challenges that students faced in Project Work. Three research studies were performed in different schools at the Junior College, Secondary and Primary levels. Junior College students found that Project Work aided them in learning problem-solving, independent research and working collaboratively with other students (Chang & Chang, 2003). The same study also showed that students were stressed by the additional workload and experienced an increase in anxiety level caused by Project Work. At the secondary school level, students who participated in Project Work felt they showed improvement in teamwork skills, communication and social skills, problem-solving skills, self-regulation skills and thinking skills (Tan, 2002). Similarly, primary school students provided feedback that they have improved in the domains of knowledge application, communication and independent learning due to participation in Project Work (Chua, 2004).

To succeed in a traditional paper-and-pencil test in the past, a student learns a pre-defined content area and practises past-year questions based on the content. While this may be an arduous task, the student is essentially passive in the learning process. In contrast, for a student to fully benefit from Project Work, he/she has to be proactive in his/her learning and collaborate with others. The group has to collectively decide what they wish to learn, think about what means they should use to acquire the knowledge they need and discover how their new knowledge can be applied in real life. Furthermore, because it is a collaborative task, students have to learn the skills of cooperation and negotiation and experience first hand the challenges of team learning. This is a very different paradigm from that of 'my examination and my grade'.

5.1.1 Changing Mindsets

One challenge to Project Work is the fact that the mindset of focusing on high examination scores is still present. With this mindset, many students are still too focused on the end of scoring well in their evaluation and fail to appreciate the more valuable and intangible learning experiences that Project Work provides. Ng (2005c) writes about the students' dilemma:

> The policy changes to develop creativity in students may, for example, push some students in the short run to focus on using their creativity in their Project Work. However, the obsession with results has not been addressed, and Project Work is examinable. The fear of making mistakes and the fear of losing out will stress out the students. They need to be 'creative' because 'creativity' leads to good grades. In time, their 'natural creativity' will wane while a pressurised 'creativity' to cook up something good will take over.

The qualitatively different pedagogy of Project Work may actually require students to put in more effort and energy in collaborating with others and seeking knowledge collectively than in studying for traditional examinations on their own. For students to be willing to put in genuine effort and truly benefit from Project Work, they need to first see its value. They must appreciate that the process they go through equips them with a valuable skill in life. The challenge is to appreciate the process while maintaining the pursuit of good results.

5.1.2 New Learning Skills

Hill and Hannafin (2001) suggest that students who are accustomed to primarily didactic, teacher-directed experiences may lack the meta-cognitive and learning skills to work within more open-ended learning environments. The lack of such skills and the conditioned dependence on the teacher's direction may lead such students to lack the confidence required to self-drive and self-regulate their projects.

While Project Work is meant to develop this kind of meta-cognitive, independent-learning and communicative skills, it must be noted that such skills are also required for students to succeed in Project Work. As Singapore's students have traditionally been in a teacher-centred and high-stakes testing learning environment, Project Work is challenging because it requires them to use learning skills that they have had little opportunity thus far to develop.

5.2 Teachers

Project Work is also more demanding on the teachers than traditional classroom teaching. Project Work demands a significant change in the teacher's role. During traditional classroom lessons, teachers take the role of experts in a subject. Their task is to transfer their knowledge to the students. But in Project Work, the role of the teacher is more that of a facilitator and coach rather than the 'sage-on-the-stage' (Ho, 2004). The onus of learning is shifted from the teacher to the student and the teacher's new role is to help his/her students develop the skills needed for independent and interdependent learning.

This is a great challenge to the identity of teachers. The teachers have been used to imparting content knowledge or fixed skills to students, based on a fixed syllabus. The teacher is the expert while the student is the 'vessel to be filled'. The teacher teaches and the student receives. But in the new education paradigm, where knowledge is not a static entity but a dynamic social construct, teachers are expected to be adept at facilitating students' knowledge acquisition, construction and application, something that teachers are not very familiar with. Guiding and coaching students as they embark on their own attempts at learning is much more challenging and time-consuming than delivering a straight lecture to a silent class.

Given these considerations, there are a few crucial points to consider regarding the challenges that teachers face in Project Work: (1) balancing Project Work supervision with pressure to 'cover' standard curriculum; (2) their perceptions about Project Work; and (3) their competence in supervising Project Work.

5.2.1 Balancing Project Work with Standard Curriculum

Singapore teachers, especially in the higher grades, face immense pressure to prepare students for examinations. As much as attempts have been made to change the education system, it is still essentially a high-stakes testing environment.

Teachers of students facing important exams feel driven to 'cover' the curriculum, which they frequently do using traditional lecture-style teaching methods (McGrath & Sands, 2004). The sustained inquiry into a specific topic, which is a hallmark of project-based learning, often conflicts with schools' attempts to cover material for the purpose of exam preparation. Thus, teachers will have to balance providing students with ample opportunity for in-depth studies in Project Work while attending to the standardized curriculum's scope and requirements (Grant & Branch, 2005).

5.2.2 Teachers' Perceptions

Teachers' perceptions about Project Work are important because they influence the teachers' behaviour and practice when supervising Project Work. Studies have been done showing the impact of teachers' personal perceptions on classroom practice (Hewson et al., 1999; Meyer et al., 1999). Understanding and acknowledging how teachers' perceptions and beliefs influence their teaching are critical to teachers' development and change in role conceptions and teaching practices (Tatto, 1998).

In a study done to assess pre-service teachers' perceptions of Project Work, 97% of the participants considered it important for their future students to be engaged in Project Work (Ho & Netto-Shek, 2004). The other 3% reported that Project Work was not important as it was 'very time consuming', 'a waste of time' and because Project Work was difficult to evaluate (Ho & Netto-Shek, 2004). While this study provided an overwhelmingly positive response towards Project Work, it is important for teachers' perceptions of Project Work to be more widely and consistently monitored. In fact, teachers' perspectives on the following questions would also impact their willingness and readiness to take up supervising roles in Project Work:

- Are the teachers' perceptions of knowledge and learning changed as well?
- Are they prepared to deal with a different nature of questions being raised in class – questions that may be less content-based and to which they may not have ready answers?
- Do they understand that their role in the new education paradigm is different, and requires them to be more like a facilitator and a coach than an expert instructor? Are they ready to take up these new roles?

5.2.3 Teacher Competence

In Ho and Netto-Shek's study on pre-service teachers' perceptions of Project Work, 16% of the 380 participants requested more training on 'how to facilitate skills development for the students, and how to assess and evaluate projects fairly' (Ho & Netto-Shek, 2004, p. 132). Whether teachers have the competence to be effective mentors and facilitators has a direct impact on whether Project Work is properly implemented at all (Lim, 2004).

Sustained project-based learning is not a simple task for students or teachers (Brush & Saye, 2000). Competent supervision of Project Work requires to comprehend how students will perform in this new learning context and to recognize that students may be ill-prepared in terms of the kind of learning skills required of them (Grant & Branch, 2005). Beyond recognizing that students may be ill-prepared, teachers should be able to give the necessary skills-instruction and guidance that students require.

Psychological studies have shown that perceptions of competence are important determinants of teacher action (Nicholls, 1984). People who perceive themselves to be competent are much more likely to participate, persist and accept challenge in that situation (Bandura, 1989, 1997). According to Lim (2004), teachers have pointed out that having supervisors with higher levels of mastery in guiding students would improve the status of Project Work as a subject, as well as teachers' support for it. Thus, training both pre-service and in-service teachers to be competent in supervising Project Work is critical for Project Work to be successfully carried out.

5.3 School Leaders

To facilitate the achievement of the TSLN vision, the way that Singapore schools are managed has been changed to allow flexibility and autonomy in the implementation of new policies and the search for school-based innovation. In the past, many functions of a school were managed centrally by MOE. Now, schools can determine their own strategic directions based on broad guidelines and have the authority to identify and address their own issues. They are also placed in school clusters to promote inter-school collaboration (Ng, 2005a, p. 4).

In order for Project Work, and indeed TSLN, to bear fruit, school leaders have to grapple with their own philosophy of what constitutes successful education. Just as students take their cue from their teachers, the teachers' attitudes towards Project Work and how they will facilitate the Project Work process are affected by the school leaders' mindsets and expectations. If the school leaders are only preoccupied with the students' achievement in the paper examinations or choose to pursue educational reforms for the sake of winning awards, it is unlikely that the teachers would be given the time and support required for a thorough and fruitful implementation of Project Work.

Therefore, the school leaders' attitude towards Project Work has a direct impact on its implementation. School leaders may not be involved in the way Project Work is carried out in the classrooms, but they decide on critical supporting structures such as timetables, allocation of teachers' training time, allocation of funding for projects, appointment of key personnel in charge of Project Work, the number of projects a teacher supervises, the amount of time allocated for consultation in Project Work and the distribution of various administration duties (Lim, 2004). In the study of pre-service teachers' perception of Project Work, 55% requested 'structural support' such as flexibility in school timetables and school-wide support (Ho & Netto-Shek, 2004). It is clear that school leaders play a crucial role in influencing the success of Project Work by creating conducive conditions that support its implementation.

5.4 Parents and the Community

Although the education reforms in Singapore require students, teachers and school leaders to adopt a wider definition of success in education, this is a great challenge because schools face constant demands and high expectations from parents and the larger community. The decisions that schools make with regard to curriculum and pedagogy are likely to be questioned by parents if they fail to see how the reforms can deliver 'results'.

Ng (2005b) provides an apt illustration of the social pressure that schools are facing. In 2004, in a move to promote the concept that academic results should not be the only goal for schools to achieve, MOE had implemented a new system of awards based on a broader criterion of excellence – one that included value-addedness, best organizational practices and achievements in sports and arts. After the release of the achievement tables, a furore arose among some of the parents of students attending one of the top schools in Singapore, because the school was absent from the list of top award winners. According to this newspaper report, the principal of the school had explained that the school was not featured on the list because it had not asked to be officially assessed by the ministry (Davie, 2 October 2004). Nevertheless, the parents were upset. Some teachers of the school claimed that since the school had recently initiated an innovation to offer a programme different from the traditional GCE 'O' level examinations, these achievement tables became more important because they were now the only means by which the school could show 'tangible results' in the current absence of GCE 'O' level examination results. According to the same report, the principal, while maintaining his confidence in the school's programme, commented:

> Looking at the reactions of some parents, it looks like we can't afford to postpone the ministry's validation any more. We will go for it next year.

Even if schools wish to cultivate a different learning culture among teachers and students, they cannot ignore the expectations and demands of parents, who are important stakeholders in education. If parents continue to demand 'tangible results' in the form of examination rankings or awards, schools will continue to be under pressure to work towards these ends. In turn, teachers' and students' attention will be directed towards these 'tangible results' and not the actual learning process, which is a critical feature of Project Work. However, it is often such intangibility that spurs teachers and students onto the road of lifelong learning, creative thinking and critical reflection.

The influence of parents and the community is not limited to the pressures exerted on schools. If parents retain the mindset that success in education is determined by their children's examination results, they will tend to see any activity which does not directly translate to these tangible results as a waste of time. This will almost certainly impact the way their children experience education. It would be unreasonable to expect students to fully appreciate the educational process when they are pressurized at every point to show 'tangible results'.

Without a change in the way that parents understand the goals of education and the notion of success, schools as well as students will be held back from a wholehearted attempt at Project Work because it can quite easily be seen as an albatross eating into precious time, time during which more work can be done towards achieving good examination results. If Project Work is taken as just another subject to be tackled, teachers and students will seek ways to cut corners in satisfying the letter of the law. The spirit of Project Work will be lost. Fernandez (2004), a journalist, wrote:

> For these reforms to work, (parents) too are going to have to do some letting go and get used to things being done quite differently from the old uniform way. Emphasising creative thinking could well mean more tricky examination questions, perhaps less homework, or assignments of a different kind. More flexible school admission criteria could mean some subjective decisions being made on who gets in and who does not. And yes, a bigger variety of school programmes could see a wider range of fees being charged. Are parents mentally prepared for these changes? … Increasingly, if education reform is to take off here, parents will have to work with principals, support teachers, encourage change and experimentation, allow for mistakes, and even accept that some system-wide changes might not always give their child a leg-up. But change, as always, takes some getting used to.

In Taiwan, it was found that parents who were involved in their children's projects via a school programme changed their perceptions about their children's learning and were more understanding of the demands that Project Work made on their children (Liu & Chien, 1998). These parents also reacted much more positively to their children's requests regarding materials and resources required for their projects. In contrast, parents who were not involved in the programme frequently complained about the expenses and the burdens associated with projects. It would be a good idea for more of Singapore's schools to expend more effort to communicate with parents about Project Work and perhaps even engage them in Project Work at the primary school level. This is likely a crucial step to acquiring greater parental and community support for Project Work.

6 Towards Thinking Schools, Learning Nation

Project Work is only one of the many initiatives under the umbrella vision of TSLN. However, many of the challenges discussed in this chapter are fundamental ones that are deeply rooted in the social psyche of Singaporean society, and similar to challenges that many other initiatives will face. While there is no doubt that the government is trying to make changes in the education system to develop creative and enterprising Singaporeans, there are inherent tensions in reconciling the educational reforms with the pragmatic social psyche.

If the goal of TSLN is to develop dynamic and independent thinkers with a lifelong passion for learning, good communication skills and a creative and enterprising mind, the focus has to be on the process rather than the output of learning. However, because of the deeply ingrained pragmatic and result-oriented mindsets of Singaporeans, no matter what the intent of the initiative may be, it is possible that the underlying essence remains the same (i.e. the functionalist and product-oriented notion of success) while the form undergoes change (i.e. what is espoused). To truly move towards TSLN, a change in the underlying essence is necessary. While this is easier said than done, this is the only way to go if TSLN is to be realized to its fullest.

In his chapter on the *Singapore Learning Society*, Ng lists among the challenges of developing the Singapore Learning Society three attitudes which constitute ‘learning disabilities’. The three attitudes of ‘bo chap’, ‘kiasu’ and ‘kiasi’ which roughly translates to apathy; fear of losing out, being left out or being behind; and the fear of getting into trouble, make a formidable combination that can result in conformity and unoriginality (Ng, 2003). As long as people are absorbed in ‘making it’ materially in life and fear diverting from the well-trod trail, it seems unlikely that a genuine passion for learning can be engendered in them. Such a passion requires them to take initiative for creating knowledge, to have the courage to question accepted wisdom and to take responsibility for their own judgments. As long as the attitudes of ‘bo chap’, ‘kiasu’ and ‘kiasi’ are present, students and teachers may appear to be involved in projects that are creative but that will not translate into a more fundamental change in perspective and attitude towards learning.

Yet, TSLN is not just ideals and rhetoric without its pragmatic value. TSLN aims to transform the learning experience of Singapore’s students so that they develop passion for learning as well as creative and learning skills that will put them in good stead in a rapidly changing environment (Goh, 1997). This is necessary for Singapore’s survival in a global economy. Singaporean employees generally do not question assumptions, especially those espoused by people in authority, and too many citizens are lacking in written as well as oral communicative skills (Shanmugaratnam, 2003). Initiatives, such as Project Work, attempt to address such concerns.

Therefore, education reform in Singapore shall always be a journey of balancing ideals with pragmatic considerations, allowing opposing forces to generate a creative tension that will determine the eventual outcome of the policies (Ng, 2007). In the meantime, while the social psyche remains pragmatic and the economy demands results, the government should continue its journey of education reform while remaining mindful of the essence and not just the form of change.

Learning is seamless and knowledge should not be artificially compartmentalized. One of the purposes of Project Work is to allow students to draw upon the various areas of learning into an interdisciplinary application. However, Project Work on its own is not sufficient in changing a deeply entrenched tendency to compartmentalize knowledge. Project Work can in fact be perceived as a new ‘compartment’ or subject to be tackled. Project-based learning is not meant to be an ‘add-on’ to the basics of education, but should be treated as integral to all other parts of the curriculum (Katz, 1994). Thus, it is imperative that the learning skills and epistemic values that Project Work espouses be incorporated more widely and holistically in the educational experience. The effort at establishing independent learning and creativity must be extended to more aspects of education than just in Project Work. More opportunities for collaborative work, independent learning and creative and critical thinking should be incorporated into the way all subjects are taught

The education system is an open system. It is heavily influenced by the political, economical and social systems of the larger society in which it exists (Ng, 2005c). Children imbibe values and attitudes not just from what they are exposed to in school, but from their families and wider society. Thus, in order for the young to embrace the values and attitudes and develop the thinking skills that are instrumental for creativity and lifelong learning, there has to be a widespread and fundamental transformation of attitude in the society beyond the education system. Although education is always a good place to begin this transformation, there is a need to trigger similar changes concurrently in the other facets of society in order for the transformation to be truly effective and lasting.

7 Implications for Reforming Learning in the Asia-Pacific Region

The case of project work implementation in Singapore is just the 'tip of the iceberg' that points to deeper tensions between the ideals and realities of education reform. While we have analysed project work as an education reform in Singapore, it is not project work per se that is the centrepiece of analysis. It is a case study that highlights the underlying assumptions and challenges of education reform. The case of Singapore demonstrates how a small state can become an economic success by getting its human resource developmental priorities and policies 'right'. This 'right' strategy has been one of controlled and well-resourced education reform implementation, fostering rapid economic growth by stressing meritocracy and high academic achievement. How relevant is this strategy in a globalized knowledge age economy? Could it be relevant to another economy in a different stage of economic development?

Education investment brings economic development – research literature verifies that (Schweke, 2004). The body of knowledge that underpins education reforms has significantly expanded too (Carnoy, 1999; Fullan, 2005). But globalization also means that many developed and developing economies are now benchmarking their education systems against one another and transferring ideas and policies from one system to another (Carnoy, 1999; Steiner-Khamsi, 2004). Also, reform ideas from the USA, Europe and Australia have increasingly influenced education reforms in the Asia-Pacific region (e.g. project-based learning, habits of mind). Therefore increasingly, as politicians look for solutions for improving economic competitiveness, they may converge onto the same set of ideas.

The Singapore experience is not unique. The Singapore government has managed to manipulate forces generated from globalization to justify its own political agenda by pushing education reforms to make Singapore more economically competitive in the global market place. The various economies of the Asia-Pacific, such as Japan, China, Hong Kong (a special self-administration region of China), Taiwan and South Korea, are all engaged in education reform, in one way or another, with similar motivation and facing tensions between the ideals and realities of education reform. For example, in mainland China, the government is trying to change from an examination-oriented education to a quality-oriented education, the intention of which is to develop students in an all-round way with a focus on creativity and practical skills. However, the challenge is the widening gap between the 'good' schools in the coastal cities and the 'poor' ones in the countryside. In Hong Kong, the school-based management approach is also a balancing game between centralization and decentralization. Each economy faces deep tensions between the ideals and realities of education reform, though such tensions may appear in different forms. This is an area that deserves the attention of researchers and academics.

Though different economies and people, the official rhetoric of the education reforms is rather similar. Education reform is a strategic response to the challenges in the new era of a knowledge-based economy. Enhanced competition in the global market means that the next generation must be differently prepared to enhance national competitiveness. The citizenry, students and teachers need to develop a global world view with a local sensitivity so as to be in line with international standards while serving local needs. Education is made more accessible. Teaching materials are more closely linked to the modern society and real life. At the systems level, power is decentralized (in varying degrees) to the schools so that they may respond flexibly to the needs of the students. At the curriculum level, new interdisciplinary approaches and pedagogies are introduced to develop critical thinking and creativity (project work is one of these approaches).

With similar rhetoric and strategies, yet mediated by local politics, culture and circumstances, it would be interesting to compare the development of these Asia-Pacific economies in the next two decades. The comparison should go beyond the form of the reform to the substance of the reform, analysing the similarities and differences between the assumptions and beliefs that have been challenged and transformed.

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Creating and Interpreting Multimodal Representations of Knowledge: Case Studies from Two Singapore Science Classrooms

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Abstract The emergence of new media is placing unprecedented demands on educational landscapes to restructure and transform. Change is sought urgently in the field of literacy pedagogy where the presence of digital technologies has spawned a vibrant and challenging interest in how teachers and pupils can prepare for the creation and interpretation of multimodal representations of knowledge. Drawing on data from a larger study investigating the use of information and communication technology (ICT) in contemporary school learning in Singapore, this chapter presents two case studies that illustrate the manner in which, and evaluates how well, pupils engaged in the process of crafting representational artefacts in learning tasks in two lower secondary science classrooms. The discussion that follows includes views on the successes and difficulties faced by the study participants in their work with multimodalities. Some suggestions are also made concerning how these difficulties could be overcome.

1 Introduction

Against the backdrop of unpredictable and fragmented globalizing economies, the emergence of new media and the rapidly increasing needs of today's learners are placing unprecedented demands on educational landscapes across disciplines to restructure and transform. In particular, paradigmatic change is sought in the field of literacy pedagogy where the presence of digital technologies has spawned a vibrant and challenging body of interest in 'multimodality', a term which refers to the practice of meaning-making involving the purposeful integration of semiotic resources including: writing, images, speech, gestures, drawing, painting and sounds to mention but a few (The New London Group, 1996; Emmison & Smith, 2000; van Leeuwen & Jewitt, 2001; Kress, 2003; Guo, 2004).

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With respect to the possible directions which literacy pedagogy could take, Kress (2003) makes the important point that language-as-writing is losing its traditional dominance in public communication. Furthermore, he contends that a language-based pedagogy is no longer sufficient for the practices that are needed in our information age. Survival in contemporary social, cultural and personal contexts requires individuals not only to identify the structure and meaning-making possibilities of multimodal texts, but also to exploit these potentials at will.

Drawing on data from a larger study investigating the use of information and communication technology (ICT) in contemporary school learning in Singapore (Freebody, Hedberg & Guo, 2003), this chapter presents a multiple-case study (Yin, 2003) that (1) describes the manner in which, and evaluates how well, pupils engaged in the process of crafting representational artefacts in learning tasks in two lower secondary school classes and (2) evaluates how well the teaching practices dealt with the identification and manipulation of critical elements in learning task design to meet syllabus expectations and the pupils' needs. The discussion that follows includes views on the successes and difficulties faced by the study participants in their work with multimodalities. The chapter seeks to make a contribution to the debate concerning how teachers and pupils can prepare for the creation and interpretation of multimodal representations of knowledge in contemporary learning contexts.

There are two reasons why the material presented and discussed in this chapter is considered important. Firstly, while education in Singapore is currently undergoing systematic study and transition (Luke et al., 2005) there is a paucity of published material relating to multimodality in this particular context. Thus, this chapter puts on record events in local classrooms and then attempts to deal with emerging issues in the development of multimodal practices that are considered germane to the region as far as one can reasonably generalize. Secondly, it is hoped that through our discussion of pedagogic practices relating to multimodality, we can trace links to educational policy initiatives in Singapore and assess their impacts. When reformation is required, new visions are required.

2 Policies and Academic Context

Since 1965, when the city-state of Singapore was formed, the government has consistently directed its education system towards the creation and maintenance of economic stability, moral fortitude and a driving sense of national purpose (Morris, 1996; Ashton & Sung, 1997; Lee, 1998). There can be little doubt that the Singapore government is aware of the challenges it faces. Take, for instance, the balance of pragmatism and foresight displayed in its groundbreaking 'Thinking Schools, Learning Nation' (TSLN) vision (Ministry of Education, Singapore, 1997). Delivered in a speech by the then Prime Minister, Goh Chok Tong, at the opening of the 7th International Conference on Thinking, TSLN begins by defining the task of education as providing 'the young with the core knowledge and core skills, and the habits of learning, that enable them to learn continuously throughout their lives' (Paragraph 7). The discourse continues by acknowledging the robustness of the Singapore education system on the one hand yet realizing that the bases of former successes may not be sufficient for an unpredictable future. Thus, TSLN is a roadmap for 'a total learning environment' involving students, teachers, parents, workers, companies, community organizations and the government (Paragraph 17). Thinking schools are tasked to be test-beds of inquiry and the learning nation's role is to innovate at every level in order to bring about the improvements required. The speech ends with a clarion call for change:

> We will bring about a mindset change among Singaporeans. We must get away from the idea that it is only the people at the top who should be thinking, and the job of everyone else is to do as told. Instead we want to bring about a spirit of innovation, of learning by doing, of everyone each at his own level all the time asking how he can do his job better. With such an approach of always looking out for improvement, always asking what is the purpose of our job and whether there is a better way to accomplish that purpose, we will achieve our ambition of national excellence. Excellence does not simply mean 'outstanding': excellence means each of us at our own level, being the best that we can be. (Paragraph 31)

In practical terms, TSLN attempts to draw explicit links, as Dewey (1900, 1902, 1990) wanted to do over 100 years ago, between education and social progress. Clearly, the design of education that has meaning for life demands the revision and renewal of traditional practices and assumptions about teaching and learning. As an illustration of the way in which TSLN has been translated into a specific educational agenda, the next sub-section reviews the philosophy and aims of the lower secondary school science syllabus currently operating in Singapore (Ministry of Education, Singapore, 2001).

2.1 Lower Secondary Science Syllabus

Devised by the Curriculum Planning and Development Division of the Ministry of Education (Ministry of Education, 2001), the lower secondary science syllabus emphasizes the need for experimentation, innovation and enterprise. The document opens with an unequivocal statement of its purposes and relevance to its intended audience:

> The rapid advances in science and technology require ordinary people to acquire basic scientific and technological literacy so as to enable them to understand and make informed decisions on matters relating to science and technology. Also, the realisation that scientific and technological developments are now shaping people's lives makes it necessary that science education should inculcate positive attitudes towards self and society. (Ministry of Education, 2001, p. 4)

The syllabus promotes a thematic approach to scientific inquiry. There are six integrated themes:

- Diversity
- Cycles

- Models and systems
- Interactions
- Energy
- Measurement

These themes and their related topics are presented in such a way that the acquisition of knowledge and the understanding of scientific concepts are mediated through the achievement of three broad aims: (1) the recognition and appreciation of the usefulness and limitations of the scientific methods to investigating and solving problems; (2) the ability to use process and thinking skills; and (3) the development of attitudes important to the practice of science, including a concern for accuracy, objectivity and inquisitiveness.

3 Theoretical Foundation: Multimodality

With the heterogeneity and hybridity of present-day texts, a central concern in any theory of meaning is to understand the implications of multimodality (Kress, 2000, 2003; Nelson, 2006). As Cope and Kalantzis (2001) explain:

> Meaning is made in ways that are increasingly multimodal; in which written-linguistic modes of meaning are part and parcel of visual, audio, and spatial patterns of meaning. Take, for instance, the multimodal ways in which meanings are made on the World Wide Web, or in video captioning, or in interactive multimedia, or in desktop publishing, or in the use of written texts in a shopping mall. To find our way around this emerging world of meaning requires a new, multimodal literacy.

Developed primarily on conceptions in social semiotics, 'multimodal literacy' is a term used by Jewitt and Kress (2003) to refer to the different ways in which meanings can be created and communicated in the world today. From this perspective, Kress (2000) argues for a new concept of literacy in which all modes and their interactions are to be considered and critically interpreted. This stance implies a shift from the notion of mere competence in literacy to one of literacy as multimodal 'design'. A multimodal design is itself a complex system of many different kinds and relations organized on a number of different scalar levels of organization (Baldry & Thibault, 2005). Furthermore, as Baldry and Thibault expound (2006, p. 172), the process of 'designing, representing and interpreting modalities, involves a constant dialectic between virtual constraints of the mode and the dynamic constraints of the mode as it unfolds and develops in real time'. Hence, as Iedema (2003) advocates, the transformative dynamics of the social meaning-making process requires, inevitably, a dynamic outlook on semiosis. In this section we draw on social semiotic perspectives in multimodality to develop the theoretical foundation and parameters for the 'analytical reasoning' (Mitchell, 1983) used in latter sections dealing with the manner in which, and how well, pupils engaged in the process of crafting representational artefacts.

3.1 Modes, Affordances and Knowledge

Modes are the elements for meaning-making in different contexts. They are, following Kress and van Leuween (2001, p. 22), understood to be 'semiotic resources which allow the simultaneous realization of discourses and types of (inter)action'. That is, modes can be utilized to create links with other times and places, and with other modes (Baldry & Thibault, 2005). From a multimodal perspective, it is essential not only to reflect on content (e.g., what drawings and writing mean), but also on the ways in which different modalities structure what is capable of being communicated. This point leads to a consideration of the affordances of modes.

Different modalities of communicative action offer different potentials for meaning. For instance, that which can be drawn may not be done equally, or is done differently, in writing and vice versa. Furthermore and crucially, the logic and affordances of modes entail users making certain claims about knowledge whether they realize it or not. According to Kress (2003, p. 57):

> If I say 'a plant cell has a nucleus', I have been forced by the mode to provide a name for the relation between the cell and the nucleus. I have named it as a relation of possession, 'have'. If I draw the cell, and have been asked to indicate the nucleus, my drawing requires me to place the element that indicates the nucleus somewhere; I cannot avoid that epistemological commitment.

By implication, multimodal representations of knowledge are realized by the user's design decisions, which are inherently epistemological, in nature. Hence, Kress (2003, p. 37) points out to educators, in particular, that '[i]t is no longer responsible to let children experience school without … understanding of the shift from competent performance to design as the foundational fact of contemporary social and economic life'.

Competent pupil performance with multimodality is further informed by the theoretical distinction made by Lemke (1998) between 'typological' and 'topological' dimensions of meaning. With 'typological' meaning or 'meaning-by-kind', natural language has a specialist function to play in expression (what modes have to 'say') whereas with topological meaning or 'meaning-by-degree', gestures and visual representations present continuous variation more easily. Consequently, potential expressive impact in multimodal communication is enabled by knowledge of the affordances of modes, their appropriate choice and designed interactions.

3.2 Transformation and Transduction in Multimodal Design

Kress (2003, p. 36) asserts that a theory of multimodal literacy must account for the complementary processes of transformation, which 'operates on the forms and structures within a mode', and transduction, which 'accounts for the shift of semiotic material … across modes'. Taken together, these processes can account for and motivate new forms of meaning as a result of 'shifting' ideas across semiotic modes. Moreover, for

Kress (2003, p. 169) the creative use of semiotic resources is 'normal and unremarkable in every instance of sign-making'. This conception of creativity views children not as little linguists abstracting rules from data but as designers, or artists, who shape semiotic resources according to their interests in their particular rhetorical situations.

3.3 Resemiotization

Resemiotization (Iedema, 2003) emphasizes the transformative dynamics of social meaning-making. In particular, it deals with how meaning-making shifts from one context to the next and attempts to explain why certain semiotics are used to do certain things at particular times. According to Nelson (2006, p. 63), 'the meaning of a multimodal artefact at any given moment is necessarily shaped by the meanings that are imputed to its component semiotic parts over time, parts that have semiotic histories of their own'. For example, in one of the pieces of students' work described below, household materials and coloured paper were utilized in a three-dimensional model to represent a cell membrane. It is important to note that the household materials used had a history and the coloured paper went through a process to become paper. The students' cell membrane only came into existence once other modes were brought together in a manner that required their purposeful interaction.

4 Theoretical Foundation: Learning Task Design

Learning tasks are the cornerstone of classroom interactions and give meaning and purpose to the resources and supports used in teaching and learning. When teachers set learning tasks, they make vital decisions that regulate the type and amount of work done (Towndrow, 2005). From a multimodal perspective, the proliferation of multimodality and new media poses an even greater challenge for teachers as task designers. According to Jewitt and Kress (2003, p. 84) the multimodal character of the learning environment is central to how students learn as 'new modal realisations are now bearers of that which is to be learnt'. In addition, it is to be expected that 'Different modes [will] demand different intellectual work from students and this work "fills up" the concept to be learnt in different ways' (Scott & Jewitt, 2003, p. 117). This section establishes the criteria for evaluating how well the teaching practices described below dealt with the identification and manipulation of critical elements in learning task design to meet syllabus expectations and the pupils' needs.

4.1 Design Dimensions in Learning Tasks

One possibility for describing and classifying learning tasks is by making reference to the nature of the structure and degree of certainty of the subject matter they are concerned with (Freebody, Hedberg & Guo, 2003). For instance, in Hannafin and colleagues (1994), learning in open-ended contexts – where a learner's intents and purposes are uniquely established and pursued – is contrasted with traditional instruction that pursues the mastery of fixed concepts done in set ways.

Jonassen (1997) extended the dimensions of open and closed learning tasks by proposing a continuum of instructional strategies based on different problem types. The principal distinction made between problems is the difference in degree of structure embedded in the task set. Well-structured problems are constrained in the sense that convergent solutions that engage the application of a limited number of rules and principles, with well-defined parameters, right answers and right ways to them are all involved. Conversely, ill-structured problems entail potentially multiple solutions and solution pathways, fewer set parameters and principles that may be necessary for an acceptable solution.

Crucially, Oliver (1999) identified teachers and learners as the principal stakeholders in teaching and learning events and showed how these parties can manipulate three overlaying elements, namely content (learning resources), learner supports and learning activities (or tasks) in order to influence learning outcomes. Subsequently, Towndrow, Tan and Hedberg (2005) classified the aspects of classroom practice where teachers exercise their discretionary authority as task designers under five interdependent headings:

1. Control of learning – When tasks are based on learner-centred inquiry, the processes, the goals and outcomes might be defined solely by the learner. When teachers define the goals and the methods by which the learners will achieve them, the interaction is largely teacher-centred.
2. Strategies – There is variation in the degree to which a topic is presented and then described by the teacher and how much control students might have in that process. In inquiry contexts, students will be asked to investigate and to collect evidence, which must then be weighed to determine an outcome.
3. Task structure – Problem-solving tasks may be distinguished by whether they have single or multiple outcomes and whether there is one (often prescribed) or multiple methods or routes in which those outcomes can be achieved (Jonassen, 2000).
4. Resources – The range of resources available to teachers and students in contemporary classrooms is enormous. Possibilities include: textbooks, workbooks, worksheets, whiteboards, transparencies, software, the Internet, media, apparatus and props. From an informed task designer's perspective, each of these items possesses a unique set of characteristics that makes them apt for specific pedagogical purposes.
5. Learning support – The most common type of support (also known as a scaffold) provided by teachers to learners is guidance in how to complete tasks successfully. When scaffolds are overt, the assistance provided to learners is usually procedural (follow these steps to achieve these results). In contrast, less explicit scaffolds are like clues that could be used by learners to disambiguate factors in complex problem-solving situations.

In what follows, we draw on these five dimensions as we examine the ways in which syllabus expectations and the pupils' needs were addressed in the case study classrooms from a task designer's perspective.

5 Method

This chapter draws on data from a study investigating the use of ICT in contemporary school learning in Singapore. Freebody, Hedberg and Guo's (2003) research proposal, titled, 'Digital Curricular Literacies' (DCL) sought answers to three broad questions:

1. How do teachers prepare students for their project work? How can that guidance be improved?
2. How do students collect and synthesize linguistic and multimodal information as they work on their projects? How can that work be improved?
3. How do students construct and present the products of their learning? How can these be assessed and improved?

Material presented in the chapter responds in spirit and intent with the second and third questions; some comments with respect to improving the ways teachers prepare students for project work are made in the concluding section. In order to demonstrate the achievement of these objectives succinctly and appropriately, a case study methodology was adopted as it permitted the researchers to investigate how a multiplicity of factors interacted to produce the objects of study, that is, the unique classroom interactions leading to the design and production of the students' work selected for detailed analysis in the research project (cf. Thomas, 1998).

5.1 Participants

Seven schools in Singapore participated in the DCL study. These were randomly selected to represent a range of socio-economic strata, based on categorizations provided by the Singapore Ministry of Education (Freebody, Hedberg & Guo, 2005). The classes selected were from the Secondary One level, which is the first year of secondary school and, in most cases, the seventh year of formal schooling. The students for the most part would be expected to turn 13 years of age in the course of the first year. From these schools, teachers were selected on the advice of the respective Principal and Heads of the History and Science Departments, and invited to participate in the project. The final number of participating teachers was 27.

5.2 Research Programme

Guided by the principles of 'design experimentation' (Brown, 1992; Kelly & Lesh, 2000; Cobb et al., 2003; Bannan-Ritland, 2003) the DCL researchers investigated the comparative effects of three distinct forms of collaboration with the participating teachers in the areas of:

- Multimodality (especially, the aptness of fit and function provided by multimodal information in the materials encountered in print-based and electronic publications)
- Text-types (the social function and linguistic structure of key genres in the discipline areas of science and history)
- Task design (a consideration of the factors determining the achievement of learning outcomes)

The DCL project team began with a Latin Square Design Repeated Measure (Lazarsfeld, 1978; Pittenger, 2003). The idea was to compare each of the aforementioned treatments in terms of its professional development (PD) implications while controlling (as far as possible) for the other two sources of variation. By grouping teachers according to school, it was envisaged that each school would pass through three rounds of PD where pre- and post-intervention effects could be observed in different sequences (see Table 1).

The interventions were conducted by the researchers in each of the study schools and took the format of workshop-style presentations that were designed to motivate the collaborating teachers to experiment with thinking- and problem-based pedagogies (Jonassen, 2000; Anderson & Krathwohl, 2001). Each workshop, which lasted half a day, consisted of an input session where major issues in the treatment area were identified and illustrated. Follow-up small group work involved teachers in discussion and planning learning tasks for subsequent implementation in their classrooms that incorporated the points covered in the preceding input sessions. Teachers were later observed in their classrooms in what might be described as a pattern-matching exercise (Yin, 2003). In particular, the researchers were interested to see if the teachers implemented ideas presented and practiced in the intervention workshops. It is also important to note that due to operational constraints, the second and third round of interventions were conducted *en masse* in a common location.

5.3 Data Collection and Selection of Cases

A diverse data set was constructed involving lesson observations, audio recordings, photographs, field notes and transcripts of interviews conducted with teachers and pupils following their classes. Notwithstanding, only a small amount of data was col-

Table 1 Latin Square Design – repeated measure programme

Teachers	Pre	PD	Post 1	PD	Post 2	PD	Post 3
Group A		MM		TD		TT	
Group B		MM		TD		TT	
Group C		TT		MM		TD	
Group D		TT		MM		TD	
Group E		TD		TT		MM	
Group F		TD		TT		MM	

MM = multimodality, TT = text types, TD = task design.

lected at both the pre- and post-intervention stages where learners were involved in the planning and production of multimodal artefacts over the course of several lessons. For the most part, data collected showed that students were required to produce short written answers in their workbooks or complete multiple-choice or gap-filling exercises.

From the modest data set available in multimodality, two cases are presented below where various articles of students' work were available for analysis along with supporting interview data from the teachers and students involved. The first case involved a teacher who had participated in the first round intervention workshop in multimodality. This case is presented in order to provide an account of how a regular unit of work was enacted following the workshop. The second case is based on data collected following the second intervention round from a different teacher in a different school.[1] This case was chosen because it was likely to yield similar or contrasting results to the first.

5.4 Data Analysis

In the first place, a coding scheme was developed by the researchers in-house and was applied to the complete units of work under consideration. Coders used an electronic or paper-based sheet and were tasked to appraise five interconnected elements of classroom interactions:

1. The social configuration of the classroom and the activities conducted within it
2. The teacher's explicit rationale presented to pupils for engaging in the activities done
3. A description of the tasks undertaken and the content knowledge conveyed (levels of abstraction and technicality)
4. Modality and the use/interaction of modes
5. Resources and technologies used

Secondly, based on the joint assumptions that (1) evidence of learning and decisions taken in using modes is embodied, in part, in what is produced in class; and (2) the ways in which a learning task is designed and implemented influence both directly and indirectly the possible outcomes in classroom-based work, exemplars of students' work were examined bearing in mind three key areas of the lower secondary science syllabus relating to scientific inquiry (Ministry of Education, Singapore, 2001, p. 14):

1. Knowledge with understanding of scientific facts, concepts and principles
2. Efficient handling, application and communication of information (science process skills and thinking skills)
3. Exploration and investigation (identification and solution of problem; evaluation of methods and suggestions for possible improvements)

[1] This teacher participated in the Text Types intervention in the first round of professional development.

In what follows, the presentation and discussion of students' work samples appears in Section 8. A number of key areas are considered relating to the use of modes and their affordances. These dimensions include: epistemological commitment, expressive impact, transformation, transduction and resemiotization. These analyses are then used as the basis for the evaluation of achievement of syllabus objectives in Section 9. As a precursor to Sections 8 and 9, the next section provides a detailed description of the classroom interactions observed in both case studies.

6 Chronology of Classroom Interactions

6.1 Case 1: Unit Topic

The topic 'Cells – structure, function and organization' is part of the syllabus theme 'Models and Systems'. It was covered in seven lessons over a two-week period. According to the lower secondary science syllabus (Ministry of Education, Singapore, 2001, p. 6) by the end of this unit of study, 'Pupils should appreciate that models are simplified representations of phenomena' and should be able ' to recognize that a system is a whole consisting of parts that work together to perform a function'. The thinking skills and processes to be emphasized in this topic are: comparison, the identification of attributes and components, observation, inference and information gathering.

6.1.1 Lesson One

The teacher began with a whole-class lecture. Questions were asked to elicit information about the structure of (onion) cells. The key differences between unicellular and multicellular organisms were made clear. Next, the teacher used a computer-animated video taken from the school's centralized learning management system to identify the different parts of animal and plant cells and explain their functions. The pupils were instructed to access the video again outside of class time and complete a worksheet for homework.

6.1.2 Lesson Two

This was a two-part lesson conducted in a biology laboratory. The teacher checked the pupils' answers to the previous day's worksheet and provided additional discipline-based content for them to note and remember. The remainder of the lesson involved hands-on work with the microscope. The teacher named its parts and explained their functions. The pupils then practised focusing and completed a gap-filling exercise in their workbooks.

6.1.3 Lesson Three

This was another presentation and practice session on the use of the microscope. The teacher began by demonstrating how to prepare and mount a plant specimen between two glass slides. The pupils repeated what they had seen by examining a sample of onion tissue. They drew what they saw in their workbooks.

6.1.4 Lesson Four

The teacher started with a question-and-answer style lecture about cells, tissues, organs and systems. The class was shown a number of realistic visual representations of human body parts and explicit links were made to material covered in a previous lesson on human physiology. The pupils were briefed about a group-based practical that would be conducted in the next lesson. They were instructed to make a three-dimensional model of a plant or animal cell using materials brought from home. The teacher explained that the pupils' work would be exhibited and that a poll would be conducted to determine the 'winner'. The groups were told to label the different parts of their models.

6.1.5 Lesson Five

The pupils arrived with a variety of materials and ideas for their models. They sat at tables and discussed the practicalities of their project in a lively manner. The class was busy and finished their work in good time.

6.1.6 Lesson Six

The teacher instructed the groups to present their work to the class. Each group displayed their model, explained its parts and spoke about the materials they had used. A few questions were asked about the labelling of the models but no 'winner' was announced.

6.1.7 Lesson Seven

The teacher delivered another question-and-answer style lecture based on all of the worksheets the pupils had used during the unit of work.

6.2 Case 2: Unit Topic

The topic 'Elements, compounds and mixtures' is part of the syllabus theme named 'Diversity'. It was taught in four lessons over a one-week period. The lower secondary science syllabus (Ministry of Education, Singapore, 2001, p. 6) states that by the end of this unit of study, '[p]upils should appreciate that there is a great variety of living and non-living things in the world' and that '[t]he study of the living and non-living things in terms of properties and changes is greatly facilitated by putting them into groups'. The thinking skills and processes to be emphasized in this topic are classification, comparison, elaboration, information gathering and evaluation.

6.2.1 Lesson One

The lesson began with a whole-class review of material relating to elements. The pupils listened attentively as the teacher overviewed the content and procedures planned for the week. The class was informed that it would be involved in a number of group-based investigations and four broad categories of inquiry were set by the teacher: (1) elements, (2) compounds, (3) mixtures; and (4) compounds versus mixtures. After that, ten teams consisting of four pupils were formed and the teacher assigned an inquiry category to each group. The groups were then asked to think of some research questions in their area and these were subsequently handwritten on lined paper and vetted by the teacher (see Appendix 1 for a sample of questions posed for each inquiry topic).

6.2.2 Lessons Two and Three

The teacher instructed the groups to begin searching for answers to their questions. Various sources of information were recommended including textbooks and the World Wide Web (URLs were provided). No other explicit guidance was given except for the requirement for each group to represent its findings on large sheets of paper that were supplied by teacher. The groups continued working on their inquiries in the third lesson.

6.2.3 Lesson Four

The final session was devoted to the presentation of the groups' findings. However, instead of asking each group to report on its own work, the groups were instructed to present material prepared by another group. Most groups opted to read aloud from the sheets of paper and there was a limited amount of teacher-led discussion after each presentation.

7 Commentary

This section examines the teaching and learning that occurred during the units of work described immediately above. Using the task design dimensions presented in Section 4, this commentary seeks to establish the extent to which the observed teaching practices dealt with the identification and manipulation of critical elements in instructional design to meet syllabus expectations and the pupils' needs.

7.1 Control of Learning

To recall, the control of learning in a task is measured by who sets the parameters of interaction that occur between the teacher and pupils in the classroom. In the 'cells' case, it was the teacher who decided the syllabus content, sequencing and pacing (Bernstein, 1990) in the unit of work. Through the teacher's predominantly lecture-driven style of presentation, the 'centre of gravity', to coin a term from Dewey (1900, 1902, 1990) was located squarely outside of the pupils. The teacher chose the task and the pupils followed instructions.

In contrast, and following the researchers' intervention expectations, the 'elements, compounds and mixtures' case presents different levels of teacher control. Much of the authority traditionally invested in teachers to decide who does what, when and how was delegated to the class. As a result, pupils worked in small groups without direct supervision for a large amount of time. But, this flexibility was constrained by the content of the syllabus and the teacher's (necessary) vetting of their research questions.

7.2 Strategies

Strategies relate to the options available to teachers in the dissemination of instructional material. In both case studies, the pupils were required to participate in order to understand, remember and reproduce knowledge. However, the modes of delivery employed were strikingly different. In the 'cells' case, the teacher adopted an approach to learning where authoritative knowledge was seemingly 'bestowed' (Freire, 1970, 2000) upon the class in deposits that were received and dutifully stored. Interestingly in the 'elements, compounds and mixtures' case, the teacher promoted education as a process of inquiry in a manner that can be likened, in part, to 'group investigation' (Sharan & Sharan, 1992) where learners work cooperatively to ask and answer questions using research methods they have designed themselves. Again, this innovation was very much in line with research expectations.

7.3 Task Structure

Problem-solving tasks may be distinguished by whether they have single or multiple outcomes and by whether there is one (often prescribed) or multiple methods or routes in which those outcomes can be achieved. In the 'cells' case, the teacher frequently set tasks where there was only one acceptable answer and where there was really only one way of reaching it. Interestingly, the model-making task did allow for some flexibility in the nature and manner of the artefacts produced but the pupils were not left entirely to their own devices. Similarly, the pupils in the 'elements, compounds and mixtures' classroom were allowed, as per the intent of the task design intervention, to explore multiple avenues of inquiry but they were constrained by the medium in which they were required to make their meanings known: the large format paper.

7.4 Resources

There are many kinds of material resources for teachers and pupils to exploit in contemporary learning contexts. A useful distinction to make between resources relates to whether the information conveyed is first-hand and unprocessed or second-hand and processed. The point to be made here is that when a high proportion of processed materials are used in teaching and learning, the intellectual space surrounding tasks is reduced.

In the 'cells' case, many of the activities conducted relied on the use of pre-packaged and processed resources. Of course, it is understood that induction into the world of science requires the mastery of accepted content and immutable facts but, prototypically, there is also a place in science classrooms for pupils to express personal knowledge, experiences and emotions. There was scope for the softer side of learning to be exercised in the 'elements, compounds and mixtures' case. Particularly, pupils were given access to unprocessed materials on the Internet.

7.5 Learning Support

Teachers can employ a range of mechanisms to manage the interrelationships between themselves, their pupils and the resources used in tasks. A common means of learning support is when teachers provide guidance on how to complete a task in terms of the content to use and/or the steps to be taken. According to Saye and Brush (2002) there are two ways in which teachers can facilitate the thinking around a learning task. The first method, 'hard scaffolding', involves providing static supports that can be anticipated and planned in advance based on a typical pupil's profile. The second channel of support, 'soft scaffolding', is more dynamic and situational. Soft scaffolds are provided spontaneously as teachers monitor and respond to their pupils' performance in tasks.

The 'cells' case exemplifies the use of minimal hard scaffolding. When the model-making task was introduced to the pupils, they were required to participate in an extrinsically motivated, competitive activity but there was little or no explanation about how to complete it successfully. The nature of the scientific inquiry in the ‘elements, compounds and mixtures’ case was less well-structured and more concept-oriented. We return to the implications of these learning support design decisions later.

8 Artefacts

This section assesses the type of multimodal meaning-making that occurred, and the epistemological commitments made, in the examples of pupils’ work shown in Figs. 1–4. This is done, primarily, in the expectation that the students’ multimodal decision-making can be made evident by scrutinizing what they designed and produced.

8.1 Animal Cell

Figure 1 is an analogic representation of an animal cell. As cells can only be seen through a microscope, the students were involved in exploiting the affordances of modes and using them to express typological and topological meanings for the naked eye. The model combines two modes of representation to form an ‘ensemble’. The first element is the available household materials that were transformed or resemiotized through design to be the various cell organelles: coloured paper

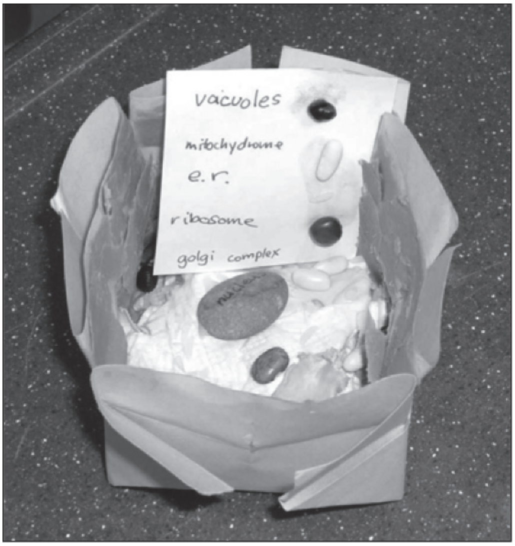

Fig. 1 Pupils’ three-dimensional representation of an animal cell

(cell membrane), cotton wool (cytoplasm), beans (vacuoles), grains of rice (endoplasmic reticulum) and a pebble (nucleus). Secondly, writing is used to identify and label the parts of the model. There is a legend and one instance of embedded text where the word ‘nucleus’ is handwritten on the pebble. This writing makes sense of the model for the viewer.

Other meanings are conveyed through the representational aspects of the model; specifically, it is proportional and the various elements portrayed have been placed strategically to craft complex topological relationships. For instance, consider the choice of folded paper to represent the double-layered cell membrane – this element is used to symbolize the ‘boundedness’ or ‘wallness’ of the cell in the sense that there is now a designed relationship between form and meaning in the material used. Interestingly, the model also assumes domain-specific knowledge of the viewer. An obvious example is the use of the two-letter acronym ‘e.r.’ for endoplasmic reticulum.

8.2 Plant Cell

Figure 2 is a three-dimensional representation of a plant cell. Again, two modes are employed to mutually inform each other and the viewer. In this instance, notepaper, crumpled paper, cardboard, two plastic bags, a table tennis ball and written text were used.

Clearly, the creators of this model thought carefully about its shape and size as the relative proportion of the cell organelles is an important concept to learn and the ‘logic of space’ in modes (Kress, 2003, p. 45) is used to good effect in realizing this objective. It is most likely that the pupils began by making a pink cardboard tray to hold the other elements in place. This shaping, that is, what

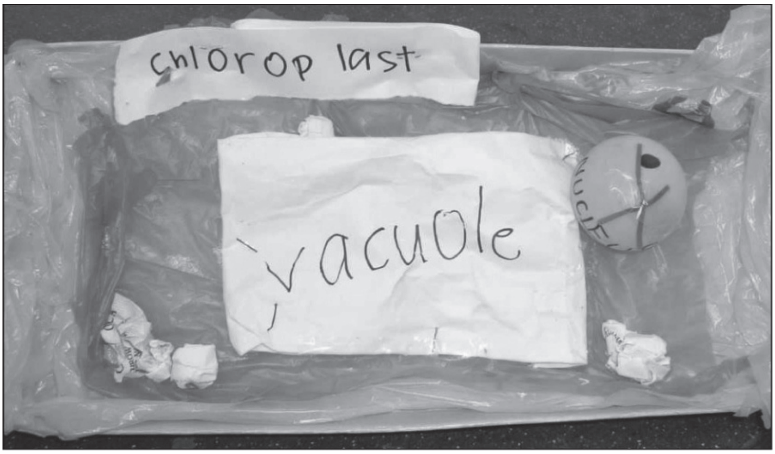

Fig. 2 Pupils’ three-dimensional representation of a plant cell

relates to the function of the cell wall, is an example of transformation where flat card was restructured into a three-dimensional container to meet the specific needs of the sign-makers. Interestingly, a bright yellow plastic carrier bag and a smaller red plastic bag were flattened and placed within the 'cell wall'. In the model the red bag 'is' the cytoplasm and the yellow bag 'is' the cell membrane.

8.3 Mixtures

Figure 3 is the product of one group's investigation into the nature of mixtures (see Appendix 1, Group C). At the macro level of analysis, this artefact consists entirely of handwritten text in blue ink on a plain white background. As such, it is a symbolic representation that is designed, in all likelihood, with decorative purposes in mind – that is, to motivate the viewer to attend to the messages conveyed on the sheet. The pupils chose to represent their findings in a bulleted list; no doubt to facilitate easy recall of the facts presented.

At the micro level, Fig. 3 employs a limited number of instances where the mode of writing is exploited for its aptness in response to the task set. Meaning-making occurs between the differential size of text in the title and the bulleted points. Additionally, through the layout of the text, these features interact in a fashion that is reminiscent of other authoritative sources of knowledge that the pupils have seen (e.g., textbooks and electronic slide presentations).

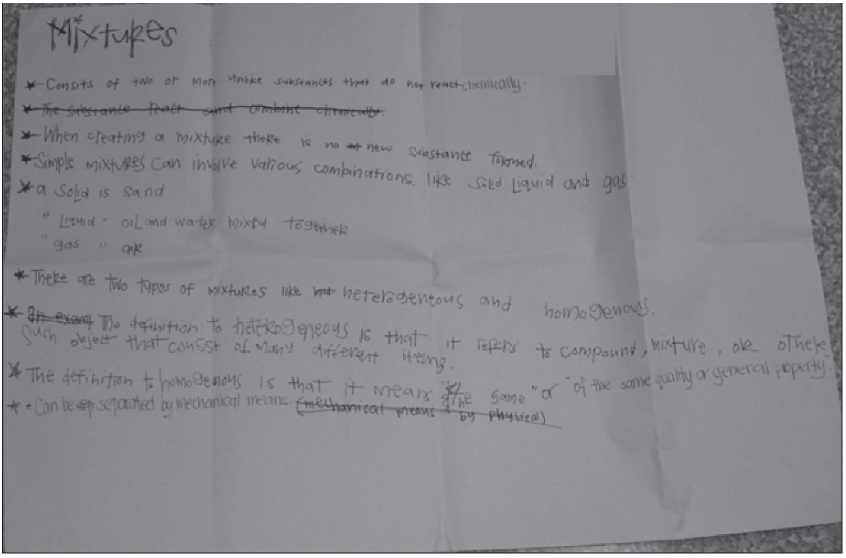

Fig. 3 Group C's findings on the topic of 'Mixtures'

8.4 Elements

Figure 4 is an ambitious multimodal representation of knowledge (see Appendix 1, Group A). This assessment is not based simply on its decorative, symbolic and 'typographical' features but the choice of modes of representation used and their meaningful combination.

There are no less than four instances where the pupils used text and pictures to make meanings that could not have been made as easily, if at all, in a mono-modal, written presentation. For instance, within the immediate proximity of the sub-heading 'Transition Metals' and the bulleted points beneath it, there is a hand-drawn representation of the Periodic Table of Elements that distinguishes this group of elements from all others. This is achieved through the use of colour (the cells for the transition metals are yellow, the rest are red). Superficially, this may not seem to be particularly surprising, but consider the complexity of attempting to specify in full sentences the same information that is conveyed in the drawing. Undeniably, the drawing works with the text to extend the meaning that is made in an efficient and apt manner.

Finally, attention is drawn to the layout of the graphical representation. Clearly, some important meanings are conveyed through nesting and embedding techniques. As in Fig. 3, points are subsumed under headings and the drawings have useful titles within them, but the distribution of these 'sections' bears little immediate relation to the order of questions that the pupils posed at the beginning of their inquiry. Although the information presented is classified, it is unfortunate that the branching and linking of concepts is not clearer.

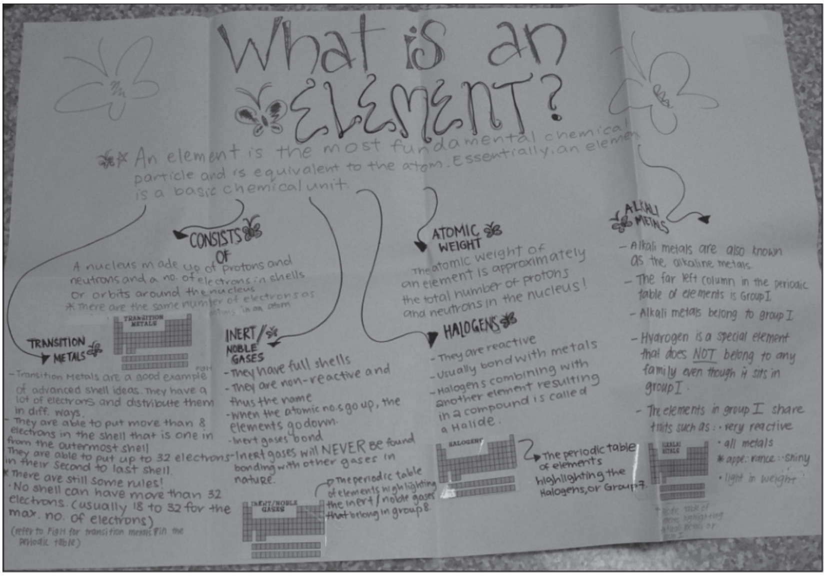

Fig. 4 Group D's graphical representation 'What is an Element?'

9 Achievement of Syllabus Objectives

This section draws together the case study material presented so far and attempts to assess the extent to which syllabus objectives were achieved. Consideration is given to levels of pupil engagement and the purposeful integration of semiotic resources.

9.1 Cells

The teacher's design intentions in the model-making practical were to create a relaxed and playful environment in which the pupils identified the attributes and components of cells. Although the task required observation and information gathering, there is also evidence from the description of classroom interactions and the samples of pupils' work to suggest that it also involved the reinforcement of the teacher's authoritative knowledge. Could more have been done to promote learning with a deeper understanding of scientific facts, concepts and principles? Comments made by the pupils in post-activity interviews suggest a number of possibilities.

The pupils recounted how they began by looking for materials they could 'lay their hands on'. Two of the three groups of pupils interviewed mentioned that they did some research on the Internet to understand more about the shapes and sizes of plant and animal cells. Later, they used these 'available designs' (New London Group, 1996, p. 81) in innovative and interpretive learning stages from lecture/book to the Internet to collecting material to creating a totally new design. Alternatively, the third group chose to fall back on their primary school textbooks and notes. Whatever the processes involved, all of the interviewees agreed that the task was fun and said that they enjoyed the group work. They also appreciated the fact that the teacher did not grade their models. However, when asked to explain the 'purpose' of the model-making task and what they had learnt through its completion, the pupils were vague as the following extract from a post-activity interview illustrates.

Perhaps weightier engagement in the cell model-making case could have been achieved if the teacher had explained its purposes more explicitly and scaffolded its processes with greater precision. Prototypically, content of this kind provides opportunities for comparison and for inferences to be made but the competitive aspects of the task narrowed the scope of exploration surrounding it. An alternative strategy might have been to start with questions that framed or set parameters for an inquiry such as: How could it be shown that a cell is a system consisting of parts that work together to perform a function? If (and it is a big if) we chose to make a three-dimensional model, which materials could we use? Where would we get them? And how could we appraise their adequacy in terms of the functions they are meant to represent? Then, the teacher could have asked each group to prepare a plan of action for discussion and agreement prior to the commencement of work. As the projects were underway, the teacher could have provided soft scaffolding concerning the pupils' attempts at integrating their resources.

Research assistant (RA):	How do you think the model helped you understand the structure of the cell?
Student 1 (S1):	It shows all the fine details of the cell.
RA:	Some parts?
S1:	It's just what is written in the magazine.
RA:	So, you learnt additional information about cells from the model?
Student 2 (S2):	Ya.
S1:	Ya.
S2:	And what structure. What it is used for.
RA:	That's the different parts?
S1:	Ya.

Indubitably, the students' cell models were creative and involved the transduction of modes, which is an inherently transformative and creative act illustrating the interrelated processes of composition and learning. And yet, if the teacher had lectured less before the students built their cell models and scaffolded the students' work differently, she could have helped them develop their multimodal literacy more effectively. Additionally, even greater engagement (in the world) might have been achieved if the students had been asked to 'design' something addressing wider problem variations (e.g., propose and make an educational aid for learning about the structure of plant or animal cells). Finally, at the end of the project of this nature, two key factors need to be dealt with by the teacher: (1) the pupils must know how well they did and be given the opportunity to reflect on their performance and (2) a way needs to be found to return from an everyday understanding of scientific concepts with everyday materials to scientific principles. Prompts that would promote such analysis include:

- Explain the partial permeability of a cell membrane.
- What can we learn about the relative position of cell organelles by building a three-dimensional model of a cell that cannot be gleaned from a two-dimensional representation?
- What is the relationship between the cell membrane and cell wall? How could changes in this relationship be explained?

9.2 *Elements, Compounds and Mixtures*

Through our intervention, we hoped to respond to the multimodality and task design issues identified in the 'cells' case. In the 'elements, compounds and mixtures' class, the teacher started with a noteworthy inquiry-based orientation and was open to our suggestions. But how much difference was made and were the pupils able to capitalize on the opportunities for thinking provided? Once again, we begin our discussion with comments made by the pupils in post-task interviews.

A total of four groups of pupils were consulted and they provided a series of frank and insightful comments on the task they had performed. Most, it was discovered, had little or no prior knowledge relating to the topics under investigation and felt that they had learnt something useful in their individual projects. They enjoyed the freedom of searching the Internet and found this to be more engaging than sitting through 'PowerPoint' presentations in class. They also appreciated the opportunities given to them to critique their peers' work. This task design feature gave them a sense of what it is like to be an authoritative source of knowledge in the classroom.

However, the pupils were also critical of their performance. They realized that there were instances in which more could have been done to make their intended meanings clearer in their graphical representations. They admitted that they could have added more pictures, images, tables and charts. There was also some doubt, as the following excerpt shows about whether their work was to be assessed:

As with the cells case, these comments suggest that the pupils would have benefited greatly from information relating to the purposes of the task and the expectations surrounding it. Although it is acknowledged that the teacher's task design allowed the pupils to distinguish elements, compounds and mixtures through information gathering, comparison, classification and analysis, it is contended that the pupils failed to reach their full potential. Two major hindrances are identified to explain this situation.

Firstly, as Fried-Booth (2002) observes, the success of a project depends to a great extent on detailed attention to planning. If at the planning stage, the teacher had mentioned or better negotiated the evaluation criteria to be used at the end of the project period, then the pupils might have had clearer expectations about what to do and how to do it. Working blind suits some pupils but for others it is tiring and fosters insecurity.

Secondly, if the teacher had scaffolded the task differently, the pupils might have had a better chance of: (1) elaborating concepts and (2) capitalizing on modes of

Research assistant 2 (RA2):	Are you being graded on this?
Student 1 (S1):	Graded? I don't think so. It's just I think this project is to help us.
Student 2 (S2):	Ya, to help us understand the chapter better.
RA2:	OK.
Research assistant 1 (RA1):	If you were being graded, would you have done better?
S1:	Yes.
S2:	Yes, definitely. And we would be given more time.
S1:	Ya.
RA1:	OK. In what sense better?
S1:	Pictures.

meaning they used to express intended meanings in a richer, more value-adding way. Consider the pupils' questions posed at the beginning of the inquiry (Appendix 1); many of the queries sought factual and well-structured information. As a consequence, the pupils' outcomes required the reproduction of authoritative, text-based material. However, if the pupils had opted for more open-ended inquiries they might have had more compelling reasons to use symbols, diagrams, charts, tables, pictures, realia, etc., to help make their ideas more comprehensible to others (cf. Ministry of Education, Singapore, 2001, p. 11).

10 Concluding Remarks

This chapter set out to illustrate the manner in which pupils engaged in the process of designing and producing multimodal representations of knowledge. Two case studies were presented from two lower secondary science classrooms in Singapore that were part of a research study designed to study and provoke change in local pedagogy and practice. Although it is fully admitted that the pool of available data for analysis was limited and that the professional development opportunities for participating teachers in the study were modest, the findings discussed above are illustrative of the manner in which certain syllabus aims and objectives in science were addressed by teachers' and pupils' working in everyday classrooms in Singapore. In particular, the case study data showed how contrasting task structures had the potential to bring about different learning outcomes but for an entirely predictable reason. Following crucial intervention work, it is suggested that the learners in the second case study were better able to engage in semiotic work with modalities because their teacher included multimodality in his learning task design considerations. Specifically, he allowed the students to investigate and to collect evidence to support their inquiries and he was not overly prescriptive about the type of outcomes possible. In fact, the only significant restriction in the task set related to the use of large-format paper in the students' presentation of findings.

When students' output is restricted to short, workbook-type exercises, opportunities are missed to use and exploit the rich array of learning resources available in contemporary learning contexts. Arguably, multimodality is a vital means by which today's learners can make sense of the world for each other (Guo, 2005, personal communication). If this point is accepted, then it is of critical importance for both teachers and students to utilize multiple modes fluently and unambiguously in order to explore and communicate competence in a specific knowledge domain beyond the level of the novice. Yet, if the lower secondary science cases considered in this chapter are anything to go by there is still much unexplored multimodal learning capability to be exploited in Singapore schools. This finding is, of course, significant in the local context but it also raises questions, more generally, about what teachers in the Asia-Pacific region can do help students prepare for the creation and interpretation of multimodal representations of knowledge.

10.1 Implications for Reforming Learning in the Asia-Pacific Region

Issues concerning the uses and affordances of different modes of representation through which today's youth can conduct their social and cultural lives can be related easily to the rapid development of new media technologies and the goal of developing media literacy education. As information spreads and awareness is raised, the advent of the information or knowledge-based society has seen governments in the Asia-Pacific region spending large sums of money on the development of ICT infrastructure. Seemingly, as any search of government agency websites confirms, no nation wants or considers that it can afford to be left behind. The widespread conviction, running against user preferences in some cases (see Bodomo, Lam & Lee, 2003) is that ICT usage and new media literacy are key strategies for the promotion and implementation of education for sustainable development in terms of the economy and social justice (UNESCO, n.d.). But beyond the often self-serving talk of developing technology-smart curricula and of wanting to create citizens who are wise consumers of information, there is, in our opinion, a largely unacknowledged and urgent need to build students' acumen in working with new media (cf. Burniske, 2006) and multimedia via teacher professional development activities that serve to critically interrogate current literacy practices relating to the consumption of information and the production of knowledge in specific domains.

Returning to science, the development of scientific literacy pertains directly to multimodality and the processing of multimedia materials. This is because, science shows an overriding importance of material things in relation to words; it connects action through experiment and demonstration, and it uses images for knowledge representation (Kress et al., 2001). Put in the words of Williamson (2005, pp. 3–4):

> Scientific literacy means being familiar with the language and actions and practices of scientists, and it also means being able to interpret scientific language, 'reading' scientific evidence, understanding why science is represented in multiple modes such as pictures, diagrams, tables, or in statistics and equations and verbal text, and how and why it is communicated in the media. Furthermore, it means being able to critique these processes and practices.

The importance of this statement lies in the realization that making science meaningful and communicating its ideas effectively is bound up intimately in the transformation of signs in particular social contexts. Crucially, this means that being able to arrange and devise multiple meaning-making modes of communication is an essential part of the educative process in science. Yet, as sound and desirable as these notions relating to 'talking science' might be, their integration into actual classroom interactions are not common in certain regional contexts; for more information about science literacy practices in New Zealand, see Hipkins and colleagues (2002, p. 181).

We speculate with a good deal of confidence (due in large part to the lack of published material available or research conducted in the field) that the previously mentioned details concerning scientific literacy in New Zealand raises a set of issues that is pertinent to all other nations with the Asia-Pacific region. Specifically, we ask, how can teachers bring new and multiple-media into their enactment of science curricula especially in cases of personal ambivalence: cases where teachers are not sure what the benefits of doing so might be (because of a lack of personal experience) or how (because of a lack of pedagogic content knowledge and the vocabulary to discuss issues with colleagues)?

There are, we suggest, a number of strategies and support mechanisms that can help science teachers move forward. But in order for these items to stand any chance of successful adoption, colleagues in contemporary or emerging contexts need to accept and understand that their work as science teachers necessarily involves helping their students to read and communicate science using a repertoire of strategies that goes beyond simply supplying short written answers. In some cases, it is expected that this is not the perception that teachers have of what science teachers are required or trained to do but urgent change is required in the profession.

In terms of instructional strategies in science that can be developed, there are two exemplary practices in New Zealand worth noting especially where English is not the first language of students. First, to make theoretical concepts assessable, teachers are recommended to access students' private world of experiences through personal anecdotes and metaphorical devices. Then, the use of diagrams, pictures and visual images provides a channel through which curriculum content can be accessed without heavy reliance of lexically dense text (Hipkins et al., 2002, p. 179).

As far as support mechanisms are concerned, teachers require top-down support for their curriculum implementation and professional development initiatives. In the area of curriculum, three items concerning task design and implementation deserve mention. First, it is crucial for (science) educators to acknowledge that multimodality can act as the catalyst that opens up the inquiry-space in a learning task. In particular, multimodality allows students to express their understandings of instructional content with greater impact through the apt selection and purposeful interaction of modes and also extend their learning explorations across time and space. Second, it needs to be realized as a matter of principle that the ability of pupils to complete a learning task successfully is a product of the extent to which its purposes have been explained and understood. When pupils have to 'second guess' what the teacher wants and when doubt surrounds a task, engagement in the classroom inevitably suffers. Furthermore, it needs to be understood that pupils can give expression to a wider range of thoughts, emotions and experiences when they are allowed to make choices about the modes they use and ways they represent their own knowledge. The practice of meaning-making involving the purposeful integration of semiotic resources occurs when the power of multimodal texts is located and defined. Teachers are advised, then, not to impose undue restraint on how pupils express their meanings. They are also counselled to monitor pupils' work in progress carefully and give advice and support when they see modes being used that are ambiguous or ineffective. Third, opportunities in regular classroom time need to be provided for pupils to reflect on two key areas in their learning performance: (1) the strengths and weaknesses of classroom approaches and (2) how improvements can be planned, implemented, monitored and evaluated.

As far as professional development is concerned, administrative support is required which would allow teachers to act as researchers in their own classrooms. Where appropriate, teachers could investigate in their own terms (perhaps with the support of academic researchers) how to facilitate the use of multiple modes of representation and articulate what the benefits are of working in this way. Additionally, we contend, that teachers need to work towards communicating their ideas relating to successful practices with their colleagues. This can be done online and could include the sharing of instructional materials and mentoring techniques. Overall, the purpose of such support networks, whether face-to-face and/or virtual, is to promote dialogue, reflection and evaluation.

Finally, given the local and regional contexts described and discussed in this chapter, it is our conviction that teachers' hands are within grasp of the levers of pedagogic change, but they must be motivated to do so in the interests of helping students learn and prepare for the future. We believe that pupils, today, are best prepared for work and study when their learning environment embraces multimodality and inquiry-based task structures as regular features of classroom interactions, but this does not mean a return to point zero. In the case of science, teachers already have ample opportunities to use various modalities in meaning-making over and above oral and written communication. This chapter shows at varying degrees of effectiveness that students can use modalities to repeat laboratory procedures, design and create three-dimensional models and draw figures and so on. The next step in integrating multimodality into regular classroom work involves learning to talk about it with other teachers and researchers in a purposeful way using a common vocabulary. Hopefully, the material presented and discussed in this chapter will facilitate such conversations.

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Appendix 1: Samples (unedited) of group inquiry questions for the unit of work on elements, compounds and mixtures

Group A: Elements

1. Why can't elements be broken down further by chemicals?
2. Who names the chemicals?
3. Why are the transition metals squeezed in between here? [The pupils drew a schematic version of the Periodic Table of elements locating the spot between the third and fourth columns that they had in mind.]

4. Why are some elements more reactive than others?
5. If some elements are man-made, wouldn't they be able to be broken down into simple substances?
6. Why do they use short forms for the elements?
7. Do metals or non-metals have all properties or do they have some?
8. Why must they become separated from metals to gases?
9. In what way is the periodic table classified?

Group B: Compounds

1. What are compounds?
2. Examples of compounds?
3. How are they formed?
4. Are they similar with mixtures?
5. What are the different ways of breaking down compounds?
6. How to differentiate compounds and mixtures?
7. How to know the number of elements in a compound?
8. Are all compounds reversable to get back its element?
9. Why must it be broken down?
10. Are there any elements that can be chemically formed into a compound?
11. What are their properties?
12. What are their characteristics?

Group C: Mixtures

1. What is a mixture?
2. Are mixtures harmful?
3. What is the major use of mixtures?
4. What are the common characteristics of mixture?
5. What are mixtures made up of?
6. How do mixtures help us?
7. What method can be used to break it down?

Group D: Compounds versus mixtures

1. What is a compound?
2. What is a mixture?
3. Why must we compare them?
4. The differences between compounds and mixtures
5. How are compounds and mixtures formed?
6. How are they useful?

7. Why must we know about them?
8. Properties of a compound?
9. Characteristics of a mixture?
10. Can they be separated?

Reforming Teaching and Learning Using Theory of Multiple Intelligences: The Macao Experiences

Kwok-Cheung Cheung

Abstract Macao is a Special Administrative Region of China where schools enjoy a high degree of autonomy and undertake school-based educational reforms. After the 1999 sovereignty transition, many kindergartens, primary, and secondary schools, as well as special schools attempted to apply Gardner's MI Theory to reform teaching and learning in order to implement an individually configured educational experience for students. This chapter discusses individually configured education in the postmodern era, and proposes a school-based MI-inspired action research paradigm for undertaking reform in instructional design, assessment practices, and the school curriculum. Based on the MI-inspired action research paradigm, research-based examples are presented of how Macao schools are making use of MI Theory to reform schooling towards learning with understanding and liberation of students' potentials and abilities.

1 Introduction

Shortly after the 1999 sovereignty transition, a number of schools in Macao began to reform teaching and learning using Howard Gardner's Theory of Multiple Intelligences (MI). At the kindergarten (i.e. K1–3) and junior primary levels (i.e. Grade 1–4), teachers used the framework of MI to assess children's learning profiles (Cheung & Wai, 2001; Cheung & Lou, 2003). Based on the multiple intelligences profiles (MI-Spectrum), teachers engaged in teaching experiments to reform teaching and learning with the aim of achieving the ideal of an individually configured education – an education that takes individual differences seriously and crafts practices in a learning environment that serves different kinds of minds equally well (Gardner, 1999; Cheung, 2002). According to Gardner (1999), the crucial ingredient of individually configured education is a commitment to knowing the minds of

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individual students, as well as learning about each student's background, strengths, interests, preferences, anxieties, experiences, and goals. The goal is to avoid stereotypes and preordained pathways for students and to ensure that educational decisions are made on the basis of an up-to-date multidimensional profile of each student. MI-inspired teaching materials and books were published as a result of these school-based teaching experiments (see Cheung, 2003a, b). At the senior primary level (i.e. Grade 5–6), some schools explored the viability of self-rated multiple intelligences assessment. These successful experiences were extended to grades at the secondary level in Macao (Cheung, Tang & Lam, 2003). It is noteworthy that all of the above school-based action research and teaching experiments were conducted by the present author and his associates from local schools and the University of Macau (see Cheung, 2004b for a comprehensive account).

At the turn of the millennium, revisions in curriculum standards in Macao and Chinese Mainland heightened the attention of schools to individually configured education in most subject areas (e.g. Ministry of Education, People's Republic of China, 2001, p. 1). With this impetus to explore significant educational reform, a series of teaching experiments and action research projects were conducted from 1999 to 2004. All teaching experiments follow a common school-based MI-inspired action research paradigm within which MI Theory is adapted for deployment in the Macao context. These projects will be further explained in Sections 2 and 3.

2 The MI Theory Applied in Macao Context

Gardner has maintained that development of MI in children cannot be an educational goal by itself. Instead, MI Theory should be regarded as one useful tool to realize valued educational goals in the postmodern era. After consulting Gardner's seminal work, the present author and his research associates summarized for local schools and teachers three core claims of MI Theory that needed scrutiny and experimentation:

1. The plasticity of MI potentials is very high in all children.
2. Intellectual differences should not be attributed simply to the amount of knowledge acquired or to the speed of cognitive processing.
3. The main purpose of nourishing children's multiple intelligences is to develop competencies and talents cherished by the societies and cultures in which they live.

The eight multiple intelligences are: (1) linguistic; (2) musical; (3) logical-mathematical; (4) spatial; (5) bodily kinaesthetic; (6) interpersonal; (7) intrapersonal; and (8) naturalist (Gardner, 1983, 1999; Cheung, 2001). The promise of MI, if realized through school-based action research, would bring about significant educational reform where: (1) children's development is balanced and holistic; (2) the focus of assessment and observation is on the individual's unique configuration of intelligences; and (3) problem-solving abilities and creativity, amongst other valued competencies, are cultivated through individually configured education. In order to help teachers make a transition from traditional classroom practices towards individually configured education within the oriental

Macao context, there is a need to educate teachers to differentiate between education practised in the past modernist era and the current challenges posed by the postmodern era. Under this backdrop, the four main foci of MI-inspired school-based action research conducted by the present author and associates will be explained and research-based examples of MI-inspired assessment, pedagogy, and curriculum will be presented in Sections 3 and 4 respectively.

3 The School-Based MI-Inspired Action Research Paradigm

3.1 Individually Configured Education in the Postmodern Era

While educators are still exploring how one should conceptualize postmodern education properly, one clear aspiration is to celebrate the diversity of human potential and to enable individual learners to be more active and agentic in their lifelong educational journey. This ideal for education in the twenty-first century is complementary to the conception of lifelong learning in a knowledge society. I argue also that it is compatible with the philosophical underpinning of Confucian education. For example, the disciples of Confucius were generally multi-talented. The Confucian school maintains that students should not possess only one single kind of talent. Instead, one should acquire diverse knowledge and skills, and nourish oneself for the germination of multiple potentials and abilities (see Cheung, 2003c for a complete account of this analysis).

3.2 Integrating 'Assessment of Learning' with "Assessment for Learning" in Classroom Practices

In the school-based MI-inspired action research paradigm explicated in Section 3.4, both 'assessment of learning' and 'assessment for learning' are emphasized. According to Birenbaum and colleagues (2006) these two aspects of assessment should be coordinated as an Integrated Assessment System (IAS). According to these assessment experts, 'assessment of learning' is generally one-dimensional, summative, inauthentic, context-independent, inflexible, and invites teachers to teach for the test. Instead, 'assessment for learning' is meant to be multi-dimensional, formative, integrated into the curriculum, authentic, context-embedded, and flexible. Based on the recommendations of Birenbaum and colleagues (2006, p. 65), there are altogether seven principles for the development of a learning IAS. They are listed below:

1. The learners participate in the assessment process.
2. Assessment is contextual and responsive, and it is aligned to instruction.
3. The focus of assessment is what the learners know and are able to do. IAS is not focusing primarily on gaps in learner knowledge and/or performance.

4. Both learning processes and products are assessed.
5. Assessment criteria are transparent to individual learners and teachers.
6. Learners and teachers get feedback about assessment results and outcomes.
7. The key aim of IAS is to inform learners and teachers on how to progress in their learning.

These principles were used to guide the development of assessment practices in the schools that participated in the action research projects on MI conducted in Macao. The systems of assessment, curriculum, and pedagogy need to be in alignment if significant educational reform is to be successful.

3.3 Some Examples of MI-Inspired Educational Research

During the past two decades around the world, there is no shortage of research at different grade levels and in different subject areas that uses MI Theory as its conceptual guide. The original significant research of Gardner and Hatch (1989) identified seven relatively independent forms of information processing that individuals exhibit in differing patterns and introduced readers to three exemplary MI-inspired educational research projects: (1) Arts PROPEL; (2) the Key School project; and (3) Project Spectrum.

Carlisle (2001) described how one preschool programme's curriculum evolved to consider children's individual differences in learning with hands-on active learning and explorative activities designed to develop the skills related to each type of intelligence. Reiff (1997) suggested that planning, teaching, and assessment should be based upon learners' individual needs and their multiple intelligences. Teaching and learning aim to help develop particular intelligences and strengthen the existing ones. These research projects are labelled as 'teaching of MI' which is further explained in Section 3.4.

Armstrong (1994) applied MI Theory in designing time-telling exercises for young learners by linking instructional activities to words, numbers or logic, pictures, music, the body, social interaction, or personal experiences. The learning and deep understanding of time concepts is the main focus of the research. Another application of MI was reported by Daniel (1997) who designed seven MI-based laboratory stations for a unit on the periodic table that focuses on the concept of patterns so that students with different learning styles could be enabled to understand the concept meaningfully. Such research is labelled as 'teaching with MI' to be explicated in Section 3.4.

There have been research attempts, such as that by Teele (1996), to examine students' dominant intelligences at different grade levels with the aim of redesigning educational systems to enable all students to succeed. Reese (2002) also examined issues of students' varied learning styles and intelligences in the career and technical education classrooms, and looked at assessment and testing methods and the technology that was available to teachers to assist in the learning process. These types of research projects are labelled 'teaching about MI' to be explicated in Section 3.4.

Finally, Saban (2002) used MI Theory to personalize students' learning experiences in an elementary school in Turkey using core courses and activities, explorations, and projects. Another is Hoerr (1997) who reported that educators at the New City School employed a school-wide approach to multiple intelligences by changing schooling practices in three directions: curriculum development, student assessment, and communication with parents. Learning centres, living museums, videotaped portfolios, and standardized examination results attested to improved student achievement. These research are labelled as 'teaching for MI' to be explicated in Section 3.4.

3.4 The Four Main Foci of MI-Inspired School-Based Action Research

Inspired by Lazear (1999a, p. 7) and the research examples cited in Section 3.3, the present author and associates proposed four main foci of MI-inspired lessons and activities. These are summarized in Fig. 1. The four foci of MI-inspired school-based action research are: (1) teaching of MI – germination of pertinent abilities and potentials; (2) teaching with MI – concept learning with deep understanding; (3) teaching about MI – monitoring growth of intelligences; and (4) teaching for MI – intelligence-fair learning environments (see Cheung, 2003b, p. 47, for the original formulation of this paradigm). Using this paradigm as a guide, school-based action research can be conducted in different types of schools and at different grade levels to achieve a wide spectrum of educational goals. Irrespective of the main focus of action research, the main purpose of assessment is to provide information to foster lifelong learning in the postmodern era and guide the direction of child development within zone of proximal development.

The main focus of teaching of MI is proximal development and in-time germination of potentials during critical periods of child development (e.g. emergent reading literacy for the 0–5-year-old). Teaching with MI is concerned with the deployment of multiple channels of learning in order to respond to children's multiple ways of knowing so that concepts can be learned with deep understanding. Teaching with MI may be applied in different school subject areas and at different grade levels (e.g. learning the 'long/short' concepts at the kindergarten level). Teaching about MI is about monitoring growth of multiple intelligences. For instance, after assessment of MI potential at school, teachers could distribute MI-Spectra to parents and students themselves, so that they have a better understanding of the multi-dimensional nature of intelligence (see Cheung, 2002 for an explanation of this process). Compatible with the philosophy of MI Theory, strength-based scaffolding, which involves remedying weaknesses while capitalizing on children's intellectual strengths, is practiced within children's zone of proximal development. Last, at the heart of teaching for MI is the construction of intelligence-fair learning environments for purposes of individually configured education (see Gardner, 1993). It is suggested that through home-school and parent–teacher cooperation, as

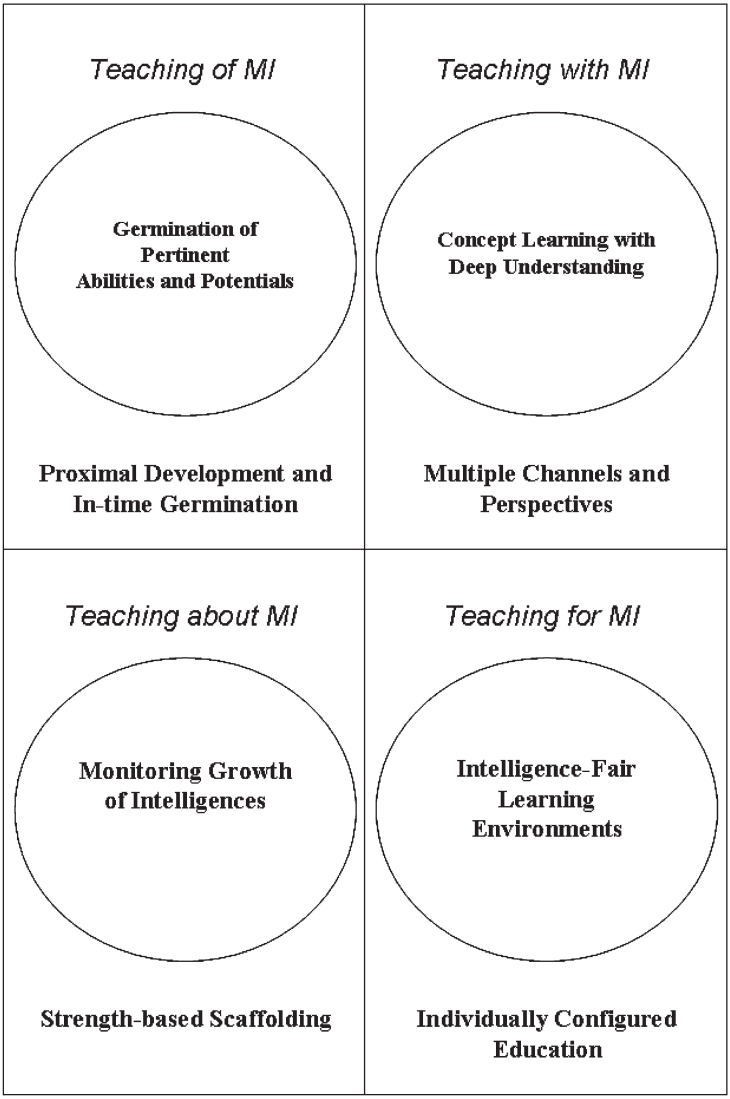

Fig. 1 The school-based MI-inspired action research paradigm

well as with the support of appropriate school policy and adequate provisions, children should be guaranteed opportunities to nourish their multiple intelligences as fully as practicable so that individually configured education can be realized.

With this school-based MI-inspired action research paradigm, it is a fervent hope of the present author and associates that students will become more willing to learn, will be happy to learn, and will be able to learn – thereby setting a firm foundation for their future studies and career pursuits.

4 Examples of MI-Inspired Assessment, Pedagogy, and Curriculum: The Macao Experiences

4.1 Teaching of MI – Germination of Pertinent Abilities and Potentials

In his Beijing tour in May 2004, Gardner delivered a keynote address in an international MI conference reiterating that he did not think that the development of students' multiple intelligences should be the primary purpose of schooling (MI Centre of Beijing Institute of Education, 2005). In Macao, schools and kindergartens echoed his view and hence have not treated the eight intelligences separately for schooling purposes. Nevertheless, in order to prepare teachers to engage in action research for teaching of MI, a book has been written detailing the essence of MI Theory, particularly the definitive concepts, intellectual manifestations, growth trajectories, and the exemplary role models of each of the eight intelligences (Cheung, 2001).

Compared to the other three foci, teaching of MI is a relatively unexplored area. One of the initial attempts in Macao to develop children' diverse potentials can be found in a consultancy project. In 2005, the Macao Social Work Department commissioned a consultancy project to the Faculty of Education to raise the quality of the services of subsidized childcare centres (CCCs) in Macao. The focus of this commissioned project was on reforming child rearing and caring practices of subsidised childcare centres in order that children's talents can be developed as fully as possible. Certainly, much more work is needed to be carried out in promoting the teaching of MI.

4.2 Teaching with MI – Concept Learning with Deep Understanding

Gardner proposed that MI had radical implications for education, particularly in terms of how much content should be covered. The MI Theory suggests that we teach fewer things, but teach them in greater depth and in many different ways. This is very different from the typical emphasis on curriculum coverage of many topics without the opportunity of in-depth learning (MI Centre of Beijing Institute of Education, 2005).

Since 1999, teaching with MI has been explored in a number of kindergartens in Macao (Cheung, 2003b). One goal is to help children master concepts with deep understanding. For example, using Gardner's Think-board, an approach for teaching the long/short concepts has been devised (see Table 1). Briefly, a Think-board is a lesson planning template in the form of a '#' grid with the core concepts long/short placed at the centre, and surrounding the centre are the activities undertaken as a response to the eight ways of knowing (the sequence of the eight ways of

Table 1 Design of MI-inspired learning activities using Gardner's think-board

1. *Linguistic* Teacher uses a table lamp and a wall to play shadow game with the children. They are asked to guess the shapes of the shadows. Children reply dogs, butterflies, etc. They are then brought to the playground to watch their shadows under the sun. At the same time, children sing the Shadow Song together.	4. *Bodily kinaesthetic* Children are brought to play ground to play the Stepping Peer's Shadow Game. Teacher asks children to discuss how they can conceal their shadows using the facilities and toys on the playgrand so as to avoid their peers step on their shadows.	6. *Naturalist* Children are asked to measure the lengths and recognize shapes of their shadows under the sun in the morning, at noon time, and in the evening. Teachers can use a chalk to mark the shadows cast on the ground and guide the children to carry out length comparisons.
2. *Interpersonal* Children are asked to make use of the biggest light source on Earth (i.e. Sun) to cast shadows that are the longest and most varied in terms of form and shape. They are encouraged to discuss and cooperate with peers to seek the optimal solution. Communication skills and mutual understanding are enhanced during the play.	*Concepts*: Long/Short *Level*: K3 *Activity*: Shadow Game	7. *Musical* Children follow the rhythm of the Shadow Song. One child serves as the shadow of his/her peer to produce movements matched with each other. 11 55 66 5 | 44 33 22 1 | 55 4 3 2 | 55 4 3 2 | 11 5 66 5 | 22 2 2 1 || (Chinese Song, lyric omitted)
3. *Logical-Mathematical* Teacher provides materials such as strips of paper and scissors. Teacher brings children to the playground and asks them to stand in different positions under the sun. Children measure the length of their peers' shadows and examine the differences in length so as to reinforce the length concept.	5. *Intrapersonal* Students are given opportunities to conduct independent studies on the topic. They reflect on what they know and want to explore. They express feelings about the activities they engage in as part of learning the long/short concept.	8. *Spatial* Teacher makes paper puppets with the children. They are divided into groups to cast shadows on a piece of white board to perform drama, e.g. use of different paper animal puppets to perform the King of Forest Drama.

knowing may be different for different lesson designs). It also allows one to analyse which of the eight intelligences are the current focus of development, and which are only playing subsidiary roles for the time being. What the teacher needs to do is to implement the activity sequence in accordance with what is planned on the Think-board. The suggested activities documented in Table 1 may take 1–2 weeks to complete, and they may be integrated or coordinated with other thematic units that have a bearing on the long/short concept.

Close examination of the design reveals that it satisfies the various requirements of a MI-inspired pedagogy. First, eight intelligences, not just the linguistic and logical-mathematical, are covered. Children with different ways of knowing have a chance to engage in the activities. To this end, teachers can engage children individually or as a group according to their strengths but also their weaknesses. Second, the design affords several authentic problem-solving contexts. For example, the Shadow Game invites children to deploy their multiple intelligences for problem-solving and creative productions. Third, children make use of resources, such as strips of papers and scissors in the logical-mathematical shadow-formation game, to engage in collaborative group learning.

During the teaching experiment, some children discover that they can form a long shadow under the sun by holding up long objects, or by queuing up into a line and have the individual shadows joined together. Some children find that they can conceal themselves in peers' shadows to avoid their shadows being stepped. Some children are observed during these activities to volunteer to help peers who have difficulties to hide themselves properly. In the Shadow Show, children exhibit their intelligences using their hands and tools to act in accordance with the script of the drama such as the King of Forest Drama. In a nutshell, teachers find that children are not only willing to learn and able to learn, but also happy to learn. These are the intended educational outcomes of a successful MI-inspired pedagogy.

The integration of 'assessment for learning' with 'assessment of learning' into an IAS ties in well with Gardner's notion of individually configured education discussed earlier (Stiggins, 2002). The effect of 'assessment for learning', as it plays out in the classroom in the afore-mentioned teaching experiment of the long/short concept, is that students keep learning and remain confident that they can continue to learn at productive levels if they keep trying to learn. In other words, students do not easily give up in frustration or hopelessness.

Table 2 illustrates a sample logical-mathematical performance assessment item, that is, 'able to compare two objects with edges of different lengths', which defines clearly the assessment criteria and assessment environment. Assessment items pertaining to all of the eight multiple intelligences other than logical-mathematical intelligence can be set in a similar manner so as to promote student learning. Table 3 details performance assessment items which seek to achieve assessment for learning the long/short concepts. Because of space limitation, the assessment criteria and assessment environment of assessment items listed in Table 3 are not presented. However, the assessment inventory of the long/short teaching experiment is compiled into Table 4.

Table 2 Sample logical-mathematical performance assessment item

	Assessment criteria		
Assessment item	Strength/High level of interest S(3)	Equivalent to age/grade level A(2)	Weakness/Low level of interest L(1)
Able to compare two objects with edges of different length	Able to compare length of two or more objects with straight edges; able to compare length of two strings, one stretched in the form of a straight line, and another in the form of a 'S' shape	No problem when the length of two or more objects with straight edges is compared	Able to compare the length of two objects with straight edges only under the guidance of the teacher and assisted by peers

Assessment environment: During group activities, children are provided a number of objects with straight edges for length comparison using strings, paper strips, and rulers. Children are invited to compare the length of two strings stretched in different shapes and orientations on the table. No quantitative measurement is needed in the length comparison.

Table 3 Performance assessment items analysed using Gardner's think-board

1. *Linguistic* • Able to express one's opinions and needs in words when working with others • Able to read and sing children songs • Able to use words to express differences when two or three objects are compared • Able to invent meaningful stories	4. *Bodily kinaesthetic* • Able to use movement of fingers to imitate shadows of animals. • Able to use pair of scissors in a dexterous manner • Able to avoid knocking off or impinging on others • Able to use all sorts of objects or methods to hide one's shadow	6. *Naturalist* • Like to explore and find out the changes in the surrounding environments • Able to propose solutions to problems according to one's observation of the environments • Able to observe the changing behaviours of day and night
2. *Interpersonal* • Willing to share one's opinions with peers, and accept peers' opinions • Able to observe the changing behaviours of day and night • Willing to participate in group activities and play games together • Treat others politely and able to queue up for activities • Able to accommodate with others, and adjust well to different learning roles	*Concepts*: Long/Short *Level*: K3 *Activity*: Shadow game	7. *Musical* • Able to move one's body and limbs according to the rhythm of music • Able to work with peers on a simple musical performance • Able to play some simple musical instruments according to the rhythm of music

Table 3 (continued)

3. *Logical-Mathematical*	5. *Intrapersonal*	8. *Spatial*
• Able to compare two objects with edges of different length • Master methods for comparing the length of objects • Understand preliminary concepts of morning, noon and afternoon • Like to raise postulates and think about how to conduct experiments	• Able to return used things back to their original positions • Able to control one's temper and sentiments • Know one's abilities and interests well • Able to acknowledge difficulties and hardships encountered	• Able to navigate freely in a constrained learning environment • Able to observe objects from different angles and viewpoints • Able to use different materials to make puppets for play and drama

Table 4 Assessment inventory of the long/short concepts teaching experiment

Assessment item	Assessment criteria		
	S	A	L
1. Able to express one's opinions and needs in words when working with others	3	2	1
2. Able to read and sing children songs	3	2	1
3. Able to use words to express differences when two or three objects are compared	3	2	1
4. Able to invent meaningful stories	3	2	1
5. Willing to share one's opinions with peers, and accept peers' opinions	3	2	1
6. Willing to participate in group activities and play games together	3	2	1
7. Treat others politely and able to queue up for activities	3	2	1
8. Able to accommodate with others, and adjust well to different learning roles	3	2	1
9. Able to compare two objects with edges of different length	3	2	1
10. Master methods for comparing the length of objects	3	2	1
11. Understand preliminary concepts of morning, noon and afternoon	3	2	1
12. Like to raise postulates and think about how to conduct experiments	3	2	1
13. Able to use movement of fingers to imitate shadows of animals	3	2	1
14. Able to use pair of scissors in a dexterous manner	3	2	1
15. Able to avoid knocking off or impinging on others	3	2	1
16. Able to use all sorts of objects or methods to hide one's shadow	3	2	1
17. Able to return used things back to their original positions	3	2	1
18. Able to control one's temper and sentiments	3	2	1
19. Know one's abilities and interests well	3	2	1
20. Able to acknowledge difficulties and hardships encountered	3	2	1
21. Like to explore and find out the changes in the surrounding environments	3	2	1
22. Able to propose solutions to problems according to one's observation	3	2	1
of the environments	3	2	1
23. Able to observe the changing behaviours of day and night	3	2	1
24. Able to move one's body and limbs according to the rhythm of music	3	2	1
25. Able to work with peers on a simple musical performance	3	2	1
26. Able to play some simple musical instruments according to the rhythm of music	3	2	1
27. Able to navigate freely in a constrained learning environment	3	2	1
28. Able to observe objects from different angles and viewpoints	3	2	1
29. Able to use different materials to make puppets for play and drama	3	2	1

4.3 Teaching About MI – Monitoring Growth of Intelligences

Teaching about MI has been shown to be effective in changing teachers' assessment practices. Project SUMIT in the USA has demonstrated the potential benefits of this approach (Kornhaber, Fierros & Veenema, 2004). Through action research and school-based teacher development, the principal of this school was successful in changing teachers' beliefs about student learning, and engaging them in large-scale classroom observations and performance assessments of student talents and potentials (Cheung & Lou, 2003). Through the development and use of SMILES (i.e. School-based Multiple Intelligences Learning Evaluation System) developed by the present author and his associates, teachers experimented with MI-inspired pedagogy after taking into account the intellectual profiles of the students (Cheung, Wai & Chiu, 2000/2002; Cheung, 2003b).

This Macao project started in late 1999, and was the first of its kind in the Chinese-speaking communities. The aim of the overall study was to establish a school-based MI assessment system in order to provide teachers with valuable information on students' intellectual profiles so as to implement MI-inspired pedagogy at the junior primary levels (i.e. P1–P4). The study was designed as an action research project involving all P1–P4 teachers in a school in Macao. They were involved in the development of the instruments for assessment throughout academic year 1999/2000. Under the guidance of the present author, the principal and teachers studied Gardner's MI Theory using the two MI books (Cheung, 2001, 2003a). Based on the MI Theory they constructed 3-point Likert scales (i.e. strong/average/low) to measure the developmental levels of the eight intelligences for individual students. When designing the assessment procedures, teachers needed to agree on the assessment environments and criteria of each of the scale items, with due attention paid to the grade levels to be assessed (i.e. similar to the one shown in Table 2). There were 10–15 items in each of the eight intelligence scales making a total of 80–120 assessments per student (see Table 5 for some sample items). The assessment was done mainly using classroom observation. While this design proved to be very laborious, it was a very rewarding undertaking.

Pilot studies were conducted to examine the feasibility of the assessment procedures. During 2000/01, data were analysed using software specifically developed for this study – SMILES. The graphic and detailed display of output assisted teachers to examine the MI profiles of their students for further processing and actions (see Fig. 2 for a screen capture of the MI-Spectrum).

There were three important outcomes from this study. First, the principal successfully established an assessment system that provided her with valuable information to help tackle problems of individual differences through setting up of MI-inspired thematic projects and co-curricular activities (see Cheung & Lou, 2003, pp. 41–44 for details). Second, the teachers were introduced to concepts underpinning the MI Theory, and were empowered to understand in what ways their students were distinctive and intelligent. Third, in addition to the regular academic reports, the parents were provided with copies of their children's MI-Spectrum. Parent–school relationships were strengthened when the school

Table 5 Sample items of multiple intelligences scales for assessing primary 1–4 children

Sample items
1. *Linguistic*
Able to use effective language to communicate in a variety of social contexts
2. *Logical-Mathematical*
Likes to play games that deploy mathematical strategies
3. *Spatial*
Able to identify and discriminate colour, shape, scenic views, and human faces
4. *Bodily kinaesthetic*
Good at using body language and actions expressively
5. *Musical*
Easily engaged in activities involving singing and playing musical instruments
6. *Interpersonal*
Responsible, possesses team spirit and works hard for the common good of the community
7. *Intrapersonal*
Able to work independently, likes to plan and schedule the time well before hand
8. *Naturalist*
Have sensitive feelings towards things in the natural environment

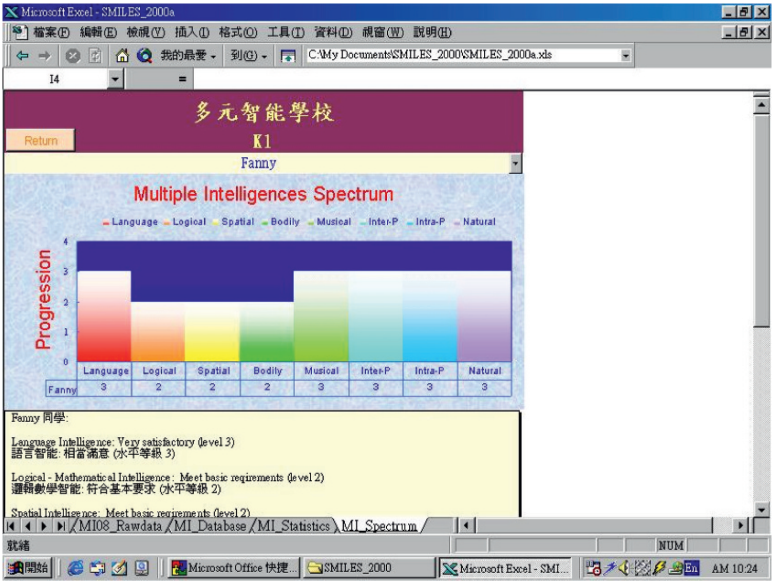

Fig. 2 Screen capture of an example of a MI-Spectrum

seized the opportunity to work together with the parents regarding study plans for the common good of the children. As far as the significance of this pioneer study is concerned, it can be shown that teacher professional development is enhanced when theory and practice can be engaged in meaningful dialogue.

Encouraged by the success of this study, research on teaching about MI was extended to the secondary levels. Another study (see Cheung, 2004a) was initiated in 2003 by the present author to establish an academic counselling system that responds to the intellectual potentials, interests, and talents of the secondary students in an established school in Macao. All students studying in Form 1–6 (i.e. Grade 7–12) levels were participants and self-assessment data were analysed at the respective grade levels and summarized in terms of individual student profiles. It must be pointed out that the MI-Spectrum and the accompanying summary reports are by no means definitive directives to advise students on the most viable academic and career paths. Teachers need to study these reports together with the students, make them aware of their multiple intelligences self-ratings, realize where their strengths and weaknesses are, and understand in what particular aspects their minds are different from their peers. While the final academic and career decisions are made by the students themselves, teachers provide guidance by emphasizing principles that stress an optimistic and strength-focused approach to individual decision-making (see Cheung & Lee, 2006, pp. 72–106 for three typical cases which illustrate how the counselling process has been carried out by the teachers).

4.4 Teaching for MI – Intelligence-Fair Learning Environments

This area of action research is more varied in nature. One example from each of the secondary, primary, and kindergarten levels, as well as the special education arena is described below.

At the senior secondary level, existing practices of streaming into arts or science curriculum choices may not take into account the MI potential of students. Likewise, choice of curriculum pathways by male and female students may not represent their actual MI potentials. When students are aware of their intellectual potentials, they can make better decisions regarding their choice of enrolment in the arts/science streams, and reduce the possibility that their exclusion from either the arts or the science curricula will limit their further pursuits.

In the school under study, the science students had a tendency to rate themselves highly on all the eight MI, whereas the arts students had a tendency to regard themselves highly at the second best level of progression of some intelligences that were not directly pertaining to science and technology (see Cheung & Lee, 2006, pp. 65–67). The analysis results also showed that amongst the eight MI, boys rated themselves more favourably than the girls on the logical-mathematical dimension. A similar but less evident pattern was seen on the naturalist intelligence dimension. In spite of these, the superiority of the girls appeared to lie on the linguistic and musical intelligence dimensions. At the same time, there were lower proportions of girls than boys on the low end of progression for spatial, musical and interpersonal intelligences, and there were higher incidences of girls than boys at the second best level for both interpersonal and intrapersonal intelligences. Based on these results, the school was able to modify streaming policies so as to make secondary schooling more individually configured than before.

At the primary level, the focus was not on the assessment of MI profiles. The primary school reported in Section 4.3 replicated and extended the Arts PROPEL of Project Zero of Harvard University. The Macao Arts PROPEL project sought to promote quality education through arts education linked with the study of relics of the heritage city of Macao. When Macao bid for UNESCO world heritage recognition, it made full use of the opportunity to organize students to study A-Ma Temple, St. Joseph's Seminary and Church, Leal Senado Building, Mount Fortress, and the Guia Fortress (including Guia Chapel and Guia Lighthouse). Through hands-on and minds-on artistic productions of these relics of civilization, arts education provides students with the opportunity to apply abilities of perception, appreciation, imagination, comprehension, reflection, and creative thinking.

Concerning these potential benefits, Gardner once remarked that being good at any intelligence does not mean one will be creative or make new discoveries (MI Centre of Beijing Institute of Education, 2005). Metaphorically speaking, having developed intelligence in one of the MI aspects just means the computing system works very well. The important educational issue is whether students with MI potentials are deploying their potential on interesting questions and whether the students are motivated to go to new directions or ask new questions. As such, Gardner concluded that creativity is different from intelligence. Using SMILES, the Macao Arts PROPEL project grouped students according to different combinations of intellectual capacities identified in the earlier MI assessments. These students were involved in a series of thematic studies across the whole primary school curriculum. These studies focused on students' development of problem-solving abilities and artistic productions. The three main means of study are musical movements (e.g. songs, dances, and mimes), visual arts (e.g. drawings, artworks, models, and photography) and writing (e.g. poems, dramas), and public speaking. Students' performances are documented in 'processfolios' – portfolios of the learning processes of the students (see Wong, 2006 for a complete account of the Macao Arts PROPEL project).

At the kindergarten level, there was active research and development work between Hong Kong and Macao curriculum specialists in seeking to understand how individually configured MI instructional materials might be designed to meet the needs of the postmodern era. Most kindergartens in Macao use Hong Kong teaching materials, so it is important to understand the changing rationale for using some of these MI teaching materials (Cheung, 2003a). In the past decades, the main characteristics of curriculum design were: (1) use children's everyday experiences to design learning activities; (2) integrate teaching contents into thematic units; and (3) practice child-centred, activity-based teaching to develop quality all-round education. At the turn of the new millennium, curriculum development is increasingly influenced by proposals based on lifelong learning. I suggest that in this postmodern era, curriculum designers should reconceptualize the main aims of education as: (1) enable each individual's inner potentials to grow and be recognized within society; and (2) empower children to grasp firmly their fate for positive living in a knowledge society (Cheung, 2003b).

At the end of the twentieth century, curriculum design in Hong Kong and Macao was efficiency-driven, emphasizing articulation of a blueprint with clearly spelledout starting points, finishing points, and pathways. Educational objectives nowadays are not envisaged as fixed signposts, nor are they stated in detailed taxonomic forms. Instead, curriculum is depicted as an individually configured educational journey within which individuals target and orient themselves for advancement and transformation. Thematic textbooks are organized as a series of stories describing events that are likely to happen in children's everyday lives. Consequently, parents and teachers know how to accompany their children to explore life journeys along which potentials are nourished and talents cultivated (see Cheung, 2003b, p. 176–186, for a critical analysis).

Content analyses of the teaching materials published by the Hong Kong Crystal Educational Publications, a joint venture amongst curriculum specialists from Hong Kong, Macao, and Chinese Mainland, reveal two broad design principles. First, the stories depicting the education journey are anchored on the four pillars of education, that is, learning to know, learning to do, learning to live together, and learning to be. Specifically, children develop languages, perception (including the natural, spatial, and musical), and thinking (including logical-mathematical) abilities. Attention is paid to children's health (especially bodily kinaesthetic aspect) to enable them to be fit for play and study. Children are able to engage in self-reflection and behave appropriately in accordance with norms and expectations. They cultivate good habits, are able to protect themselves, and learn to steer their own life journeys with confidence and responsibility. Knowledge of MI is envisaged as essential to structure learning experiences along this ongoing trajectory of child development. Second, as the stories are structured in thematic units, a succession of content webs can be drawn using a spiral approach. In line with the MI Theory, these webs should focus on essential content that seeks to nourish love and care, inspire inner potentials, develop talents and abilities, establish problem-solving abilities, and engage students in creative productions. Teachers are reminded that deployment of webs for instruction should not restrict or stifle children's growth and development.

For the special education students in Macao, one government special school modelled on the Making Learning Visible (MLV) Project of Harvard University with a focus on educating children as individual and group learners (Project Zero & Reggio Children, 2001). This project started in 2004 and was commonly known as MINDS (Multiple Intelligences Nurture and Documentation Study) – a project with a dual focus on the setting up of intelligence-fair learning environments for purposes of individually configured education, and on making a shift from assessment of learning to assessment for learning (see Fu, 2004, for more information on the MINDS project).

5 Summary

This chapter describes action research projects conducted by a number of Macao schools using MI Theory to reform teaching and learning during the post-transition period (i.e. 1999–2004). The outcomes of the teaching experiments and reform initiatives so far are very positive and encouraging. MI Theory is still an emerging theory that requires further scrutiny and empirical support. As Gardner noted:

> My theory might not be the right theory. But at least it's a theory that takes into account what we know about human biology, human culture, human history and individual differences. The theory claims that instead of having one general computer, we have a number of special computers that don't work equally well for one person from another. Even if the theory is right in general, the details certainly have to be worked out in the future. (MI Centre of Beijing Institute of Education, 2005)

In this regard, the Macao action research projects presented in this chapter contribute to the body of MI literature. Three remarks stemming from the Macao experiences worthy of the readers' attention are summarized below.

Although MI is still a developing theory, it flourishes at a time when educational practitioners in the Chinese Mainland, as well as in Macao, are seeking a scientific but accessible framework to revise the school curriculum so that it is more adaptive to individual differences. Gardner's notion of individually configured education is not new. It resonates with ancient Chinese culture, and opens up for further consideration of the wisdom of ancient educational literature of oriental cultures and traditional Chinese values.

MI cannot be developed in a social or cultural vacuum. Educational practitioners need to analyse how the societies they reside in are transiting from modern to the postmodern era in order to have a better idea of what kinds of education are desirable for citizens and what kinds of talents and workforce can serve the societies well. Once there is consensus of educational aims amongst the educational practitioners, MI Theory can be a very useful tool to accomplish the proposed educational aims.

MI is not an educational theory per se, and as such it alone is not sufficient to initiate and sustain educational reform. Nonetheless, the school-based MI-inspired action research projects exemplified in this chapter are producing promising results, particularly with regard to the following four aspects:

1. MI Theory provides a topology of the human mind that can guide teachers and parents in creating zones of proximal development for children with diverse potentials.
2. MI Theory reminds teachers of the importance of multiple ways of knowing and hence urges them to use multiple channels and multifarious perspectives to teach concepts with deep understanding.
3. Monitoring growth of intelligences through strength-based scaffolding is a viable strategy when teachers are confident in assessing children's MI and easy-to-use computerized software systems are available to assist teachers to validate the assessments they observed and those self-rated by their students.
4. MI Theory guides teachers in designing assessment-fair and intelligence-fair learning environments in order to achieve the ideal of individually configured education and inclusive education.

It is noteworthy that this action research paradigm is not specific to particular grade levels; nor is it confined to research conducted in certain curriculum subject areas.

6 Implications for Reforming Learning Within Asia-Pacfic Region

One distinctive characteristic of the learners in the Asia-Pacific region is that many of their ancestors have been influenced by the Chinese cultural tradition, particularly the Confucian heritage that has prospered up to now for over 2,000 years (see Biggs & Watkins, 1996 for the characteristics of Chinese learners). These Asian learners are populated in major Asia-Pacific states like China, Taiwan, Hong Kong, Macao, Korea, Japan, and Singapore. Studies of international assessment of educational achievement and literacy, such as the PISA studies, have highlighted the incongruence between the high performance and the use of some 'controversial' learning practice among Asian students (OECD, 2004). Western learning theories often either fail to explain how this incongruence may have come about, or fall into the trap of accounting it entirely from the Western perspective (Stigler & Hiebert, 1999). For example, one unsuccessful attempt of explanation from the Western perspective is related to the practice of rote learning among Asian learners. From the Western perspective, the use of rote learning indicates the absence of meaningful learning and therefore the association of rote learning practice with a high level of performance among Asian learners has been considered as a paradox. One may be surprised to find out that rote learning among Asian students can indeed bring about understanding (Stigler & Hiebert, 1999; Fan et al., 2004).

In light of the discussion above, educational practitioners should be reflective in applying Gardner's MI Theory to guide curriculum and pedagogic reforms in Asian classrooms. It may not be appropriate to transplant the seminal studies done by Gardner and his associates without a careful consideration of various contextual constraints and affordances in Asian classrooms. The Macao studies reported in this chapter serve as exemplary practices that have taken the contexts of Chinese learners into consideration in the course of designing MI-inspired learning activities.

Apart from sharing with each other the experiences related to the application of MI Theory among countries of the Asia-Pacific region, concerted efforts are needed to clarify several major concerns crucial to the applications of MI Theory in Asian classrooms:

1. *How is one to judge whether a learning task or curriculum can be claimed as MI-inspired?* This question is important because many courses and curricula designed in the region have claimed that they are MI-inspired. Some schools even label themselves as a Gardner's school in order to attract public attention.
2. *How is one to measure students' progress in the classrooms that claim to practice MI-inspired curriculum and pedagogy?* Many schools in the region are still struggling to measure MI properly. Parents are puzzled to find that their children's levels of multiple intelligences are not progressing in ways similar to other achievement measures. Teachers feel embarrassed when they cannot explain satisfactorily to parents why MI assessment results are not congruent with related academic performance, for example, some students rated as high in logical-mathematical intelligence may not score high in the mathematics test.

3. *At which grade levels should one start to practice individually configured education based on MI theory?* Many educational practitioners believe that MI ideas are more palatable for the junior than senior grades. The Macao's experiences reported in this chapter show that MI ideas can be practiced at different grade levels. Of course, one should take note that different problems may be associated with the application of MI Theory to students of different age groups or students learning in diverse contexts.

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Makabayan in the Philippine Basic Education Curriculum: Problems and Prospect for Reforming Student Learning in the Philippines[1]

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Abstract The Philippines' Department of Education undertook a curriculum reform for basic education with the goal of improving student learning to meet the more complex demands of Philippine society amidst globalization. The 2002 Basic Education Curriculum has three key reform themes: (a) the articulation of more complex and higher-level learning goals, (b) the streamlining and integration of learning areas in the curriculum, and (c) the use of creative and innovative teaching approaches to improve student learning. These themes are discussed in the case of *Makabayan* – a new learning area that integrates several subjects with the goal of helping each Filipino student to develop a healthy personal and national identity. The problems in realizing the curriculum aims are discussed, focusing on the difficulties in fully articulating the ideal curricular elements, constraints in the implementation, and the weak conceptualization of the learning reform in the context of Philippine education.

1 Introduction

It is generally acknowledged that a curriculum needs to be updated regularly, not only to incorporate new knowledge but also to adapt to changing environmental, social, technological and global contexts. The Philippines follows the same pattern of curriculum development and reform practices like most other countries. In 2002, the Philippines' Department of Education (DepEd) undertook a grand curricular reform effort, which resulted in the 2002 Basic Education Curriculum (or BEC). But unlike curriculum reforms in other countries which involve a slow process, the BEC was implemented rather fast. The DepEd Order No. 25 (s. 2002) on the

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implementation of the BEC states that studies on the previous curriculum began within the DepEd in 1986, and more explicit consultations with other stakeholders began in 1995. However, the formal curriculum reform process was initiated around March 2001. The BEC was implemented nationwide in June 2002 in all public primary and secondary schools in the country, 15 months after the curriculum reform process began. The BEC is still being implemented up to the present.

This chapter explores the BEC reform as a case of an official educational reform that aims to improve student learning by focusing on the emergent learning area in the curriculum that is referred to as *Makabayan*. In the first section of the chapter, the foundations and features of the BEC are discussed. The second section proceeds to detail the reforms embedded within the new learning area of *Makabayan* and describes how this new curricular feature was explicated and implemented in various levels of the educational bureaucracy. The concluding sections summarize some of the issues that arise in this particular attempt to reform learning in the Philippine basic education sector.

2 The 2002 Basic Education Curriculum Reform

2.1 The Foundations for the Curriculum Reform

Not much is documented about the curriculum development process for the BEC.[2] However, the documents published by the DepEd (2002a, b) on the BEC clearly indicate that the most central theme in the curriculum reform process is the need to improve the quality of learning by being creative and innovative in how the educational processes are designed and delivered. The main push for the desire to improve the quality of learning is the need to be relevant and responsive to the changing global and local environments, particularly to the explosion of knowledge in these contexts. The BEC document articulated this aim as follows:

> We have to educate our Filipino learners to filter information critically, seek credible sources of knowledge, and use data and facts creatively so that they can survive, overcome poverty, raise their personal and national self-esteem, and realize a gracious life in our risky new world. (p. 4)

The BEC document further articulates the need to empower Filipino learners for lifelong learning as this would allow them to best confront the challenges posed by the changing social forces: ‘Filipino learners need … to be competent in learning how to learn anywhere even when they are left to themselves’ (p. 4).

[2] We can infer from documents published by the DepEd (2002a, b) that the process was largely an internal one involving Committee on Curriculum Reform (ComCurr), which was chaired by the DepEd’s Undersecretary for Programs with various DepEd Bureau Directors, Division Chiefs, and other in-house curriculum experts as members. The ComCurr had one overall consultant, several subject area consultants, and an (external) advisory council composed of educators, researchers, curriculum experts from the private education sector.

However, external and internal evaluations of the national curriculum for basic education prior to 2002 consistently indicate that the national curriculum is inadequate for developing these high-level learning competencies among children. Two key problems have been noted about the previous national curriculum. First, the curriculum seems to be overcrowded. The Presidential Commission on Education Reform (PCER, 2000) noted that there are too many subjects within the curriculum and too many topics, competencies, and skills that need to be covered in each of the subjects. This overcrowding of the curriculum tends to emphasize the need to cover the wide range of subject matter over the need to process the subject matter more deeply (Bago, 2001), thus hindering the development of higher-level thinking skills and of lifelong learning competencies. Second, the curriculum adopts a 'one-size-fits-all' approach. Indeed, the curriculum is homogeneous not only in terms of content, but also in terms of process, which limits the relevance of the curriculum to the diverse types of Filipino learners and to the diverse contexts of these learners (Philippine Human Development Network, 2000).

2.2 The Themes of the Curriculum Reform

In consideration of the perceived problems of the previous national curriculum and the newly espoused learning goals for the BEC, three very strong themes are found in the philosophy and design of the BEC: (a) the development of higher and more complex learning competencies among Filipino learners, (b) the streamlining of the curriculum and integration of learning areas, and (c) the use of creative and innovative teaching approaches. These three themes are briefly discussed in the following sections.

The learning goals defined in the BEC clearly go beyond the acquisition of a specified set of knowledge and skills. In the section on 'Philosophy of the 2002 Curriculum' (DepEd, 2002a), the learning goals of the BEC are defined as follows:

> The ideal Filipino learner in our rapidly changing world is one who is empowered for lifelong learning, is an active maker of meaning, and can learn whatever s/he needs to know in any context. Such an empowered learner is competent in learning how to learn and has life skills so that s/he becomes a self-developed person who is *makabayan* (patriotic), *makatao* (mindful of humanity), *makakalikasan* (respectful of nature), and *maka-Diyos* (godly). (p. 8)

The learning goals defined in this ideal can be classified in the range of meta-learning and meta-cognitive skills that cut across the different domains of learning. More important, the learning goals have a strong affective and value component; thus, the cognitive skills are supposed to be guided by appropriate beliefs and values that are deemed important by Philippine society. The connection between the higher learning goals and values is made explicit in the following statement: 'It is learning how and not just what, in order that learners do the work themselves and thus have an experience of genuine democracy, where people have not only rights but also responsibilities' (p. 9).

The second theme emphasizes the need to streamline the curriculum to allow students to focus their efforts at developing the core learning competencies with sufficient depth and complexity. Thus, the BEC has restructured the study areas from eight subjects to five learning areas. The change in nomenclature from 'subject' to 'learning areas' also reflects the new emphasis on the learner and the learning processes, rather than subject content. These five learning areas are: Filipino language, English language, Science, Mathematics, and *Makabayan* (which will be discussed later). The reduced number of learning areas allows for the increase in time allotment for each area, with the goal of giving students more time to develop the desired competencies. The BEC also emphasizes the integration of learning competencies across learning areas, further maximizing the opportunities to strengthen learning.

The third theme highlights the need for more innovate and creative pedagogies for enabling students to attain the complex learning goals. Although the document refrains from directly referring to cognitive constructivism, much of the details of the teaching–learning processes advocated in the BEC are clear articulations of constructivism. For example, the document defines the learner as 'an active maker of meaning' (p. 8), and 'active constructors of knowledge' (p. 9), whose knowledge is contextualized in his/her experiences (pp. 8–9). The document also redefines the elements of the teaching–learning processes in ways that align with the constructivist and other post-behaviourist and post-structuralist approaches to education. The BEC advocates stronger interactions among students, teachers, instructional materials, and learning technologies. It encourages multi-disciplinary approaches, as well as, increasing opportunities of contextualizing knowledge and skills, drawing from the students' personal, community, sociocultural experiences to make the learning process more meaningful and relevant (pp. 10–11). One of the most critical revisions in this curriculum is in how the teacher is recast:

> The ideal teacher … is not the authoritarian instructor but the trustworthy facilitator or manager of the learning process. She is not somebody on whom learners always lean but somebody who gradually rids them of the tendency to lean. She enables the learners to become active constructors of knowledge and not passive recipients of information. The ideal teacher helps student to learn not primarily answers but how to reflect on, characterize and discuss problems, and how, on their own initiative, they can form or find valid answers. (p. 9)

The BEC document calls on teachers to innovate and be creative in their teaching so that they may develop the most appropriate means to help the diverse types of learners attain the goals of the BEC. This summons for innovation acknowledges the need for teachers to be curriculum makers, as they need to contextualize the national curriculum in ways that are most appropriate for their students. This implicit empowerment of teachers as curriculum makers is unprecedented in the history of Philippine formal education.

2.3 Some Comments on the Curriculum Reform

The documentation on the BEC indicates that the curriculum reformers were appropriating the contemporary global discourses on the need to focus on student learning, on lifelong learning, and the attainment of learning competencies that are relevant for global and local needs (cf., Delors, 1996; Haw & Hughes, 1998; and other discourses on the changing character of education amidst globalization). The BEC explicitly emphasizes the need for Filipino learners to be competitive in the knowledge society and the borderless global economy. This thrust has been criticized by some sectors of the education community on ideological grounds. For example, the Alliance of Concerned Teachers decried that the new curriculum 'will sacrifice the education of the youth, who will become cheap laborers in the world market instead of productive Filipinos with a strong sense of history, culture, arts and all-around skills' (San Andres, 2002; see also Arao, 2002).

As noted earlier, the BEC also appropriates various contemporary educational philosophies, notably cognitive constructivism, with its emphasis on the role of the learner in active knowledge construction and on pedagogical approaches that support the knowledge construction processes. There are also references to themes of multicultural education, problem-based learning, teaching for multiple intelligences, and other popular contemporary discourses in education. If we consider the educational paradigm being espoused in the BEC, we can consider this curriculum reform effort as truly radical as it proposes a major paradigm shift in the basic education curriculum and related processes. Indeed, some of the theoretical elements articulated in the curriculum reform involve beliefs, practices, and ideals that run counter to the entrenched culture of Philippine formal education. Previous analysis of the elementary education curriculum (Bernardo, Reyes & Limjap, 2002), for example, has revealed that the learning goals expressed in the Philippine Elementary Learning Competencies (PELC) tend to be very domain-specific knowledge, particularly of the low-level (declarative and procedural) types. The previous curriculum focused largely on low-level thinking skills and did not encourage integration of competencies across subjects or within subjects. A similar trend has been observed in studies of teachers' lesson planning and classroom questioning practices (Bernardo, Prudente & Limjap, 2003; Bernardo et al., 2005) and of elementary and high school textbooks (Bernardo, 2000). Given the prevailing curricular and pedagogical context in Philippine basic education, the shifts being proposed in the BEC can be considered truly radical.

Whether the theoretical appropriations in the paradigm shift of the BEC converge in a coherent curriculum framework should also be subject to more careful analysis. A study of the learning goals in Philippine elementary education has indicated that there are gaps in the alignment of the broad curricular goals articulated in previous broad policy documents and the more specific operational curricular goals in curriculum documents that are used by the teachers (Bernardo et al., 2002). In this regard, attention must be paid to how the theoretical prescriptions come to be contextualized as the curriculum is implemented in various schools.

In the next section, these concerns are discussed in the context of one of the new learning areas in the BEC – the *Makabayan*.

3 The Makabayan Learning Area

3.1 Articulating the Reform Themes in a New Learning Area

The most important themes in the BEC reform are highlighted in the new learning area defined in the BEC – the *Pagkabamakakabayan* (love of country) or *Makabayan* (patriotic) for short. The BEC document declares that '(a)mong the learning areas [*Makabayan*] will be the most experiential, interactive, interdisciplinary, and value-laden' (p. 10).

The BEC document articulates the nature of this new learning area as follows:

> As a practice environment, *Makabayan* will cultivate in the learner a healthy personal and national self-concept, which includes adequate understanding of Philippine history and genuine appreciation of our local cultures, crafts, arts, music, and games. *Makabayan* will promote a constructive or healthy patriotism, which is neither hostile nor isolationist toward other nations but appreciative of global interdependence. (pp. 10–11)

In concrete terms, the learning competencies and values defined in this learning area are actually the same core competencies and values in several subjects in the old curriculum: Social Studies, Home Economic/Technology and Livelihood Education, Physical Education, Music and Arts, and Values Education. Thus we can see a rather ambitious attempt at curricular integration. This integration of competencies and values is made possible with the introduction of a unifying theme, which is the development of 'a healthy personal and national identity' and a 'constructive and healthy patriotism'. Thus the competencies and values in the old subjects are to be reconceived in relation to a higher-level, over-arching goal. The learning competencies that were the goals in the previous subjects need to be processed in more complex ways by the students as they aim to develop the noble long-term objectives of the integrated learning area. Therefore, more than in any of the other learning areas, *Makabayan* embodies the two important themes of the BEC reform: the articulation of higher and more complex learning goals, and the streamlining and integration of learning areas.

In line with these two characteristics of the *Makabayan* learning area, the BEC document also expresses the need for significant changes in the how *Makabayan* should be taught. The BEC document states this as follows:

> Ideally, … *Makabayan* entails the adoption of modes of integrative teaching which will enable the learner to personally process and synthesize a wide range of skills and values (cultural, aesthetic, athletic, vocational politico-economic, and ethical). … Schools are allowed to design and contextualize the implementation of *Makabayan*. A substantial integration of competencies and topics can be done in this learning area. (p. 22)

The document sends a clear message that schools and teachers would be given flexibility in designing the teaching–learning environments that would best allow students to attain the complex objectives of the new learning area. This is in sharp contrast to the common practice of providing teachers with very detailed teachers' guides on how to implement lessons in the curriculum.

3.2 Early Criticisms and Resistance

Soon after the first drafts of the concept paper on the *Makabayan* learning area were distributed for consultation with the different sectors of the basic education hierarchy, the proposal was subject to various negative commentaries ranging from strong scepticism to rather harsh criticisms.

The scepticism came from teachers and curriculum experts who were concerned about whether a meaningful and coherent integration can be achieved given the varied range of competencies and values covered in the previous subjects. Previous research has found that there is no proper framework that defines the inclusion and organization of the various learning competencies and topics in social studies (Diaz, 2000; Hornedo, 2000), physical education, health, music and arts (Sta. Maria, 2000), technology and home economic subjects (Lazo, 2000; Miralao, 2000). More specific concerns have been raised regarding the effectiveness of the proposed integration of competencies in helping students actually develop the desired knowledge and values related to patriotism (Mendoza & Nakayama, 2003). Such observations create scepticism regarding the ability of the curriculum reformers to meaningfully integrate the learning competencies across these varied subject areas.

The harsh criticism came mainly from teachers from the affected subject areas. One form of criticism was based on the notion that the time allotment would be lessened for some of the subject areas to be subsumed under *Makabayan*. The teachers asserted that this would result in not giving enough time and emphasis in the development of the different competencies that were covered in the different subject areas (Araya, 2002; San Andres, 2002). A related concern was that the reduction of the time allotment for some of the subject areas would mean a reduction in the workload, and also the compensation and benefits of the affected teachers.

As the proposal was not yet very detailed in the early stages, there were also strong apprehensions that the proposal would mean that some teachers would lose their jobs as their subject areas would not longer be taught (and the corresponding teaching positions would be declared redundant). But the teachers from this sector were assured that their expertise would still be needed as the complex set of learning goals will still require teachers to handle learning activities addressing the different competencies from the different subjects. This assurance was later expressed in the Executive Summary of the BEC document explicitly declared: ‘No teacher will be made redundant and none will be underloaded or overloaded in the implementation of the restructured curriculum’ (p. iii).

3.3 Dilution of a Key Reform Theme

Unfortunately, the response to the various criticisms required that some degree of separation be maintained among the various subject areas that were supposed to be integrated. In the later drafts of the BEC, it became apparent that the integration of the different subject areas under *Makabayan* was not going to be as drastic or extensive as originally conceived. The BEC document states:

> In light of the diversity of disciplines within *Makabayan*, each discipline is provided initially its own weekly time allotment from Grade 4 to Fourth Year in order to ensure that every core competencies that, in the initial years of the implementation of *Makabayan*, can not be taken up in integrated units of learning tasks. (pp. 22–23)

To alleviate the concerns of the teachers of the different subject subsumed under *Makabayan*, the different subjects were simply maintained but these were now clustered under the superordinate learning area of *Makabayan. Makabayan* became a mere ‘heading’ for the old subject areas.

Consider the pertinent curricular prescriptions for Grades 6. *Makabayan* for Grade 6 students comprises of the following three subjects with specified weekly time allotment: (a) 200 minutes of *Sibika at Kultura* (Civics and Culture), (b) 200 minutes of *Teknolohiya, Edukasyong Pantahanan at Pangkabuhayan* (TEPP; Technology, Home Economics, and Livelihood Education), and (c) 200 minutes of *Musika, Sining, Edukasyong Pangkatawan at Pangkalusugan* (MSEPP; Music, Arts, Physical and Health Education).

For each year level in high school, *Makabayan* comprises of the following four subjects with specified weekly time allotment: (a) 240 minutes of *Araling Panlipunan* (AP; Social Studies), (b) 240 minutes of TEPP, (c) 240 minutes of MSEPP, and (d) 60 minutes of *Edukasyon sa Pagpapahalaga* (EPP; Values Education). The BEC document further suggests that the 240 minutes for MSEPP be divided as 60 minutes each for *Musika* (Music), *Sining* (Arts), *Edukasyong Pangkatawan* (Physical Education), and *Pangkalusugan* (Health).

Thus, although Grade 6 students are supposed to have 600 minutes a week of *Makabayan*, they actually have 200 minutes each for three different subjects. Similarly, high school students are supposed to have 780 minutes a week of *Makabayan*, but they actually have three subjects with 240 minutes each and another with 60 minutes (data on time allotments are taken from DepEd, 2002a, pp. 24–25).

The separation of the subjects under *Makabayan* is further demonstrated in the rating system for the *Makabayan* learning area (DepEd, 2003). In the first 3 years of high school, *Makabayan* has 3.7 unit credits. The 3.7 is actually separately distributed as follows: (a) 1 unit credit for AP, (b) 1.2 for TEPP, (c) 1.2 for MSEPP, and (d) 0.3 for EPP. The students’ grades for *Makabayan* are supposed to be computed using a weighted average scheme, with the weights roughly corresponding to the unit credits for each subject area. Thus, each student gets a separate grade for each of the four subject areas, and these are reflected in the student’s report card. But there is an ‘integrated” *Makabayan* grade is computed by giving different weights for each subject grade. A student’s grade in AP contributes 27% to the *Makabayan* grade; the grades in TEPP and in MSEPP each contribute 32.5%; and the remaining 8% comes from the grade in EPP.

In view of how the students’ learning times are allotted and how their grades are to be computed, it is very clear that there is no actual structure or process that has been specified to articulate the integration of the competencies from various subject areas with the view of developing students’ health personal and national identities.

The dilution of the key reform theme of integration is expressed so clearly in the attempt to string together the distinct subject areas into a meaningless acronym:

> The disciplines within *Makabayan* can be represented by the acronym SIKAP, where S stands for *Sibika*, *Sining*; I for Information (and Communication Technology); K for Kultuta; AP for Araling Panlipunan, Pagpapahalaga, Pangkatawan, Pangkalususgan, Pantahanan at Pangkabuhayan. (p. 23)

3.4 Reasserting the Key Reform Themes on Teaching

The proponents of the BEC assert that the integration of the subjects and competencies in *Makabayan* is supposed to be realized in the approach to instruction, even as the organizational and content features of the subject are not actually very different from the previous 'non-integrated' curriculum. According to Cruz (2002), the content and approach of the BEC is not radically different from the old curriculum, but the BEC's demands of the teachers are clearly different. For *Makabayan*, the teachers are expected to go beyond teaching for their specific subject areas. For example, the music teacher is supposed to integrate concepts and competencies from arts, health and physical education, technology and livelihood education, social studies, and even values education (DepEd, 2002a, pp. 28–30). Various types of integrative teaching strategies are suggested, including thematic teaching, content-based instruction, focusing inquiry, and generic competency model (DepEd, 2002a, pp. 30–34). Teachers are even encouraged to innovate, explore, and experiment with different teaching-learning approaches to better achieve the goals of integration (see e.g., Cruz, 2005).

The guidelines for the implementation of the BEC (DepEd, 2002c) indicate that the teachers of the different subjects under *Makabayan* are supposed to work together to ensure the integration of learning competencies across the subjects. The guidelines actually specify that a coordinator for *Makabayan* shall be designated to oversee the various activities related to *Makabayan*, particularly the collaboration among *Makabayan* teachers. Beyond these general directives, the school administrators and the *Makabayan* teachers are actually being empowered to design the teaching–learning environments for the different *Makabayan* subjects in ways that are most appropriate for their schools and students. This empowerment is in line with another key reform theme: the creative and innovative use of varied teaching approaches to help students attain the higher curricular learning goals.

3.5 The Second Round of Criticisms

As the implementation of the BEC became imminent, and preparations for the implementation began taking place, a second round of criticisms was expressed. The teachers of the subjects that would be subsumed by *Makabayan* were said to have aired 'a litany of complaints' (Araya, 2002). Teachers complained about more demanding work and longer work hours for the same pay. They also complained about having to integrate concepts from subjects of which they had no expertise, and that there was not sufficient time or training provided to prepare them to do the required planning and preparation for integrated teaching. There were very practical complaints about the lack of materials to attain the desired learning competencies and values in the *Makabayan* curriculum. Some teachers had a specific concern on the language of the instructional materials in some of the *Makabayan* subjects. For example, the technology and livelihood education was taught in English and using English language materials. The course that is now subsumed in *Makabayan* has to be taught in Filipino and using Filipino language materials that are not yet available. Many of these concerns were also raised within the forums organized by the DepEd to assess the early implementation of the BEC (DepEd, 2002b), and have been addressed and are continuously being addressed by the DepEd.

However, more fundamental problems have been noted by curriculum experts and other scholars. While the *Makabayan* curriculum has articulated very lofty goals for development of healthy personal and national identities among our students, and that the design of the curriculum empowers teachers to be flexible in how they integrate the competencies in the different *Makabayan* subjects towards these goals, these curricular articulations have not been fleshed out in sufficient detail. Many of the other curricular documents which are used by the teachers to prepare their day-to-day lessons have not been revised. For example, the Philippine Elementary Learning Competencies (PELC) and the Philippine Secondary Schools Learning Competencies (PSSLC) which specify the scope and sequence of topics and competencies to be covered by teachers every week have not been changed.

Given that many of the immediate inputs to the curriculum that teachers have access to (e.g., scope and sequence, textbooks, teaching materials, and assessment instruments) have not been changed, it is not clear how the integration of competencies in *Makabayan* would be implemented by different *Makabayan* teachers. Given that the schools and teachers did not have a lot of time and resources to adequately prepare for the implementation of this integrated learning area, it is not clear how the integration of the competencies and how integrative teaching would be concretized in the various *Makabayan* classrooms. It is very likely that in many classrooms, inertia would set in, the status quo would be maintained, with no actual streamlining or integration of subject area competencies being implemented. Some curriculum experts even feared that a significant and useful concept like ‘curriculum integration’ might gain a bad reputation if it is implemented inappropriately and/or without proper preparation.

Another problem noted by scholars and curriculum experts is that there is no coherent framework articulated for integrating the various curricular elements in the *Makabayan* learning area. Conceptually, the development of a healthy personal and national identity in the context of globalization is a potentially viable integrating framework. But the framework needs to be fleshed out in a way that clearly shows how the various competencies in the different subjects can be meaningfully integrated within this framework. This fleshing out will require rethinking the very topics and competencies covered in the subjects under *Makabayan*, streamlining these, and retaining only those that can be effectively and meaningfully used by teachers in helping student attain the goals of the learning area. The streamlining of curricular elements at this most operational level has not been done. Thus, teachers are still required to cover all the topics and competencies defined in the previous curriculum, whether or not they can be meaningfully linked to the *Makabayan* goals.

It seems that there are still gaps in how the integration as conceptualized in the BEC document are supposed be implemented in the actual classroom lessons that teachers will develop, and these gaps will remain as long as the subject areas are kept separated, and the specific conceptual forms of integration are left undefined. A more radical and extensive reform of the *Makabayan* curriculum seems to be required to attain the goals of the course, but the realization of such a reform seems to have been hampered by constraints within the formal basic education system.

A *Makabayan* teacher was recently asked how the implementation of the new learning area was going in their school. She replied, '*Makabayan? Wala naman nagbago. Ginagawa pa rin namin yun dati*'. Translated literally, '*Makabayan? Nothing has changed. We still do what we did before the curriculum reform*'.

4 Curriculum Change: Constraints in the Context

4.1 Summarizing the Intended vs. the Actual Reform

The Philippines' Department of Education undertook a much needed and well-intentioned curriculum reform when it implemented the 2002 BEC. The reform policy document indicates how the various curricular reforms are intended to improve student learning. But as shown in the implementation of the new learning area, *Makabayan*, these intentions may not be realized at all.

As was articulated in the *Makabayan* learning area, the BEC reform focused on three important themes: (a) setting higher and more complex learning goals, (b) streamlining and integrating the learning areas, and (c) employing more creative and innovative teaching approaches, including integrative teaching. In many different ways, these themes were diluted in form, substance, and implementation.

In *Makabayan*, the complex learning objectives were well articulated in the main documents, but were not sufficiently expressed in all curriculum materials. Most of the curricular materials that teachers had immediate access to have not been changed. Thus, the complex cognitive and value-laden learning objectives of *Makabayan* were left floating, with teachers attending to the same low level content- and skills-oriented learning competencies of the subjects in the old curriculum.

The streamlining and integration of different subject areas into one learning area was realized in a very superficial way. For practical purposes, the various classes remained intact and separate, with distinct learning goals, and rating systems. It did not help that the curriculum reformers left undefined how the various curricular elements (topics, competencies, textbooks, etc.) were supposed to be integrated. There was a vaguely defined framework, but this was not sufficiently articulated in the most concrete and operative curricular documents. At present, there is not much evidence of the integration, the most critical feature of the *Makabayan* reform.

Teachers of *Makabayan* were very vocal about the need for them to do more work, to undertake more training, for a reform effort which they were not very enthusiastic about. At the outset they resisted possible moves of fully integrating the various subjects under *Makabayan* and thus were able to maintain the status quo as regards their teaching work load and arrangements. Further research and documentation will have to be done to determine to what extent the *Makabayan* teachers actually used the freedom and flexibility they were granted to experiment with and to explore new integrative teaching strategies.

The BEC embodied an ambitious curriculum reform effort, which requires a major paradigm shift in the basic education system in the Philippines. Some of the major changes involved are: (a) reconceptualizing goals in terms of learning objectives instead of subject matter content; (b) designing curriculum elements in consideration of student learning processes instead of subject matter organization; (c) redefining the roles of the teacher and the student as interactive partners in attaining curricular goals; and (d) empowering the schools and teachers to be curriculum co-makers by allowing them to flesh out the details of the curriculum reform.

This radical shift in the underlying educational philosophy of the new curriculum is certainly a very positive and bold move on the part of the DepEd and is one that should be affirmed and supported by all stakeholders. But it seems that as is shown in the case of *Makabayan,* the DepEd was not able to fully articulate the curriculum reform that was needed amidst constraints and resistance within the basic education environment where these reforms had to be effected. What might have gone wrong?

The problem might be that this radical shift seems to have been conceptualized in a vacuum. That is, the reform was not effectively conceptualized within the realities of the Philippine basic education system, and was implemented hastily, without careful consideration of how the reforms would be received by the system.

4.2 Teachers: Key Stakeholders in Curriculum Reform

Changing the very nature of the goals and objectives of a curriculum requires that the various implementers of the curriculum fully understand the nature of this change. Teachers are perhaps the most important stakeholders in any curriculum reform process. As such, they will need to develop a full appreciation of the value of redefining curricular goals and to acquire a whole set of new approaches for teaching for these new goals. This would not and could not happen by decree. This also does not happen by simply telling teachers, ‘this is what you should do now’ and providing them short-term training courses on these new strategies. Teachers would need to go through the careful and even painful process of examining their fundamental beliefs about their profession, their subject matter, and their students.

It would not be fair to say that Filipino basic education teachers are resistant to change. But it would not be inaccurate to say that they have not been quick to acquire new teaching approaches even if they have been provided with opportunities and support for doing so. Research studies point to weaknesses in the preparation of Filipino teachers (see, e.g., Wong-Fernandez & Reyes, 2003), but the slow change in acquiring new teaching approaches while already in service might be due to more structural features of the basic education system. A study on the effectiveness of the in-service teacher development programmes of the DepEd and other educational agencies (Bernardo, Clemeña & Prudente, 2000) suggests that the design of these programmes may be flawed and that the working environment of the teachers might not be supportive of changes in the teachers' approaches. The study indicates that there are many features of the basic education system (e.g., extensive and highly prescriptive monitoring and surveillance, non-transparent incentive systems, and lack of material and organizational support from administrators) that tend to undermine teachers' efforts to change their pedagogical approaches.

If the DepEd desires that teachers significantly change their teaching practices, the DepEd should address the constraints within the system that are unsupportive of such changes. The DepEd cannot simply direct and expect teachers to change, if the system within which they operate will not encourage, support, and sustain these changes in a meaningful way.

But a more fundamental concern is how to involve the teachers in the curriculum reform process, and how to make teachers fully understand the radical philosophical paradigm shifts involved in the reform being undertaken. If the DepEd fails to more meaningfully involve teachers in the reform process, they will run into problems with how the teachers will actually implement the new curriculum. The DepEd's problem would not be those teachers who loudly criticize the curriculum reform, as they probably comprise a rather small minority of teachers. Instead, their problem would be the large majority of teachers who will try to follow and implement a revised curriculum they do not fully understand.

4.3 Full Articulation of the Revised Curriculum Elements

In a way, it seems naïve that the DepEd thought that articulating the goals and elements of the curriculum reform in one major policy document would be sufficient to express all the important aspects of the reform. Aside from curricular statements at the policy level, there are many other curriculum-related documents that operate at various levels of the educational process. These documents (e.g., PELC, PSSLC, division- and district-level curriculum, and lesson plan guides) are very detailed and have been entrenched in the practices of many schools and teachers. These more detailed curricular articulations actually determine how the curriculum is given life in classrooms in different parts of the country. That these documents were not addressed during the curriculum reform process and prior to the implementation of the BEC is another example of the weak conceptualization of the reform.

In hindsight, the reform process should have produced an extensive battery of documents that fully flesh out the higher-level learning goals, the integration of competencies and values, and the innovative and creative teaching strategies in the integrated *Makabayan* curriculum. This set of detailed documents would provide the teachers and educational administrators at the various levels of the bureaucracy a very lucid articulation of what the new learning area is and how it should be.

The purpose of making such detailed articulations available is not to prescribe to teachers how they should teach the subject (which would run counter to another important theme of the curricular reform), but to give them better information to process for purposes of understanding and learning about the new *Makabayan* learning area.

It is hard to imagine how these full and detailed articulations of the *Makabayan* curriculum reform could have been done by the DepEd in the absence of a clear integrating framework, and with the constraint of having to keep the various subject areas separate. But again in hindsight, it might have been possible to do so if the new curriculum, particularly the new learning area of *Makabayan*, was not implemented too quickly, and if more time was given to fully articulating the framework and elements of the curriculum reform, helping prepare the teachers to implement the curriculum, and developing the materials to support the curriculum.

4.4 Centralized Reform Efforts

The highly centralized curriculum reform process might be one factor contributing to its weak conceptualization. Related research (Bernardo & Garcia, 2006) has raised concerns about the top-down approach adopted by the DepEd in its educational reform efforts. The study noted that many of the reform initiatives that come from the top of the educational hierarchy might be inappropriate and unresponsive to the problems encountered by schools in very diverse conditions and contexts. Problems were also noted in the implementation and monitoring at the lower levels of the educational hierarchy (e.g., incorrect transmission of the programmes that result in the dilution of the interventions downstream).

Some educational scholars who are optimistic about the implementation of the *Makabayan* learning area point the opportunities for moving the curriculum design process from the centre to the periphery, so to speak. Cruz (2005) proposed several guiding principles for the teaching of *Makabayan*; the first two principles are:

> First, *Makabayan* is a work-in-progress, not a completed work. Because each high school holds … regular sessions among its *Makabayan* teachers where continuous integration of lessons takes place, there is no single *Makabayan* curriculum completely applicable to all schools. Strictly speaking, there is no *Makabayan*, but there are *Makabayans*. There can also be no fixed list of lessons and competencies, because each school designs *Makabayan* according to the changing needs of its students and the community to which it belongs.
>
> Second, *Makabayan* is a work-in-progress from below, not from above. Because no human being can possibly understand all the aspects of *Makabayan* …, no one in the Central Office of the Department of Education can dictate what the individual schools need to do. Just to take a simple example, take an agricultural high school in a place where there is no electricity and where people usually eat only one meal a day. How can someone in Metro Manila, used to computers connected to the internet, figure out what competencies students in that school must have in order to find a job? The content of *Makabayan* has to come from the schools themselves, not from any central office.

The ‘open-ended’ quality of the *Makabayan* learning areas lets schools and teachers create the curriculum at their level, free from the prescriptions and scrutiny of the DepEd central office. But this might be an opportunity that schools and teachers would rather not enjoy, or might not be prepared to face. It might be better if the schools and teachers were first asked if they agree with the basic design of the learning area and if they are willing to work in fleshing out the *Makabayan* curriculum within this basic design.

4.5 Prospects for Reforming Learning Through the BEC

The implemented version of the *Makabayan* learning area does not seem to be very different from the old curriculum, and as such, it is hard to be optimistic about the prospects of improving student learning with this reform. But it would not be fair to say that the BEC has failed. Although the BEC has not fully articulated and realized the themes of the curricular and learning reforms, it has, in a rather forceful way, called the attention of the educational sector to an alternative way of thinking about learning in schools, and to the role of curriculum in this process. Concepts such as articulating curricular goals in terms of higher and complex cognitive goals, integrating core competencies within multi-disciplinary learning areas, thematic, integrative, problem-oriented, and inquiry-oriented teaching approaches, and empowering schools and teachers to design curriculum have now been forced into the Philippine basic education discourse. The various stakeholders of Philippine basic education will continue to make sense of such concepts and find ways to make them work within the constraints of the Philippine education system. As school improvement efforts from the ground, especially those supported by People's Organizations and Non-Government Organizations seem to be quicker and more effective (Bernardo & Garcia, in press), it is very likely that such efforts would co-opt and implement the same reform themes expressed in the BEC. Thus, although the BEC is not likely to directly result in improved student learning in primary and secondary schools in the country, it has provided a new vocabulary and philosophy for allowing Philippine schools to better address student learning in years to come.

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Reforming Medium of Instruction in Hong Kong: Its Impact on Learning

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Abstract The compulsory Chinese-medium teaching policy has been in place in Hong Kong since September 1998, one year after the handover of sovereignty. To date, very few studies have been conducted on the impact of the compulsory Chinese-medium teaching policy on learning. The public perception is that the English standards of students have further declined. As for the results of content-based subjects, some subjects have improved while others have maintained the same level. In this chapter I will examine the reform on medium of instruction and find out the impact of Chinese-medium teaching policy on learning generally, and specifically in students' attitude and motivation in learning at Chinese-medium schools, in the processes of learning content-based subjects through the mother tongue, in the examination results, and in students' medium-of-instruction preference. Ten schools have been surveyed. The theoretical underpinning of this article is Cummins' bilingual theories.

1 Introduction

A consultation document entitled 'Review of medium of instruction for secondary schools and secondary school places allocation' was issued by the Education Commission of Hong Kong (Education Commission, 2005) in February 2005. This delayed consultation on medium of instruction, which was scheduled to have been published at the end of 2002, instigated another new wave of heated debate surrounding Chinese- and English-medium instruction.

Medium of instruction has been an unresolved age-old problem in Hong Kong for more than three decades. As pointed out by the international visiting panel in its report 23 years ago, 'there is a classic public policy dilemma: whether to jeopardize the educational progress of the majority … in order to guarantee a sufficient number of competent English speakers; or to value the whole group … but

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accept the loss in capacity to deal with the international environment and hence a possible decline in the economic prosperity' (Llewellyn et al., 1982, p. 30). The central argument brought up by the two camps in support of their respective medium-of-instruction policy has remained unchanged, albeit that Hong Kong has experienced dramatic metamorphosis in the economic, political and sociocultural arenas in the past three decades.

This chapter will first provide an overview of the medium-of-instruction issue in Hong Kong and highlight the governmental efforts in tackling the issue through language policy changes and reforms. I will examine the case of Hong Kong applying Jim Cummins' bilingual theories. The findings of my recent surveys on medium-of-instruction policy will throw light on the impact of reform in medium of instruction on learning. Based on the survey findings, this chapter argues that by promoting bilingual education, we can move beyond the rivalry between Chinese-medium instruction and English-medium instruction; and bilingual education meets the demands for the increasing internationalized and globalized Hong Kong economy.

2 Reform in Medium of Instruction

2.1 The Debate on Medium of Instruction

There have been three stages of debate on medium of instruction during the past 30 years or so in Hong Kong.[1] The status of English and the demand for English in the society as well as policy-making have been changing throughout these three stages as a result of political, economic and social metamorphoses in Hong Kong. Consequently, the nature and the focus of the debate have shifted in each of these three stages.

The debate first started in the aftermath of the riot[2] in the late 1960s. Anti-colonial feeling was high especially among the young elite[3] during the late 1960s and the late 1970s – the first stage of debate. Because of the impact of the progressive movement in the West, social movements began to take roots in Hong Kong (Poon & Wong, 2004). Chinese as Official Language Movement[4] was the one that had a bearing on the debate of medium of instruction within education. That was why the debate at this stage was quite political-oriented.

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[1] This is my classification based on my understanding of the language policy scene amid the political, economic and social changes in Hong Kong in the post-war era.

[2] A riot broke out in 1967 in Hong Kong. It was organized by local pro-Beijing workers and students against the colonial rule of the then Hong Kong government.

[3] It refers to the baby boom generation born after the Second World War.

[4] English used to be the sole official language in Hong Kong. A group of activists started to fight for legalization of Chinese in the late 1960s and Chinese was enacted as a co-official language in 1974.

As in other colonies, diglossia was evident in Hong Kong (Fishman, 1971; Ferguson, 1972). The colonial language – English – enjoyed the supreme status of the high language whereas Chinese, the low language, did not gain an official status until 1974 – 132 years after Hong Kong was colonized by Britain in 1842 (Hong Kong Government, 1974). The unbalanced statuses of English and Chinese in society found their way into education. Secondary schooling in Hong Kong is traditionally bifurcated into English-medium schools (which were then called Anglo-Chinese schools) and Chinese-medium schools (which were then called Chinese middle schools). English-medium schools outnumbered Chinese-medium schools during this period. The former was preferred because English as a colonial language was accorded a higher value; for instance, a pass in English in the Hong Kong Certificate of Education Examination[5] was a requirement for entering the civil service. However, the social demand for English during this period was not high as Hong Kong was then merely a city manufacturing garments and toys.

Cheng (1979) and Cheng et al. (1973) sum up the main argument at this stage. Medium of instruction was a historical and political issue. English-medium instruction (EMI)[6] was imposed on Hong Kong students through colonialism. The supporters of EMI argued that English gave students opportunities for well-paid jobs and for higher education. However, the advocates of Chinese-medium instruction (CMI) posited that learning through the mother tongue was better than through a second/foreign language. Children's intellectual and educational development, creativity and sensitivity would be sacrificed if they learnt through their weaker language.

A number of empirical studies conducted during the 1970s reported some harmful effects of using English as the medium of instruction in schools (Cheng et al., 1973; Cheung, 1979; P. K. Poon, 1979), but the problem of EMI was not very serious then because the education system was basically elitist and those who studied in government-aided secondary schools could overcome the hurdle of English language in one way or another (Poon, 1993, 1999, 2000).

The debate continued and entered its second stage during 1980s and 1997. This was a period in which Hong Kong established itself as an international centre of trade and finance as the result of a great economic boom. The changing economic status boosted the demand for proficient English speakers in Hong Kong. On the other hand, with the decolonization process in place coupled with the flourishing economy, the status of English in the territory had changed from a colonial language to an international language (Johnson, 1994; Lord, 1987; Pennington & Yue, 1994; Poon, 2000). English became much wider spread in the society and even more highly valued than before. EMI was originally superimposed on students in the previous period, but then turned out to be a most preferred choice of students and their parents (Poon, 1999, 2000, 2004).

[5] A public examination taken by students after Secondary 5 (i.e. Grade 11 in the American system) and an equivalent of Britain's GSCE.

[6] The majority of primary schools in Hong Kong use Chinese as the medium of instruction. EMI is introduced at secondary level only.

The 1970s saw the rapid expansion of school education in Hong Kong. Mass education, which formally began with the introduction of 9-year free and compulsory education in 1978, brought about myriads of problems in education. Medium of instruction was one of them. As mentioned above, the sudden shift of teaching medium from Chinese to English in Secondary 1 did pose some problems on students in the era of elite education. The adverse effect is even more deeply felt in the era of mass education. Many students in the so-called English-medium schools during this period were not able to learn through the English medium due to the declining English standards. Mixed code, that is, mixing both English and Chinese in a discourse, was common in these schools (Johnson, 1983; Johnson et al., 1984; Johnson & Lee, 1987).

The debate about the medium of instruction in the second stage was less political-oriented than in the first stage because of subsided anti-colonial feeling. The focus shifted to students' declining English standards and the subsequent use of mixed code as a result of expansion of education and 9-year free and compulsory education (Education Commission, 1984, 1986, 1990, 1996; Lin, 1990; Pennington, 1995). The advocates of CMI reiterated their stance that mother tongue was the best medium of learning and using mixed code was harmful to students' language development, while the supporters of EMI emphasized the practical value of English as an international language and the dire need of Hong Kong as an international city for good English speakers. Laissez-faire policy-making pertaining to medium of instruction prior to 1997 favoured the English-medium supporters, thus deepening the cleavage between the two camps. Meanwhile, the problem of mixed code teaching aggravated.

The third stage of the debate erupted in the post-handover period since 1997. The issue of medium of instruction has once again become politicized mainly because of the Hong Kong SAR (Special Administrative Region) Government's[7] tightening governance in education (Poon & Wong, 2004) and its subsequent new language policy put forward in September 1997 (Education Department, 1997b). Details of the changing medium-of-instruction policies will be discussed in the next section.

For the patriots, nationalism should come first and the return of Hong Kong's sovereignty to mainland China is a golden opportunity for enforcing mother tongue (i.e. Chinese) rather than a foreign language (i.e. English) as the medium of instruction in all secondary schools. The new policy-maker is inclined towards the patriotic view especially when the education scene is taken into consideration – that is, the English standards of local students continue to dip, the problems of using English as a medium of learning linger, and the use of mixed code in the classroom has become more widespread. The education groups which have been fighting for CMI for decades thus join hands with the government. Nonetheless, enormous pressure keeps coming from the business sector, and the demand for better English standards has been escalating as a result of globalization and Hong Kong's repositioning in the world economy and China's strategic planning. Meanwhile, parents and the majority of schools are pledging for more English-medium schools, whose number has shrunk from about 340 to 114 since the compulsory CMI policy was in

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[7] This is the official name of Hong Kong after the handover.

operation in September 1998, for the obvious reason that English being an international language brings a better career path and thus a brighter future.

With the new compulsory CMI policy in place, the problem of mixed code has been resolved to quite a large extent because many former so-called English-medium schools have been forced to change to Chinese-medium schools under the new policy. However, one trade-off is its adverse impact on English standards and learning as revealed in the results of the first cohorts of graduates under the new policy taking the Hong Kong Certificate of Education Examination and the Hong Kong Advanced Level Examination in 2003 and 2005 respectively. It is against this background that I have undertaken the surveys to find out the impact of changing medium-of-instruction policy on learning.

2.2 Changing Policies in Medium of Instruction

Traditionally the Hong Kong government followed the footsteps of Britain to adopt a laissez-faire policy towards medium of instruction (Poon, 2000, 2004). A formal policy proposing the use of the Chinese medium in junior secondary school did not appear until the White Paper on secondary education (Board of Education, 1974) was out. However, this medium-of-instruction policy was never enforced during the first stage of debate as there was no implementation plan. The laissez-faire policy persisted until the second stage of debate – the period which saw the decline in English standards and emergence of use of mixed code in English-medium schools as mentioned previously.

In 1990, the Education Commission proposed a more clear-cut medium-of-instruction policy in its fourth report (Education Commission, 1990) for junior secondary education (the government has no control over the medium of instruction of senior secondary education as free and compulsory education is provided up to junior secondary 3 only). The streaming policy aimed at rectifying the problem of mixed code – which was viewed as a contributing factor of declining English standards – through putting students of different language abilities in three different types of schools, namely English-medium schools, Chinese-medium schools and two-medium schools. Although Poon's study (2000) found a number of factors that might hinder its implementation, the streaming policy was by then the most comprehensive, theory-driven, research-based and pragmatic medium-of-instruction policy with a framework and an implementation plan.

The streaming policy could have survived had it not encountered the change of sovereignty in 1997, nor had the decision-maker in the Hong Kong SAR government been less political in making education policies (Poon, 1999).[8] About 3 months prior to the handover when the streaming policy was in full swing, the then

[8] Poon argues that proposing compulsory CMI policy 'was a political move – a gesture to appease China. Hong Kong was on the brink of returning to China: it seemed legitimate to enforce the use of Chinese as the medium of instruction especially when a myriad of problems have arisen during implementation of the streaming policy' (1999, p. 139).

Department of Education[9] suddenly issued a consultation document ('the Firm Guidance') proposing a compulsory CMI policy in April 1997 (Education Department, 1997a) – which means all secondary schools would be forced to go Chinese-medium. The proposal triggered a third round of debate pertaining to medium of instruction, which was even more acute than the previous two stages because the interest of various parties was at stake. The Government finally gave way to landslide opposition from schools, parents and students (*Ming Pao Daily*, 3 May 1997; *Sing To Daily*, 13 May 1997; *South China Morning Post*, 19 September 1997). The 'Firm Guidance' was then revised as the 'Guidance' in September 1997 (Education Department, 1997b). Under the revised compulsory CMI instruction policy 114 schools (later changed to 112 as 2 schools left the public sector) were granted exemptions and approximately 70% of schools were made Chinese-medium. The number of Chinese-medium schools was escalating in the past decade, from 12% in the laissez-faire period to 38% as projected by the then Education Department in 1994 when the streaming policy was enforced, and further up to 70% in 1998 when the compulsory CMI policy was enforced.

2.3 The Latest Reform in Medium of Instruction – Consultation Document on Review of Medium of Instruction

The Hong Kong SAR government shelved the streaming policy without offering the public an explanation[10] and enforced the implementation of compulsory CMI policy in September 1998. A Review Committee on medium of instruction comprising members of the former Board of Education and SCOLAR[11] was to undertake a formal evaluation of the CMI policy and submit a report by the end of 2002. Nonetheless, the views of the Review Committee were so divided that the Hong Kong government decided to put off the formal review for 2 years and extend its coverage to include the review of the Secondary School Places Allocation System. A Working Group under the Education Commission was subsequently set up in July 2003 to review these two areas. A consultation document entitled *Review of medium of instruction for Secondary Schools and Secondary School Places*

[9] The Education and Manpower Bureau used to be a decision-making body whereas the Education Department was to implement school education policies. Because of restructuring and streamlining, the Education and Manpower Bureau and the Education Department merged in 2001.

[10] The Education and Manpower Bureau did this skillfully and the public were not even aware of the shift in policy. According to Poon (2004, pp. 58–59): 'The "Firm Guidance" and the "Guidance" were originally meant to help fully implement the streaming policy according to the framework stipulated in the Education Commission Report no. 4 in 1990 (Education Commission, 1990). They in effect actually abolished the streaming policy and proposed a new direction for Hong Kong's medium of instruction policy – the compulsory Chinese medium instruction policy.'

[11] The full name of SCOLAR is 'Standing Committee on Language Education and Research', which used to be under the advisory committee 'Education Commission', is now under the Education and Manpower Bureau.

Allocation was issued in February 2005. The consultation was completed in early July 2005 and the Hong Kong government is going to announce whether the compulsory CMI policy will remain or not.

It is proposed in the consultation document to continue with the current CMI policy at junior secondary level because 'Mother tongue teaching makes it easier for students to acquire subject knowledge, master high-order thinking skills, and develop interest in learning' as claimed by the Working Group (Education Commission, 2005, p. iii). However, the three prescribed criteria for English-medium teaching laid out in the 'Guidance' (Education Department, 1997b, p. 5) are further tightened as follows:

1. Student ability: An English-medium school should have at least 85% of its Secondary 1 intake being EMI-capable. The Education and Manpower Bureau provides schools with information of the MIGA (Medium of Instruction Grouping Assessment)[12] of their student intake every year.
2. Teacher capability: Instead of being assessed and certified by the principal, the teachers are required to attain a certain level of English as prescribed by the Education and Manpower Bureau (e.g. a Grade C or above in the HKCEE,[13] Band 6 or above in IELTS).
3. Support measures: Instead of merely providing some bridging courses for students, the schools are required to set out their support strategies and specific measures in their school development plans and annual school reports. Their support measures will be assessed by the Education and Manpower Bureau based on the results of schools' self-evaluation, external school review and/or quality assurance inspections (Education Commission, 2005).

In addition, a 'Changing Trains' model is proposed. Schools will be reviewed every 6 years. Those English-medium schools which are not able to fulfil the three prescribed criteria will have to switch to CMI whereas the aspiring and 'EMI-qualified' Chinese-medium schools can apply to become English-medium schools.

The proposed changes in medium of instruction have attracted severe and widespread criticism from schools, parents and academics (Cheng, 2005; *Ming Pao*, 2005a, b; Poon, 2005a, b; *The Standard*, 2005). The 'Changing Trains' model is likely to exert more pressure on schools, teachers, students and parents as English-medium schools are still their preferred choice. The stability of the school system would also be shattered by the 6-year review cycle.

The effects of the recently proposed further changes to the compulsory CMI policy are yet to be seen. However, research on the effects of the compulsory CMI policy as a whole since its operation in September 1998 is scant. The present study aims firstly to find out the impact of the changing medium-of-instruction policy on

[12] Students are assessed and categorized into three groups: Group I – able to learn effectively in either Chinese or English; Group II – able to learn more effectively in Chinese; Group III – able to learn better in Chinese but may also learn effectively in English.

[13] See note 5.

ten schools which were forced to go Chinese-medium in 1998, and then to discuss the findings in the context of historical debate in medium of instruction with a view to finding a solution for Hong Kong.

3 Theoretical Framework

The theoretical framework for viewing the issue of medium of instruction in the present study is bilingualism and bilingual education. As discussed previously, the age-old debate in Hong Kong dichotomizes EMI and CMI, and focuses merely on the advantages/disadvantages of using English or Chinese as medium of instruction in secondary schools. Traditionally very little attention has been paid to bilingual education in Hong Kong. Several authors (e.g. Kuo, 1986; Lord, 1979; Siu, 1979; So, 1987) have advocated bilingual education but their works are descriptive and not in the context of medium-of-instruction policy. In my two studies on medium-of-instruction policy in Hong Kong (Poon, 1998, 2000), I put forward a bilingual mode for Hong Kong's education. I argue that bilingual education had in effect been practised on a large scale before 1998 when the majority of secondary schools were English-medium schools, although neither the Hong Kong government nor the scholars had ever viewed it in this light. However, the scale of bilingual education has been downsized to less than one quarter of the school population since the implementation of compulsory CMI policy in September 1998. The Hong Kong government's assumption of changing the medium to Chinese is that students will find it easier to learn content-based subjects (e.g. Mathematics, Integrated Science, Social Studies) through their mother tongue and thus be better motivated to learn and become higher achievers. The surveys in the present study provided empirical data pertaining to the validity of the government's claim. A positive finding may indicate that the shift to CMI is the right track for Hong Kong; otherwise, an alternative path should be sought to address the issue of medium of instruction – that is, bilingual education, which, in my view, coheres rather than dichotomizes EMI and CMI.

The term 'bilingual education' as employed in this chapter refers to the use of two languages as medium of instruction in formal schooling (Baetens Beardsmore, 1994; Fishman, 1976; Hornberger, 1990). The greatest output of bilingual education is bilinguals, who are presumably superior to monolinguals in many respects, such as divergent and creative thinking, metalinguistic awareness and communicative sensitivity (Baker, 2006). As models of bilingual education abound and they are informed by different theories of bilingualism, one must find an appropriate model that suits the social milieu of one's own region/country.

The bilingual education model that I proposed in my previous studies on medium-of-instruction policy in Hong Kong (Poon, 1998, 2000) mainly draws on Cummins' bilingual theories. Of all the concepts and models that Cummins has developed over the last three decades, I have selected the Interdependence Hypothesis and the Threshold Hypothesis as the bases for discussion.

In his Interdependence Hypothesis Cummins (1981) proposes the Common Underlying Proficiency (CUP) model of bilingualism, which postulates that L1 and L2 skills are interdependent although the surface features of different languages (e.g. pronunciation, spelling) are separate. By 'CUP' Cummins specifically refers to the cognitive/academic dimension of language proficiency (CALP) rather than the other dimension of proficiency – basic interpersonal communication skills (BICS)[14] (Cummins, 1985 [1980]). Experience with one language can promote the development of cognitive/academic language proficiency underlying both languages. Transfer of this proficiency across languages will occur provided that there is adequate exposure to the L2 and adequate motivation to learn it.

Research in the past 20 years has indicated an overwhelming support for the Interdependence Hypothesis (Cummins, 1991; Fitzgerald, 1995; Verhoeven & Aarts, 1998; Wagner, 1998). However, Cummins (2000) finds that both advocates and opponents of bilingual education have frequently misinterpreted the Interdependence Hypothesis by assuming that transfer of knowledge and academic skills across languages will happen automatically. In fact it is the knowledge and academic skills that help form the underlying cognitive apparatus – that is, the central processing system that underlies the interdependence of L1 and L2 proficiencies – which is used 'to interpret textual meaning rather than being 'transferred' directly across languages' (Cummins, 2000, p. 190). Vygotsky sums up the interdependence relationship between L1 and L2 as thus: 'The child can transfer to the new language the system of meanings he already possesses in his own. The reverse is also true – a foreign language facilitates mastering the higher forms of the native language' (Vygotsky, 1962, p. 110). Language transfer is rendered possible only when L1 and L2 reach a threshold level.

The Threshold Hypothesis also attempts to explain the relationship between the degree of bilingualism and cognition (Cummins, 1976). There are two thresholds of bilingual competence: the lower threshold level and the higher threshold level. Below the lower threshold level, children have low levels of competence in both languages, and there may be negative cognitive effects (e.g. unable to comprehend, apply, analyse, synthesise or evaluate knowledge). Between the lower threshold level and the higher threshold level, children have age-appropriate competence in one language only and cognitive effects are neither positive nor negative. When children's bilingual competence reaches the higher threshold level, they have age-appropriate competence in both languages, and there are positive cognitive advantages. Cummins criticizes the Threshold Hypothesis as remaining 'speculative' and 'not essential to the policy-making process' (Cummins, 2000, p. 175) about two and a half decades after it was first proposed, mainly because the conditions under which language affects cognitive growth is vague to specify as the conditions vary extensively. However, one finding is well supported: '[T]he continued development

[14] In his BICS/CALP Distinction, Cummins defines the former as 'the manifestation of language proficiency in everyday communicative contexts' and the latter as 'the manipulation of language in decontextualized academic situations' (1985 [1980], p. 137).

of bilingual children's two languages during schooling is associated with positive educational and linguistic consequences' (Cummins, 2000, p. 175). This finding, in fact, rectifies a common misinterpretation about the Threshold Hypothesis: L1 must be built up to a 'threshold' level before literacy in L2 should be introduced.

Cummins' bilingual theories adopt a cognitive and constructivist view of language learning. They are basically psychological and individual. I will go beyond the psychological and individual frame of Cummins' theories by adding a social dimension to my theoretical framework. The reasons are twofold. Firstly, the focus of my inquiry is on language policy, which is 'either a macro- or microsociological activity involving deliberate and organized efforts to solve language problems, which very often have a social, political and/or economic orientation' (Poon, 2000, p. 117). Secondly, medium of instruction is related to bilingual education. Education per se is a sociological construct involving public money, government policies and the interest of various stakeholders. Therefore, the bilingual education model (Poon, 1998, 2000) that I postulate and use for discussion in this study draws on only some of the concepts posited by Cummins (i.e. the Interdependence Hypothesis, language transfer and the Threshold Hypothesis) without adhering to his overall frame. My bilingual education model for Hong Kong will be elaborated in the 'Discussion' section below.

4 Research Methods and Results

4.1 Research Problem and Question

As mentioned previously, medium of instruction has been a thorny issue puzzling Hong Kong for several decades. Not only does it pose a practical problem for the policy-maker to find a long-term solution to it, but it also provides a research problem for academic pursuit. I embarked on this research problem more than 10 years ago and the endeavour has continued until today. Language policy scenes have been changed and revamped over and over again, and yet the core problem remains the same – namely, *what is the best medium-of-instruction policy for Hong Kong?*

The compulsory CMI policy has been in operation for 8 years. Only three large-scale studies, of which one was conducted by the Government (SCOLAR, 1999, cited in Education Commission, 2005), one was commissioned by the Government (The Chinese University of Hong Kong, 2004, cited in Education Commission, 2005) and one was conducted by a Government-funded centre – Support Centre for Teachers Using Chinese as the Medium of Instruction at The University of Hong Kong (2002, cited in Education Commission, 2005). The scope of these studies is quite broad and they generally look at the following aspects of medium of instruction after implementation of the CMI policy in both Chinese-medium and English-medium schools: experiences and views about the new medium of instruction policy, effectiveness of CMI at junior secondary levels, medium of instruction at senior secondary levels, the effect of CMI or EMI on the learning and psychosocial development of students. A focused survey comparing the effect of changing the medium of instruction from English to Chinese on teaching and learning in junior secondary schools is lacking.

The Hong Kong Government has reiterated over and again the benefits of CMI – namely, students will find it easier to learn content-based subjects through their mother tongue and thus be better motivated to learn and become higher achievers – and high-handedly shifted the medium-of-instruction policy from the streaming policy to the compulsory CMI policy in 1998. What is happening to those schools that have experienced the shift of teaching medium? How do principals/vice-principals, teachers and students feel about the Chinese-medium schools? How do they view teaching and learning in Chinese-medium schools? What is the actual language use in Chinese-medium schools?

All the above questions contribute to the framing of my research question – *What is the effect of compulsory Chinese medium-of-instruction policy on teaching and learning at junior secondary levels in the former English-medium schools?*

4.2 Research Method

In this study, two surveys were conducted to solicit views about learning in Chinese-medium schools from different perspectives: the perspectives of principals and teachers as well as those of students. The two questionnaires included items on topics about students' attitudes towards Chinese-medium schools, learning various subjects and learning in general, actual language use in class, effects of CMI and personal preference for CMI. The strength of the survey design is that findings in the student survey can be corroborated with those found in the teacher survey. In addition, the principals and teachers who participated in the teacher survey were capable of providing a comparative view as they taught in the same schools for at least 8 years and witnessed the change in medium of instruction in September 1998.

Ten schools were selected to take part in the current study based on the following criteria:

1. History: The selected schools must be at least 8-years old and claim to adopt English-medium or two-medium (i.e. Chinese-medium/English-medium) prior to September 1998. According to the government statistics (Education Commission, 1994, p. 22; Planning and Research Division), there are more than 200 schools that fall into this category.
2. Banding[15]: As the majority of schools that have the above historical background are Band 2 and 3 schools, the schools selected should cover three bandings but with more Band 2 and 3 schools.

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[15] Hong Kong students are categorized into three bands pertaining to their academic achievement, with Band 1 being the top and Band 3 the bottom. Schools claim to be Band 1 schools if the majority of their intake is Band 1 students.

Table 1 Profile of selected schools

School	History	Banding	Location
A	40 years	3	Kowloon
B	17 years	3	New Territories
C	30 years	2	Kowloon
D	15 years	2	New Territories
E	30 years	3	New Territories
F	23 years	2	New Territories
G	52 years	3	Kowloon
H	20 years	1	New Territories
I	40 years	2	Kowloon
J	9 years	2	New Territories

3. Location: If possible, the schools selected should be spread out geographically in Hong Kong Island, Kowloon and the New Territories.[16]

Table 1 describes the profile of the selected schools.

To develop a more comprehensive view of the issue in question, the surveys recruited different categories of school stakeholders, for example, the principals/vice-principals, the panel chairpersons, the subject teachers, and the students. Stratified sampling was applied to select participants from these stakeholder groups to participate in the surveys. In each school four categories of participants were selected according to the following criteria:

1. The principal or the vice-principal – they represent the decision-maker at the school level.
2. The panel chairpersons of five subjects, that is, English, Chinese, Mathematics, Integrated Science (IS) and Social Studies – they represent the decision-maker at the academic subject level.
3. The subject teachers who have taught the above five subjects in junior secondary (i.e. S1–S3) preferably for at least 8 years. For each subject two teachers were selected.
4. Eighteen students were selected from each school. For each level (i.e. S1, S2, S3) there were 6 students (2 high achievers, 2 average achievers and 2 low achievers).

Table 2 shows the profile of the selected participants.

4.3 Results and Findings

To find out students and teachers' views about CMI in these schools that have shifted their medium of instruction from English to Chinese since September 1998, and to address the research question pertaining to the effect of compulsory CMI

[16] It is not always possible to do so because schools that fit all three criteria may not agree to participate. Of all three criteria, the location factor is comparatively less crucial, so compromise has been made and it turns out that the participating schools are located in two areas instead of three.

Table 2 Profile of selected participants

School	No. of principals/ vice-principals(I)	No. of panel chair-persons(II)	No. of subject teachers(III)	Total no. of teachers (I+II+III)	No. of students	Total no. of participants
A	–	2	5	10 (3 did not report their positions in school)	17	27
B	1	7	8	16	18	34
C	1	5	8	14	18	32
D	1	7	8	16	18	34
E	1	6	9	16	18	34
F	2	7	7	16	10	26
G	1	8	6	15	18	33
H	1	4	10	15	18	33
I	1	5	10	16	18	34
J	1	5	9	16	17	33
Total	10	56	80	150	170	320

Table 3 Comparison of views of teachers and students on different variables

Variables		Teachers		Students		
		M	(*SD*)	M	(*SD*)	*t* value
TQ1/SQ1	Students happy in CMI schools	3.48	(*0.63*)	3.74	(*0.95*)	−2.94**
TQ5/SQ8	Motivated in learning	3.23	(*0.95*)	3.64	(*0.93*)	−3.87***
TQ9/SQ11	Mixed code used in lessons	2.94	(*1.28*)	2.66	(*1.18*)	1.98*
TQ11/SQ13	Learning faster through CMI	3.66	(*0.95*)	3.67	(*1.00*)	−0.14 (N.S.)
TQ12/SQ14	Learning better through CMI	3.49	(*0.96*)	3.58	(*1.05*)	−0.83 (N.S.)
TQ13/SQ15	More interaction between teachers and students through CMI	3.74	(*0.92*)	3.66	(*1.01*)	0.66 (N.S.)
TQ17/SQ16	Continue with CMI for benefit of students	3.31	(*1.16*)	3.33	(*1.23*)	−0.12 (N.S.)
TQ18/SQ17	Continue with CMI for benefit of schools	3.15	(*1.13*)	3.20	(*1.18*)	−0.40 (N.S.)

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; N.S. = non-significant results.

policy on teaching and learning in these schools, t-test, correlation and Oneway ANOVA analyses were conducted.

First of all, the t-test analyses compared the views of teachers and students on Chinese-medium schools, motivation in learning at Chinese-medium schools, the actual use of language in the classroom, the effect of Chinese teaching medium on learning processes, and medium-of-instruction preference. Table 3 shows the teachers and students' scores on these variables.

The results of t-test showed that there was a significant difference between teachers and students in their views on students' feelings about studying in CMI schools (t value = −2.94, $p < 0.01$) and motivation in learning English, Chinese, Mathematics, Integrated Science and Social Studies (t value = −3.87, $p < 0.001$) (Table 3). Frequency counts indicate that less than half of the teachers (48%) agreed that students felt happy in CMI schools, but almost 60% of students shared this view (TQ1 – see the appended teacher and student questionnaires for the coding of variables). Likewise, the percentage of students (about 60%) thinking that students were more motivated in learning was higher than that of teachers (40%) (TQ5/SQ8). However, one interesting point is that the rate of teachers opting for 'neutral' pertaining to whether students were happy in CMI schools (47%) and whether they were motivated in learning (36%) was very high – close to the figures for 'agree'. That means there were quite a large proportion of teachers who were not sure whether students really had positive feelings and attitudes about studying in CMI schools. This finding is consistent with the responses to the two questions requiring the teachers to compare the present students with the students before implementation of the compulsory CMI policy in their feelings (TQ4) and motivation (TQ6). For TQ4, only 28% of teachers agreed that the present students enjoyed studying more than the past students, and interestingly more than half of the teachers (about 53%) remained 'neutral'. For TQ6, about 42% agreed that the present students were more motivated in learning than the previous students, but the 'neutral' rate was high (about 33%). A breakdown in statistics showed that the level of motivation varied from subject to subject: (a) English (64% of the teachers disagreed with the above statement that the present students were more motivated in learning than the previous students); (b) Chinese (24% rated disagree and 52% neutral); (c) Mathematics (about 13% rated disagree but 53% neutral); (d) Integrated Science (about 7% rated disagree but 30% neutral); (e) Social Studies (7% rated disagree but about 24% neutral). That means English teachers among all other subject teachers were the least satisfied with the present students' level of motivation in learning compared with the past students. However, the results did not indicate that teachers of other subjects found the present students more motivated than the past students. On the contrary, the teachers' attitudes were quite ambivalent, particularly the teachers of Chinese and Mathematics because more than half of them chose 'neutral'.

The results of t-test also showed that the views of teachers and students on the use of both Chinese and English (i.e. mixed code) in the classroom were significantly different (t value = 1.98, $p < 0.05$). Both teachers and students generally agreed that mixed code was used in all subjects except Chinese although there were more teachers who agreed than students. Frequency counts for the reasons provided are as follows (TQ10/SQ12):

1. Because it was more convenient to explain in mixed code (48% of teachers rated agree; about 47% of students rated agree)
2. Because the teacher had to prepare students for EMI as the school shifts its medium of instruction to English in Secondary 4 (or year 10) (33% of teachers rated agree; about 67% of students rated agree)

3. Because the standards of students' English were low (39% of teachers rated agree; about 35% of students rated agree)
4. Because the teacher had difficulty in using English only as medium of instruction (23% of teachers rated agree; about 36% of students rated agree)

One tricky point pertaining to the question of whether mixed code was used in class is that in principle all lessons except English were to be conducted in Chinese after implementation of the CMI policy. If the policy had been well implemented, the response to this question should have been 100% Chinese and very clear cut. Variation in the answers implies different practices in different schools, namely, some schools used Chinese only while others mixed Chinese with English.

As regards the effect of Chinese teaching medium on learning processes, the results of t-test analyses showed that there was no significant difference between teachers' and students' views on whether students learnt faster (TQ11 & SQ13, $p = 0.982$) and better (TQ12 & SQ14, $p = 0.408$) through the medium of Chinese, and whether there was more interaction between the teachers and the students through the medium of Chinese (TQ13 & SQ15, $p = 0.511$). In other words, both students and teachers shared similar views. More than half of the teachers and students agreed with the above statements.

Concerning the medium-of-instruction preference, the results of t-test analyses showed that the teachers and students' views on whether it is better to continue with CMI for the overall benefit of the students (TQ17/SQ16, $p = 0.903$) and for the overall benefit of the school (TQ18/SQ17, $p = 0.690$) were not significant. In other words, both teachers and students shared similar views. About 40% plus teachers and students agreed with the statements that the school should continue with CMI for the benefit of both the students and the school. The high neutral rate (30% plus), however, implies ambivalence prevailed among one third of teachers and students. That explains why when the students were asked to indicate whether they would accept the offer by an EMI school (SQ18), 42% said they would definitely accept the offer. It implies that CMI may be beneficial to students in terms of learning processes, but when it comes to the choice of actual medium of instruction, students are more inclined towards EMI.

In addition to t-tests, correlation analyses were employed to further investigate the relationship between some of the variables with a view to identifying the actual key factor that affects the teachers and students' medium of instruction preference. Whether students are happy in CMI schools can be taken as an indicator of positive effect of CMI policy on teaching and learning. If students are happy, normally it can be expected that they are motivated in learning (TQ5/SQ8), learn faster through CMI (TQ11/SQ13), learn better through CMI (TQ12/SQ14) and have more interaction with teachers (TQ13/SQ15). Accordingly, the school should continue with CMI for the benefit of students (TQ17/SQ16) as well as for the benefit of school (TQ18/SQ17). Correlation analyses were therefore conducted to establish the relationship between the indicator variable – 'students happy in CMI school' (TQ1/SQ1) – and the other related variables respectively – 'more motivated in learning' (TQ5/SQ8), 'learn faster through CMI' (TQ11/SQ13), 'learn better through CMI'

Table 4 Relations between teachers' perceptions of students' happiness and other variables

	TQ1 Students feel happy about studying in CMI school
TQ5 More motivated in learning	0.25**
TQ11 Learn faster through CMI	0.23**
TQ12 Learn better through CMI	0.26**
TQ13 More interaction between teachers and students	0.24**
TQ17 Continue with CMI for benefit of students	0.36***
TQ18 Continue with CMI for benefit of school	0.38***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 5 Relations between students' feeling in CMI schools and other variables

	SQ1 Students feel happy about studying in CMI school
SQ8 More motivated in learning	0.39***
SQ13 Learn faster through CMI	0.53**
SQ14 Learn better through CMI	0.50**
SQ15 More interaction between teachers and students	0.50**
SQ16 Continue with CMI for benefit of students	0.48***
SQ17 Continue with CMI for benefit of school	0.40***

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

(TQ12/SQ14), 'more interaction between teacher and students' (TQ13/SQ15), 'continue with CMI for the benefit of students' (TQ17/SQ16), 'continue with CMI for the benefit of school' (TQ18/SQ17). Tables 4 and 5 show the relationship between these variables perceived by the teachers and the students respectively.

Table 4 and Table 5 above indicate that the variable of 'Students feel happy in CMI school' was significantly and positively correlated with all the variables pertaining to students' motivation (SQ8), learning processes (SQ13, 14, 15) and medium-of-instruction preference (SQ16, 17) from both the perspectives of teachers and students. Presumably students should be very positive about studying in CMI schools. However, the results of another correlation analysis performed on the variable of 'accept the offer of EMI school' and two different sets of variables (those concerning motivation and learning processes; and results of academic subjects) were non-significant. Table 6 shows the results.

The non-significant results above mean that students' decision of accepting the offer of an EMI school was not related to their positive views about the benefits of studying in CMI schools, nor their academic results. In other words, there may be another important factor, other than those related to motivation and learning benefits, that affects students' decision on the choice of medium of instruction (MoI).

To further investigate the issue of students' MoI decision, a Oneway ANOVA analysis was performed comparing the views of students from schools of different bandings (Band 1 being the highest and Band 3 being the lowest in academic attainment) on their MoI preference. The result was nonsignificant. In other words, students irrespective of schools' achievement bandings shared similar views about

Table 6 Relations between students' MoI preference and other variables

	Correlation with SQ18. Student would accept the offer of EMI school
A. Motivation and learning processes	
SQ8 More motivated in learning	0.09 (N.S.)
SQ13 Learn faster through CMI	–0.04 (N.S.)
SQ14 Learn better through CMI	–0.10 (N.S.)
SQ15 More interaction between teachers and students	0.03 (N.S.)
B. Results of academic subjects	
SQ19a Chinese	–0.17 (N.S.)
SQ19b English	–0.26**
SQ19c Mathematics	–0.16 (N.S.)
SQ19d Integrated Science	–0.15 (N.S.)
SQ19e Social Studies	–0.24*

*$p < 0.05$; **$p < 0.01$; N.S.= non-significant results.

Table 7 Comparison of views of students from schools of different bandings on MoI preference

	Band 1		Band 2		Band 3		
	M	(*SD*)	M	(*SD*)	M	(*SD*)	*F* value
SQ18 Accept the offer from an EMI school	3.54	(*1.45*)	3.42	(*1.26*)	3.00	(*1.28*)	2.02 (N.S.)

N.S.= non-significant results.

MoI preference and they would tend to transfer to EMI schools if given an offer. Table 7 shows the result.

The results of both correlation (Table 6) and Oneway ANOVA (Table 7) analyses affirmed that students valued EMI more although they realized the benefits of CMI schools as mentioned previously. The discussion section will explore complex issues related to the MoI preference.

On the part of teachers, Oneway ANOVA analyses were also conducted to explore differences originated from the school banding on the following variables: (1) TQ4 – 'present students enjoying studying more than past students'; (2) TQ12 – 'students learning better through CMI'; (3) TQ16 – 'present students having better results than past students'; (4) TQ17 – 'continue with CMI for benefit of students'; (5) TQ18 – 'continue with CMI for benefit of school'. Table 8 shows the results.

Significant group differences were found in all the variables except TQ16. In the view of teachers, students from lower banding schools generally learnt better through CMI. There was a remarkable difference between teachers from schools of different bandings in their views on whether the school should continue with CMI for the benefit of students and for the benefit of the school. The teachers from Band 3 schools agreed to these views more than the teachers from Band 1 and Band 2 schools. However, teachers regardless of the school bandings shared the same view that the present students did not necessarily have better results than the past students although there had been a shift in the MoI since 1998. Apparently this finding is contradictory to the belief and expectation of the supporters of CMI policy.

Table 8 Views of teachers from schools of different bandings

	Band 1		Band 2		Band 3		
	M	(*SD*)	M	(*SD*)	M	(*SD*)	*F* value
TQ4 Present students enjoying studying more than past students	3.40	(*0.63*)	2.90	(*0.71*)	3.28	(*0.82*)	4.94**
TQ12 Students learning better through CMI	3.07	(*1.10*)	3.27	(*0.93*)	3.76	(*0.89*)	5.27**
TQ16 Present students having better results than past students	2.60	(*0.69*)	2.69	(*0.69*)	2.85	(*0.67*)	1.16 (N.S.)
TQ17 Continue with CMI for benefit of students	2.27	(*0.83*)	3.14	(*1.09*)	3.79	(*0.97*)	13.63***
TQ18. Continue with CMI for benefit of schools	2.13	(*1.30*)	2.97	(*1.01*)	3.72	(*0.95*)	16.51***

**$p < 0.01$; ***$p < 0.001$; N.S.= non-significant.

Below is a summary of findings drawing on the above data analyses:

1. There was a significant difference between teachers and students in their views on students' feelings about studying in CMI schools and motivation in learning various subjects. More students than teachers agreed that 'students feel happy in CMI schools and are more motivated in learning'.
2. There were quite a large proportion of teachers who were not sure whether students really had positive feelings and attitudes about studying in CMI schools.
3. English teachers among all other subject teachers were the least satisfied with the present students' level of motivation in learning compared with the past students.
4. There were quite a large proportion of teachers of other subjects who were not sure whether the present students were more motivated than the past students.
5. Both teachers and students generally agreed that mixed code was used in all subjects except Chinese.
6. Both teachers and students generally agreed that CMI has positive effects on students' learning processes.
7. Both teachers and students shared similar views about whether the school should continue with CMI. About 40% plus agreed that the school should continue with CMI, but about 30% plus were not sure whether the school should continue with it.
8. The variable of 'Students feel happy in CMI school' was significantly and positively correlated with all the variables pertaining to students' motivation, learning processes and MoI preference from both the perspectives of teachers and students.
9. Students' decision of accepting the offer of an EMI school was not related to their positive views about the benefits of studying in CMI schools, nor their academic results.

10. Students irrespective of bandings shared similar views about MoI preference and they would tend to transfer to EMI schools if given an offer although they realized the benefits of learning in CMI schools
11. Students from lower banding schools generally learnt better through CMI than EMI.
12. The teachers from Band 3 schools agreed more than the teachers from Band 1 and Band 2 schools that the school should continue with CMI.
13. Teachers regardless of the school bandings shared the same view that the present students did not necessarily have better results than the past students before the shift of MoI in 1998.

5 Discussion

According to the Hong Kong government and the supporters of CMI, it will be easier for students to learn content-based subjects through their mother tongue, and students will be better motivated to learn and thus become higher achievers. The survey results in the present study shed light on the validity of these claims. Finding 8 establishes the positive correlation between the variable of 'Students feel happy in CMI schools' and the variables pertaining to students' motivation and learning processes (i.e. learn faster, learn better and have more interaction in class). In other words, under normal circumstances, students who feel happy will be better motivated and find learning in CMI schools effective and beneficial. Both teachers and students participated in the surveys generally agreed that Chinese teaching medium has positive effects on students' learning processes (Finding 6). This particular finding provides some support to the government's claim about the benefits of using CMI. However, the other findings about students' motivation prevent us from accepting the government's claims.

Finding 1 indicates that teachers' views differed significantly from those of students. Fewer teachers than students thought that students are happy and more motivated in CMI schools. As a matter of fact, a large proportion of teachers were not sure whether students really have positive feelings and attitudes about studying in CMI schools (Finding 2). When teachers were asked to compare present students' motivation in learning with that of past students, English teachers among all other subject teachers were the least satisfied (Finding 3), possibly because there has been a decline in students' English standards since the implementation of compulsory CMI policy in 1998, as evident in the dramatic drop in the number of candidates taking Syllabus B of English Language subject in the Hong Kong Certificate of Education Examination – a more difficult syllabus than Syllabus A – since 1998. Poon's studies (1999, 2000) reported similar views provided by principals and teachers pertaining to students' motivation in learning English. Apart from English, quite a large proportion of teachers of other subjects in this study were not sure whether the present students were more motivated than the past students (Finding 4). As the majority of teachers had taught in the schools for 8 years or above, they had a reference point in mind and were able to compare the present students learning through the Chinese medium with the past students learning through the English medium. The teachers' ambivalent views showed that they were not positive about this proclaimed benefit of CMI – that is, students will be better motivated in learning. As for the other proclaimed benefit concerning the academic results, teachers regardless of the school bandings shared the same view that their present students did not necessarily have better results than their past students before the shift of medium of instruction in 1998 (Finding 13). Again, this is evident in the results of content-based subjects in the Hong Kong Certificate of Education Examination. If we compare the results of the candidates of 2002 with those of 2003, the year which saw the first cohort of students having completed their secondary education through CMI, we find the pass rate in some subjects has increased, but that of other subjects has decreased. That means the claim that CMI facilitates students' learning and helps them to become higher achievers cannot be established. Nonetheless, students' ability is a crucial consideration in the choice of MoI. In our findings, students from lower banding schools generally learnt better through CMI than EMI (Finding 11); this is consistent with another finding that teachers from Band 3 schools agreed more than the teachers from Band 1 and Band 2 schools that the school should continue with CMI (Finding 12).

These findings affirm Cummins' (1976) claim in his Threshold Hypothesis that there are positive cognitive advantages only when children's bilingual competence reaches the higher threshold level. As Band 3 students' language competence, especially English competence, is low, their cognitive development is affected and this obviously has a negative impact on their academic achievement. If they study in English-medium schools (like most secondary students prior to 1998), they will be put in a disadvantageous position. Therefore, English medium only or Chinese medium only is not a viable option for Hong Kong.

In addition to the benefits of CMI on learning, it is worthwhile looking at the actual language use in the classroom. As the schools surveyed are Chinese-medium schools, presumably Chinese is the only language used in teaching and learning in all subjects except English. Interestingly, both the teachers and students surveyed generally agreed that mixed code was used in all subjects except Chinese (Finding 5). Why is there such discrepancy? Like most secondary schools in Hong Kong, these 10 secondary schools surveyed were assigned the status of Chinese-medium schools by the Hong Kong government in 1998. Students in these schools have to learn through the medium of Chinese until they have completed their compulsory education by the end of junior secondary education. As for senior secondary education, the compulsory CMI policy does not apply. In reality many so-called Chinese-medium schools shift their MoI from Chinese back to English in Secondary 4 and above.

A closer look into the case reveals that the shifting of MoI from Chinese to English in Secondary 4 and above is supported by a dominant social value that English is superior to Chinese even in the post-colonial period, in which English as a colonial language would presumably lose its supreme status. However, English has always been in high demand in Hong Kong because of its instrumental value for education and career advancement (Boyle, 1997; Li, 2002; Pierson, 1987; Pennington & Yue, 1994; So, 1992). Hong Kong people understand perfectly well that English as an International Language is a key to success in the era of globalization, as Li observes, ‘This self-awareness is deep in the psyche of Hong Kong Chinese, a psyche which transcends boundaries across generations and socio-economic classes’ (Li, 2002, p. 51). That explains why Chinese-medium schools have to address the needs of the parents, and start preparing students for the shift in the English medium even in Secondary 1 through the use of mixed code; otherwise, they will lose their competitive edge especially in times of shrinking student population.

A further discrepancy is identified in the data concerning MoI preference. Finding 7 indicates that both teachers and students shared similar views about whether the school should continue with CMI – about 40% plus agreed that the school should continue with CMI, but about 30% plus were not sure whether the school should continue with it. Once again, teachers and students’ ambivalent attitudes showed that the choice is not as straightforward as it appears – that is, Chinese teaching medium has positive effects on students’ learning processes as generally agreed by both teachers and students (Finding 7), and therefore they all agreed that the school should continue with CMI. On the part of the students, they were generally quite positive about studying in CMI schools, and they found learning productive in the sense that learning is faster, better and more interactive through the Chinese medium (Findings 6, 8). However, surprisingly, though, quite a large number of students chose to study in English-medium schools if they were given an offer irrespective of their bandings (Findings 9, 10).

Digging deeper in these apparently incongruous findings lends us some insight about the power of social forces. Learning in the classroom involves not only the teachers, the students, the curriculum, the pedagogy and the teaching materials, but also other stakeholders, such as the subject panel heads, the principals, the school supervisors, the government education policy-makers, the parents as well as the community at large. All the stakeholders are exerting their influence on the process of learning in one way or another, but are at the same time being influenced by some social forces at play, for instance, the economic force, the political force, and the social values. Medium of instruction is more than an educational issue. The students as well as the schools’ (including the principals and teachers’) choices of MoI are to quite a large extent determined by the dominant social values, which are framed by various forces in their social milieu. The government’s top-down language policy cannot change people’s core value.

To recap, the apparent contradictions in the findings of the survey are revealing. They are the outcome of the old debate on MoI lingering for more than three decades in Hong Kong as discussed previously. The flaw of the debate lies with the polarity of views posed by the two camps. Neither the supporters of CMI nor those of EMI realize the importance of bilingual education. Nor are they aware of the Common Underlying Proficiency governing different languages as posited in Cummins’ language learning theory – Interdependence Hypothesis (1981). Although Chinese and English are linguistically distant languages, research as reported by Cummins (2000,

p. 176) has affirmed that a strong foundation in one language can enhance academic, cognitive and linguistic functioning of another language. Transfer of cognitive/academic dimension of language proficiency (CALP) across languages is possible, though not automatic, when the proficiency of these languages has reached the threshold level. According to Cummins' Threshold Hypothesis (1976, 2000), when children's bilingual competence reaches the higher threshold level, they have positive cognitive advantages. Only if the two polarized camps involved in the heated debate had some knowledge of Cummins' bilingual theories would they join hands and spend their time and efforts in promoting bilingual education in Hong Kong. By 'bilingual education', I adopt Fishman (1976), Hornberger (1990) and Baetens Beardsmore's (1994) definition, that is, 'the use of two or more languages as MoI in formal schooling' (Hornberger, 1990, p. 14).

The bilingual education model that I proposed about 10 years ago (Poon, 1998, 2000) is based on the then streaming policy. Some details such as the proportion of students in different types of school might be overtaken by time, but the spirit can still be applied to the current scenario. According to the Education Commission's research figures (Education Commission, 2005, p. 12), 40% of S1 students are capable of learning through the English medium while the remaining 60% should learn through Chinese. Thus on proportion about 190 out of 470 plus schools should be EMI schools in order to accommodate the EMI-able students, but the number of EMI schools was set at 114 when the CMI policy was first implemented in 1998. Obviously some EMI-able students are misplaced at CMI schools, and grievances are, therefore, inevitable. My proposed bilingual education model employs a more flexible approach to MoI. There are three types of school: the EMI-schools, the two-medium schools and the CMI-schools. The two-medium schools are free to stream students according to the capability and needs of the schools by class (i.e. some EMI classes and some CMI classes), by subject (i.e. some EMI subjects and some CMI subjects), by level (e.g. S1 being CMI, S2 partially EMI and S3 EMI), or a mixed mode of by class, by subject and/or by level. This bilingual education model, if well implemented, would ease the tension between the two polarized camps and address the needs of students of different abilities, and more importantly, cater for the demands of the Hong Kong society in the process of globalization.

6 Implications for Reforming Learning within the Region

The Hong Kong case is a good example to demonstrate the complexity of MoI policy – an important issue facing a post-colonial country or region. While nationalism or patriotism plays an important part in the entire Discourse,[17] other social forces have

[17] 'Discourse' with a small 'D' refers to continuous piece of spoken or written language as the result of an act of communication. 'Discourse' with a capital 'D' is more than just language, and it refers to 'ways of coordinating and integrating words, signs, acts, values, thoughts, beliefs, attitudes, social identities, as well as gestures, glances, body positions, objects and settings' (Gee, 1996, p. 6).

to be taken into consideration in reforming learning in general, and in reforming MoI in particular. Some post-colonial countries in Asia-Pacific, for example, Malaysia, Singapore and the Philippines, experienced the dilemma of upholding nationalism while maintaining economic stability of the state as well as the well-being of different ethnic groups four to five decades ago. These countries perceived the colonial language ‘English’ in such diverse manner that English was assigned very different statuses in the MoI in government school education. Malaysia went to one extreme by changing its MoI at school from English to Malay after a riot in 1969, 10 years after its independence (Gill, 2002; Gupta, 1997; Ozog, 1993) whereas Singapore swung to another extreme by keeping English as the only MoI (Gupta, 1997). The Philippines, on the other hand, takes the middle ground by adopting the bi-subject model. The 1974 Bilingual Education Policy mandated the use of English as MoI for the subjects English, Science and Mathematics, and the use of Pilipino (Tagalog) as MoI for other subjects (Gonzalez, 1998).

With the passing of colonialism in its classical sense and the spreading of English from the Inner Circle to the Outer Circle and the Expanding Circle (Kachru, 1983) in the second half of the twentieth century, English has become a denationalized International Language (Brutt-Griffer, 2002) permitting communication between peoples in the international arena. The status of English in Hong Kong has also undergone changes from a colonial language to an international language since the economic boom in the 1980s (Johnson, 1994; Lord, 1987; Pennington & Yue, 1994; Pierson et al., 1980; Poon, 2000). Globalization is another gigantic force that gathered momentum in the wake of the new millennium (Baylis & Smith, 1997; Stiglitz, 2002). The demand for a single language – the global language ‘English’ – has never been so high in human history. It is in this new context that Hong Kong and its neighbours in the region talk about reforming education and learning. Hence Hong Kong should get rid of its old paradigm of viewing English-medium teaching as a colonial liability, but rather as a legacy in harmony with Chinese-medium teaching. The present study affirms some findings pertaining to social values in the following two large-scale longitudinal studies commissioned by the Hong Kong government: (1) ‘Students in EMI schools found learning through English less effective but believed that EMI teaching would bring about a better prospect. In contrast, students of CMI schools found learning through the mother tongue more effective but felt that mother-tongue teaching would be disadvantageous to their future development’ (The Chinese University of Hong Kong, 2004, cited in Education Commission, 2005); (2) ‘Half of the parents believed that it was more important to perform better in English than in other academic subjects’ (SCOLAR, 1999, cited in Education Commission, 2005). It is evident that MoI policy is more than an issue of education and learning. The government should pay heed to the hidden social forces in formulating the MoI policy – a lesson that the Asia-Pacific countries should learn or may have learnt. Otherwise, Hong Kong would follow the footsteps of Malaysia, which mistakenly adopted the ‘all-Malay’ MoI policy in 1969 and switched back to the bilingual policy in January 2003 (Kuppusamy, 2002), and English in Malaysia ‘has almost come full circle’ (Gill, 2002, p. 102) after experiencing declining English standards since more than three decades ago.

7 Conclusion

The present study investigated the impact of the current CMI policy on learning in the 10 schools surveyed. It was found that both the students and the teachers had mixed feelings towards CMI albeit certain aspects of learning are apparently quite effective. Their ambivalent attitude was probably affected by the supreme value accorded to English in the process of globalization. The Hong Kong government's recently proposed 'Changing Trains' model would further tighten the CMI policy, thus aggravating the tension between the CMI and EMI camps. It is not likely that the English standards of Hong Kong students would improve under the current CMI policy. On the contrary, the bilingual education model I proposed (Poon, 1999, 2000) encompassing both CMI and EMI in the entire school curriculum should be considered seriously for implementation in the Hong Kong school system. The justification is that bilinguals are superior to monolinguals not only in language skills, but also in cognition, academic skills, verbal skills and social skills (Cummins, 1976, 1981, 2000). More importantly, the age-old conflict between the CMI and EMI camps is likely to be resolved if the bilingual education model is employed.

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Appendix 1: Survey for Principals/Teachers

TQ1

Students feel happy about studying in a CMI school

TQ2

Why do some of them feel happy about studying in a CMI school?

i. Because it is easier to understand the lessons
ii. Because it is easier and more convenient to ask questions in Chinese
iii. Because the lessons are more interesting
iv. Other reasons (please specify) _____

TQ3

Why don't some of them feel happy about studying in a CMI school?

i. Because they think that CMI schools are not as good as EMI schools
ii. Because they feel that they are looked down upon by others
iii. Because they are afraid that their English will not be as good as those studying in EMI schools

iv. Because they are afraid that their results in the public examinations will not be as good as those studying in EMI schools
v. Because they are afraid that they will have difficulty in studying at universities, which usually use EMI
vi. Because they are afraid that they will not be able to find a good job in future
vii. Other reasons (please specify) _____

TQ4

Compared with the students before 1998–1999, the year in which the school changed its medium of instruction from English to Chinese, the students now enjoy studying more.

TQ5

Students are motivated in learning English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects. *(For teachers, please circle one subject: for principals/vice-principals, you may circle more than one subject.)*

TQ6

Compared with the students before 1998–1999, the year in which the school changed its medium of instruction from English to Chinese, the students now are *generally* more motivated in learning English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects. *(Please circle the same subject(s) as in no. 5.)*

TQ7a

Why are the students now *generally* more motivated in learning English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects than the students before 1998–1999? *(Please circle the same subject(s) as in no. 5.)*
i. Because other subjects have become easier now due to the change of medium of instruction, so they can concentrate more on English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects
ii. Because the teaching methods of English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects are more interesting now
iii. Because there are more resources for English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects now
iv. Because there are NETs in the school now [for the English subject only]
v. Because Chinese is now more important and they need Chinese to learn other subjects [for the Chinese subject only]
vi. Other reasons (please specify) _____
OR

TQ7b

Why are the students now generally less motivated in learning English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects than the students before 1998–1999? *(Please circle the same subject(s) as in no. 5.)*

i. Because other subjects have become easier now due to the change of medium of instruction and they can get higher marks in these subjects, so it is not necessary to make too much effort in English/Chinese/Mathematics/Integrated Science/Social Studies/all subjects
ii. Because they don't need English to learn other subjects now, so English is not as important as before [for the English subject only]
iii. Other reasons (please specify) _____

TQ8

Is English *only* (i.e. not mixed code) actually used to teach English? *(For English teachers and principals/vice principals only.)*

TQ9

Mixed code (i.e. both English and Chinese) is actually used to teach English/Mathematics/Integrated Science/Social Studies/all subjects except Chinese. *(For teachers, please circle one subject; for principals/vice principals, you may circle more than one subject.)*

TQ10

Why is mixed code (i.e. both English and Chinese) used to teach English/Mathematics/Integrated Science/Social Studies/all subjects except Chinese? (*Please circle the subject(s) as in no. 9*.)

i. Because the standards of students' English are low
ii. Because the teacher has difficulty in using English ***only*** as medium of teaching
iii. Because the teacher has difficulty in using Chinese ***only*** as medium of teaching
iv. Because it is more convenient to explain in mixed code
v. Because the teacher has to prepare students for EMI as the school shifts its medium of instruction from Chinese to English in Secondary 4 and above
vi. Other reasons (please specify) _____

TQ11

Students learn English/Mathematics/Integrated Science/Social Studies/all subjects faster through the medium of Chinese. *(For teachers, please circle one subject; for principals/vice-principals, you may circle more than one subject.)*

TQ12

Students learn English/Mathematics/Integrated Science/Social Studies/all subjects better through the medium of Chinese. *(For teachers, please circle one subject; for principals/vice-principals, you may circle more than one subject.)*

TQ13

There is more interaction between the teacher and the students when teaching English/Mathematics/Integrated Science/Social Studies/all subjects through the medium of Chinese. *(For teachers, please circle one subject; for principals/vice-principals, you may circle more than one subject.)*

TQ14

Compared with the teaching before 1998–1999, the year in which the school changed its medium of instruction from English to Chinese, the teacher has more time left now because the students no longer need to struggle with the English medium.

TQ15

If you agree with the statement in no. 14, how does the teacher make use of the time left in class for the teaching of English/Mathematics/Integrated Science/Social Studies/all subjects? *(For teachers, please circle one subject; for principals/vice-principals, you may circle more than one subject.)*

i. Ask students to do more problem-solving type or higher-order thinking activities related to the topics already covered.
ii. Add more topics.
iii. Explain some difficult topics again.
iv. Assign more exercises related to the topics already covered.
v. Ask students to revise the topics already covered.
vi. Let students do some reading related to the topics already covered.
vii. Let students watch some videos or films related to the topics already covered.
viii. Let students do whatever they like.

TQ16

Compared with the students before 1998–1999, the year in which the school changed its medium of instruction from English to Chinese, what have the results of the following subjects in the HKCEE been in your school since 2003?

i. The Chinese subject is better than before.
ii. The English subject is better than before.
iii. The Mathematics subject is better than before.

iv. The Integrated Science subject is better than before.
v. The Social Studies subject is better than before.

TQ17

For the *overall benefit* of the students, it is better to continue to use Chinese in S1–S3 as the medium of teaching in English/Mathematics/Integrated Science/Social Studies/all subjects. *(For both teachers and principals/vice principals, you may circle more than one subject.)*

TQ18

For the *overall benefit* of the school, it is better to continue to use Chinese in S1–S3 as the medium of teaching in English/Mathematics/Integrated Science/Social Studies/all subjects. *(For both teachers and principals/vice-principals, you may circle more than one subject.)*

Appendix 2: Survey for students

SQ1

You feel happy about studying in a CMI school.

SQ2a

Why are you happy about studying in a CMI school?

i. Because it is easier to understand the lessons
ii. Because it is easier and more convenient to ask questions in Chinese
iii. Because the lessons are more interesting
iv. Other reasons (please specify) _____
OR

SQ2b

Why are you not happy about studying in a CMI school.

i. Because CMI schools are not as good as EMI schools
ii. Because CMI school students are looked down upon by others
iii. Because I am afraid that my English will not be as good as those studying in EMI schools
iv. Because I am afraid that my results in the public examinations will not be as good as those studying in EMI schools

v. Because I am afraid that I will have difficulty in studying at universities, which usually use EMI
vi. Because I am afraid that I will not be able to find a good job in future
vii. Other reasons (please specify) _____

SQ3

You like to learn English very much.

SQ4

You like to learn Chinese very much.

SQ5

You like to learn Mathematics very much.

SQ6

You like to learn Integrated Science very much.

SQ7

You like to learn Social Studies very much.

SQ8

You are now *generally* motivated in learning.

SQ9a

Why are you now *generally* motivated in learning?

i. Because other subjects (except English) are taught in Chinese and they are easy to understand
ii. Because there are NETs in the school now
iii. Because Chinese is now more important and I need Chinese to learn other subjects
iv. Because the teachers use interesting methods to teach us
vi. Other reasons (please specify) _____
OR

SQ9b

Why are you now *generally* not motivated in learning?

i. Because other subjects (except English) are taught in Chinese and they are easy to understand, so it is not necessary to make too much effort in learning
ii. Because other subjects (except English) are taught in Chinese and I can get high marks in these subjects, so it is not necessary to make too much effort in learning
iii. Because I don't need English to learn other subjects, so English is not as important as before

SQ10

Your English teachers use English *only* to teach English.

SQ11

Mixed code (i.e. both English and Chinese) is actually used to teach all subjects except Chinese.

SQ12

Why is mixed code (i.e. both English and Chinese) used to teach all subjects except Chinese?

i. Because the standards of students' English are low
ii. Because the teacher has difficulty in using English *only* as medium of teaching
iii. Because the teacher has difficulty in using Chinese *only* as medium of teaching
iv. Because it is more convenient to explain in mixed code
v. Because the teacher has to prepare students for EMI as the school shifts its medium of instruction from Chinese to English in Secondary 4 and above
vi. Other reasons (please specify)_____

SQ13

You learn all subjects faster through the medium of Chinese.

SQ14

You learn all subjects better through the medium of Chinese.

SQ15

There is more interaction between the teacher and the students when you learn through the medium of Chinese.

SQ16

For the *overall benefit* of the students, it is better to continue to use Chinese in S1–S3 as the medium of teaching in all subjects.

SQ17

For the *overall benefit* of the school, it is better to continue to use Chinese in S1–S3 as the medium of teaching in all subjects?

SQ18

You will definitely go to an EMI school if you are given an offer.

Problems and the Direction of Reform for Education in Japan Today

Kimiharu Sato

Abstract The basic principles of learning theory in elementary and middle high schools have been putting stress on students' active and voluntary learning activities in school for the last 20 years. The main theories informing Japanese educational practice, especially for elementary and middle high school, are Piaget's theory of cognitive development and researches of cognitive psychology or cognitive science focusing on the students' active construction of their own knowledge and understanding. The most recent movement of educational practice in Japanese schooling has been a return to thebasic 3Rs of learning (writing, reading, and arithmetic). The main background for this movement is the fact that the Japanese students' achievement level has been continuing to decline from the top level among other countries (from the results of the IEA International student assessment of science and mathematics [TIMSS]), and the OECD/PISA.The main reason for this fall in the achievement level of Japanese students compared with countries such as Singapore and Hong Kong, where a high level of student achievement in science and mathematics has been maintained, is that the total time of lessons at school per week has been decreasing since 2002. From 2002, Japanese schools closed on Saturdays each week, and so the contents and amount of the learning curriculum changed and cut down from those before 2000. Managers and executives of big companies in Japan have been approached to help raise the low level of Japanese school students' achievement to higher standards, because talented and competent students are needed to keep the power of the Japanese economic activity and industrial technology high in order to compete with other countries in the international game of economic power.

The same result of the TMSS-R in 1999 also suggested that the motivation of students in Japan and Korea to achieve has become weak gradually, and that the time spent on voluntary learning activities at home by Japanese middle high school students has really been decreasing during the last 20 years. The competition to pass high school and college entrance examinations has been intense in both Japan

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and Korea, and the students of both countries have been compelled to study to get a high achievement-test score. New reform movements for increasing the intellectual motivation and the voluntary learning activities of students have been tried, and the basic trend for these new reforms of school is the rearrangement of the learning class as a community of collaborative learning. The same reciprocal teaching which Brown and Palincser have proposed for guiding the students' active group learning and discussion has also been used as the basic practical idea for the new classroom learning at some Japanese elementary and middle high schools. The social constructive theory and the Vygotskian sociocultural approaches towards stimulating and supporting the initiative and voluntary learning activities of the middle high school students will be helpful for the theoretical frameworks for understanding the significance of such educational practice. I will also discuss the theoretical possibilities of the Vygotskian sociocultural approaches towards the new educational movements in Japan.

1 The Problem

The results of two international academic achievement surveys in December of 2004 had a huge impact on those in the field of education in Japan. The two surveys were Programme for International Student Assessment (PISA), administered by the OECD, and Trends in International Mathematics and Science Study (TIMSS), administered by the International Association for the Evaluation of Educational Achievement (IEA).

Until now, Japan has always maintained a top-class standard in the world for middle and high school student performance. This high level of achievement has marked the success of Japanese schools and has been said to demonstrate the excellence of the Japanese education system and its teaching methods (Stigler & Hiebert, 1999; Lewis, Perry, & Hurd, 2004). Much of the attention given to this high level of achievement has come from industries needing advanced scientific technology to survive in resource-poor Japan.

When the results of the two international assessments, TIMSS 2003 and OECD/PISA 2003 were released, discussions on the decline in student achievement and the plight of Japanese education bombarded Japanese mass media; in particular, major newspapers published a special series on education. Especially, two big newspapers, the Asahi (*Asahi-Shinbun*) and the Yomiuri (*Yomiuri-Shinbun*) in Japan, reported the results of the downslide in high school students' mathematical literacy and reading literacy attainment on OECD/PISA 2003 as a special column for 2 weeks in December 2004 and March 2005. Surrounding all this media attention, the Minister of Education, Mr. Nariaki Nakayama, blamed the decline partly on too little classroom hours and too little learning material required for high school students; he declared the need for educational reform. He asked the Central Council for Education to revise the course of study for each school level for improving students' scholarship, on 15 February 2005. This Council is an advisory body to the Minister of Education. Behind the arguments of both the minister and mass media were statements from university professors who complained of an increase in students' lack of basic academic skills, as well as an increase in middle and high school students who were not interested in science.

In response to this apparent crisis in education, there are those who advocate that classroom hours should be increased, with emphasis placed on mastery of basic knowledge and skills. Nishimura (1999, 2001), Professor of Kyoto University, has asserted consistently that the recent tendencies of lowering of achievement levels and of poor motivation to study hard in Japanese undergraduates are mainly caused by reducing the number of school hours under the revised course of study from 1998. Wada (2003) has also stated that the lowering of academic achievement in children is caused by reducing the curriculum and the number of school hours under the revised course of study. On the other hand, poor performance on the most recent OECD/PISA could be interpreted as indicating a low level of knowledge application and thinking ability, an argument that has been made in the past as well. Manabu Sato (2005), Professor of Tokyo University, has pointed out that the high school students who were tested on OECD/PISA 2003 had studied under the pre-revised course of study, and the lowering of academic achievement on OECD/PISA could not be caused by the revised course of study. Rather than promoting rote learning and repetition of knowledge, there is a strong push to focus more on problem-solving skills. Educational reform in Japan today is wavering between these two courses of action. In the following sections, I will first explain the results of two international academic achievement surveys that caused the strong dispute about the lowering of achievement levels and about whether the revised course of study from 1998 was right or wrong.

Second, some recent problems of Japanese students' learning activities focusing only on an entrance examination to high school and the undergraduate will be discussed. I will focus on the fact that the distribution of the high school students' academic achievements score on OECD/PISA 2003 by school was greater than in many countries, and this distribution by school was predetermined by the socio-economic status of the pupil. Hence I consider that Japan can rapidly become a competitive society in the educational system as well as confronting economic inequality.

In conclusion I will discuss the possible ways of educational reform in Japan and how students can become intrinsically motivated to learn. Academic achievements which OECD/PISA are seeking are critical thinking skills and problem-solving abilities, and those cannot be derived from the content of teaching which only concentrates on basic and essential knowledge and skills.

1.1 Results of the International Academic Achievement Surveys

OECD/PISA 2003: In December 2004, the results of one international academic achievement survey sent a wave of shock across the education sector in Japan. Scores from the Programme for International Student Assessment (OECD/PISA), administered by the OECD in July of 2003 revealed that the academic level of Japanese high school students had declined. For example, the mean average score of Japanese high school students' reading literacy had decreased from 522 in 2000 to 498 in 2003 (National Institute for Educational Research, 2004). Compared to previous scores from 2000, Japan had dropped from first to sixth place in mathematical literacy, and from eighth place to fourteenth in reading literacy. The top three countries in mathematical literacy were Hong Kong, Finland, and Korea. Finland was the top scorer in all survey subjects, including scientific literacy and problem-solving.

Taking a closer look at Japan's student performance on the OECD/PISA 2003, Japan took second place for scientific literacy, the same as in 2000, and remained in the top performance group. In fact, there was no significant statistical difference in the scores for the top four countries, and it would be fair to say that they all have equivalent academic levels. In first place was Finland, followed by Hong Kong in third and Korea in fourth. This same top-scoring group again took the first four places in problem-solving, with Japanese students placed fourth after Korea, Hong Kong, and Finland, again with no significant statistical difference. Since problem-solving was a newly added subject on the OECD/PISA 2003, no comparison can be made with the 2000 test.

In contrast, Japan dropped to the second performance group in both mathematical literacy and reading literacy, with lower student scores compared to 2000. The decline in reading literacy was especially large. Japan dropped from top to sixth place in mathematical literacy, and actual scores were much lower and there was a significant statistical difference compared to the four top-placed countries. The top group in mathematical literacy was made up of Hong Kong, Finland, Korea, and the Netherlands.

The OECD/PISA 2003 scores of most interest to people in the education sector were for reading literacy. From eighth place in 2000, Japan dropped even further in 2003 to 14th place. Although still ranking within the second group of scores, there was a difference of approximately 50 points compared to Finland (Japanese students' mean score was 498 and those of Finnish students was 543). The greatest concern was that, compared to countries in the top-scoring group such as Finland, Korea, Canada, or Australia, students in Japan had a wide range of scores. The mean score and standard deviation of each country were respectively the following (National Institute for Educational Research, 2004): Finland 543 (81), Korea 534 (83), Canada 528 (89), Australia 525 (97), and Japan 498 (106). The number in parentheses indicates the standard deviation. While there were some students with high scores, there were also a fair number of low-scoring students who contributed to a large point spread. For example, the percentage of the total number under score 400 was 17.5% in Japan, and in Finland, Korea, and Canada, it was a relatively low proportion (Finland: 5.0%, Korea: 5.8%, Canada: 8.4%). The decrease in scores of these low-performing students is thought to be an important factor contributing to the drop in rank to 14th place on the OECD/PISA 2003. There were also significant differences across schools, again indicating an expanding point spread among students (see section on high school student achievement and the disparity between schools and Table 5). Although the uniformity of student achievement has long been claimed as one of the great successes of Japanese schools, the results of the

OECD/PISA 2003 make it clear that academic disparity has begun to grow in the Japanese education system.

The poor ability of high school students to apply learned knowledge was also apparent in the OECD/PISA 2003 scores, especially in the two fields of mathematics and reading. To begin with we must remember that the emphasis of the OECD/PISA is on testing how students apply the knowledge and skills they have acquired during their compulsory elementary and middle school education to real-life situations. It is very different from TIMSS, which evaluates the level of learned curriculum content. The scores from OECD/PISA further illustrated what had in fact been pointed out previously (see, e.g., Takahashi, 1997), that although Japanese high school students were able to learn curriculum content, they were not good at using and applying this knowledge in everyday life.

As part of the mathematical literacy section of the OECD/PISA 2003, students were also given questionnaire surveys on their approach, attitude, and motivation towards learning. Mathematical literacy was surveyed in detail as the central subject for 2003; reading literacy was the main subject in 2000. The surveys revealed that Japanese high school students had lower than average affirmative responses to being interested in mathematics (positive response percentages of mathematical studies to the total number of Japanese students and OECD average were respectively 32.5% and 53.1%), indicating a declining motivation to study. However, these results must be interpreted with caution before drawing the conclusion that student motivation has declined. It has been stipulated that Japanese students have a tendency to answer affirmatively less often than students from other countries, and it is also important to consider that there are different standards for affirmative or negative responses.

The number of study hours after school can probably be a useful yardstick to gauge students' motivation to learn. In general, Japanese students studied approximately 6.5 hours per week, 2.4 hours less than the OECD average (National Institute for Educational Research, 2004, chapter 6, background of learning, p. 286). In terms of the time spent on studying mathematics, OECD countries had an average of 3.1 hours, compared favourably to Japan's 2.4 hours. These statistics are a concrete indication of the decrease in study time among Japanese students, which can probably be taken as an indication of a decline in learning motivation. We shall discuss the problem of declining motivation later in this chapter along with the results of a separate survey.

1.2 TIMSS 2003

The results of a second international academic achievement survey, the TIMSS 2003 administered by the IEA, were released following the OECD/PISA results (TIMSS 2003 report by Mullis et al., 2004). The purpose of TIMSS is to evaluate the level of science and mathematics proficiency in fourth- and eighth-grade (second grade at middle high school in the Japanese school system) students. Precursors to TIMSS were conducted beginning in 1964 to compare mathematics and science achievement internationally, and the current form of TIMSS has been administered every 3 years since 1995. The third TIMSS took place in 2003, and Japan had participated in all three surveys.

Compared to TIMSS 1999, there was no ranking change in 2003 for mathematics, with fourth-graders taking third place and eighth-graders taking fifth place. The top-ranking countries were all in East Asia, with Singapore in first place followed by Hong Kong, Taiwan, and Korea. Although Japanese students did not drop in the international ranking, there was a significant statistical drop in the actual mathematics scores of eighth-graders (average score was 570 in 2003 and 579 in 1999, according to the TIMSS 2003 report).

In science rankings, eighth-graders fell to sixth place from fourth place in 1999, and fourth-graders dropped from second to third. Although these placements were not statistically significant, fourth-grade scores had dropped a statistically significant ten points since 1999. These results from the TIMSS 2003 reveal that although Japanese elementary and middle school students remain at a high level in international rankings, mathematics and science scores are starting to decline compared to 1999.

1.3 Impact of PISA and TIMSS on Japanese Education

After the release of the OECD/PISA 2003 and TIMSS 2003 results one after another in December 2004, Japanese newspapers and other mass media responded with sensationalist headlines proclaiming Japan's fall from the top. As already mentioned in Section 1, two big Japanese newspapers, the Asahi (Asahi- Shinbun) and the Yomiuri (Yomiuri- Shinbun), reported the end of the dream in which the Japanese have indeed believed that their educational system has been one of the best in the world and that their students' academic abilities might bemaintaining the top ranking in the world. Especially Japan has been depending on technology for developing itsindustry, so the educational system has stressed onbuilding up talented people for science and technology. Based particularly on the drop in ranking in reading literacy and the slight trend towards decreasing mathematics literacy scores, many people expressed the opinion that a lack of the basics, the so-called 3Rs, was to blame. Some attribute the performance decline to the policy of a 5-day-week school system. Beginning in April 2002, Japan had switched to a 5-day-week school system, with classes no longer conducted on Saturdays. As a result, there was less class time available and curriculum material had to be limited. Following the OECD/PISA 2003 and TIMSS 2003 results, many people have argued that this decrease in school time has contributed to the decline in student performance. These people have at first insisted on the significance of 3Rs basic learning, and have negative attitudes to the revised course of study from 1998, which placed emphasis on the cultivation of zest for living and aimed towards the shift from the reduction and concentration of teaching and learning.

Mr. Nariaki Nakayama, the Minister of Education, has declared a need to change the education policy previously set by the Ministry of Education, and has aggressively pushed for more class time devoted to the basics. According to Nakayama we need to rethink the reducing of the number of school hours and the curriculum under the revised course of study from 1998 for getting rid of the lowering of achievement levels as of 18 January 2005 (from Asahi-Shinbun, 19 January 2005).

For a long period following the end of the Second World War, Japanese education policy has emphasized the acquisition of basic learning. Behind this policy was the ultimate objective to produce human resources that would be able to support the technology industries that were essential to Japan's post-war recovery and growth. With this goal, it was inevitable that the basic 3Rs would dominate education. Until 1980 Japanese education generally supported the systematic acquisition of basic knowledge and skills, such as reading, writing, and arithmetic (3Rs) skills, and in fact the basic 3Rs continued to dominate the development of policy and school curriculum until the end of the 1980s. Beginning in 1990, however, the Ministry of Education introduced the concept of fostering thinking ability and creativity of students, moving away from the past emphasis on compulsory learning activities that focused on memorization. In 1991, the Ministry started the new curriculum stressing on children's intrinsic motivation, thinking skills, and cultivation of their interests. This new policy was based on the idea that technological innovation would require innovative and creative people. The direction of educational policy shifted from a cram system to one that would foster students' ability to learn on their own. As for the future direction of education we have agreed with the new educational policy of the Ministry according to which the following qualities are required as future citizens: the ability to find their own assignments, to learn how to learn, to learn to think for themselves, to judge and act independently, and to solve specific problems properly. It was at this juncture that Japan implemented the 5-day-week school system used in many industrialized countries in the West.

Sensing the threat of decline in student achievement, however, there has been an increase in views once again advocating more classroom hours and a greater emphasis on the acquisition of basic knowledge and skills. At the end of the 1990s, there arose a strong vocal debate about the lowering of academic achievement from some segments of the society, and subsequent policies have tended to shift towards tightening academic standards. The policy promoted by the Ministry of Education had been a departure from cram-style schooling focusing on repetition and memorization. Today, Japanese education stands at a crossroads between encouraging self-motivated learning, problem-solving, and application skills, and emphasizing the acquisition of teaching-centred basic knowledge.

Within a year since the release of the OECD/PISA and TIMSS results, debates have raged over the problems of student achievement and educational reform. Are we sure that a decrease in the time spent studying, a decrease in classroom hours and material, is what is at the root of lower student achievement? This subject will be further discussed below.

2 Debate Over Setbacks in Student Achievement:To Go Back to Basics or To Nurture Problem-Solving Skills?

In the half-century following the end of the Second World War, there have been a number of debates surrounding declines in student achievement levels, and consequent controversies over educational reform and implementation. Under the direction of the USA at the end of the Second World War, Japan started a new education system based on a pragmatic model of educational reform most often associated with John Dewey. Rather than simple transmission of knowledge, the basic tenet of schooling was to teach students how to understand and form knowledge on their own, based on the experiences of everyday life. Implemented as the first post-war educational reform, this experiential education sought to encourage self-directed problem-solving skills. Both theoretical and empirical research claimed success particularly in the subject of social studies (a key promoter was Professor Kaoru Ueda). Beginning around 1950, however, others began to express the view that student achievement levels were falling and that the systemized knowledge needed to form the basis of experiential learning had not been sufficiently established. The central figure in this call for the systemization of learning material and transmission of knowledge was Professor Ryouzou Hirooka. Thus began the first debate over academic achievement and ability in post-war Japan. In the many debates and discussions since then, the controversy has continued to sway between two objectives: to aim for mastery of basic knowledge, and to encourage problem-solving skills that will allow students to apply their own knowledge in real life (Nakauchi, 1971).

The second major debate occurred towards the end of the 1960s and into 1970, with a push to promote results in science as an objective of education. This movement grew out of the development of advanced educational content and curriculum that aimed to foster concrete abilities in students. It was argued that student achievement should be defined with a scientific approach, and limited to subjects that were measurable based on curriculum and lesson content. At the same time, there were some who argued that academic achievement should not be defined only by the ability to repeat learned material, but should also include student motivation and attitude. The fundamental meaning of student achievement was fought over and ended without producing a unified opinion, and the topic has yet to be taken up since then in Japan. In the USA, Howard Gardner of ‘Project Zero’ at Harvard University has been at the centre of theoretical and empirical research on student academic ability and development. Compared to these comprehensive discussions on the nature of academic ability and approaches to education in the USA, there is a decided paucity of research in Japan. This lack of discussion is what has caused Japan to panic at the results of international student achievement assessments, and it is what has made the direction of educational reform so unstable.

A third round of controversy has emerged in recent years over the decline of student achievement. Although the debate was triggered by the release of the OECD/PISA 2003 and TIMSS 2003 results in December 2004, concerns had already been raised over a growing number of university students who lacked the basic knowledge and ability to complete a higher education (Nishimura, 1999, 2001). These trends were given even more attention after being backed up by data from the international achievement assessments.

Because of its dependence on industry, Japan has had to maintain an advanced level of technology to ensure its national stability. The long-running approach to education has therefore been centred on mathematics and science in the hope of producing top technical experts, and particularly to ensure uniform levels of knowledge and ability for all students. It was necessary to give priority to the educational objective of forming a uniform knowledge base, rather than developing the creative individual (Rohlen & LeTende, 1996). Over the past 20 years, on the other hand, the view has emerged that it is increasingly necessary in today's world to foster students who are capable of new ideas and creative work. In the span of two decades, the content of Japanese education has shifted from cram-style teaching to classes that develop a student's ability to learn and solve problems independently (Ministry of Education, 1996). Because of the decline in student achievement, however, the pendulum is once again starting to swing back in the direction of knowledge-cramming and rote learning.

A similar kind of fluctuation in educational objectives may also be found in other countries. In the wake of the 1997 financial crisis, many East Asian countries such as Korea, Taiwan, Singapore, and Hong Kong also experienced a similar kind of shift in their educational concerns as demonstrated in their educational reforms. Of course, it goes without saying that contemporary educational reform in these countries must be discussed and compared in further detail. A discourse on various educational topics and reform policies in East Asia can be found throughout the other chapters of this book.

3 Problems of Japanese Education as Revealed by the International Assessments

The results of the OECD/PISA 2003 and TIMSS 2003 indicate not only a downward trend in student ability levels in Japan, but also a number of problems with today's education. These issues, as related to the findings of the two international achievement assessments, will be discussed below.

3.1 Has the Performance of Teachers Declined?

Japanese education has been highly regarded for producing students with top-class academic levels, serving as evidence of a good school system. In particular, the excellence of Japanese teachers and teaching content has been given attention by US researchers studying the Japanese education system (Stevenson & Stigler, 1992; Lewis, 1995; Rohlen & LeTendre, 1996). US researchers have most recently analysed the various roles and functions of discussion and study groups formed by Japanese teachers, and concluded that this teacher-led training system was one of the factors sustaining the high level of education in Japan (Lewis, 2002; Fernandez, 2002).

More than 80% of primary to high school teachers are university graduates, with a large number of elementary and middle school teachers graduating from 4-year teacher-training colleges. Most teachers have high educational qualifications and specialized knowledge, as well as higher socio-economic status. Finding employment in Japan has been difficult over the past 10 years of economic recession, and teaching attracts many people because of the good salary and working conditions. However, the number of teachers who can be hired is limited due to the shrinking population of children in Japan. This has made the employment examination for teachers extremely competitive. Compared internationally, Japan has a very high level of teachers with specialized knowledge and uniform teaching qualifications (Sato & McLaughlin, 1992; Lewis, 2002). There are also numerous teacher-training programmes with increasing opportunities for on-the-job training. As stated in the detailed survey research of Japanese schools mentioned above, the high level of Japanese education has been sustained by such common arrangements as pairing veteran and less-experienced freshman teachers in the same school, or having teachers observe their co-workers' classes and critique each other's teaching methods in discussion groups (Lewis, 2002). These activities, which aim to improve the specialized skills and knowledge of teachers, will certainly continue to play a large role in supporting a high-achieving level of students. There have also been two studies on teachers in different countries: one compares teaching across seven TIMSS-participant countries, including Japan (Heibert et al., 2003), and the other compares differences in classes and teaching methods of teachers in Japan, the USA, and Germany (Stigler & Hiebert, 1999). These studies both remark on the benefit of instruction method study groups conducted especially among elementary school teachers in Japan. More of this kind of joint research and international comparative study should be encouraged in the future, as it is certainly useful when considering academic achievement and the results of international assessments, and perhaps holds the key to educational reform.

As factors related to academic achievement, OECD/PISA also surveys such aspects as teaching ability, student learning motivation, and learning environment. The 2003 assessment concentrated on these factors as they relate to mathematical literacy. Following Korea, the results for Japan showed that class environments were highly motivating, but that students did not believe that teachers were giving their full effort to the support of learning (National Institute for Educational Research, 2004, chapter 6, background of learning, p. 237). In fact, Japan was far below the OECD average in this regard. While these results rely on the emotional judgement of students, what is clear is that many Japanese high school students do not have a positive impression of their schools or teachers (e.g. teachers do not listen to student opinions, or teachers do not help when assistance is needed). Combined with the fact that positive evaluations by students in Japan fall short of the OECD average, it should be understood that high school teachers in Japan are not doing a good job of motivating their students. On a survey question asking whether or not teachers give students the chance to voice their own opinions, students answered that their teachers did not give enough opportunities. When school principals were asked if teachers were motivated to teach, it was clear that morale was not high among teachers in Japan. The countries with highest teacher morale were Finland and Ireland. In addition to student evaluations, it will be necessary to take a multi-dimensional approach to assessing the ability of teachers (from the result of the OECD/PISA 2003, National Institute for Educational Research, 2004, chapter 6, background of learning, p. 246).

3.2 Has Students' Motivation To Learn Declined?

One of the indicators of students' learning motivation is time devoted to studying outside of school. The PISA 2003 report found that extra-curricular study time for high school students in Japan was less than the OECD average of 8.9 hours at 6.5 hours, including cram and prep school time (from the result of the OECD/PISA 2003, National Institute for Educational Research, 2004, chapter 6, background of learning, p. 286). Korea, Ireland, and Italy were all over 10 hours. It should be noted that the assessment was taken at the end of the school year in other countries, whereas it was only three months into the school year in Japan, when freshman students had been relieved of studying for high school entrance exams. Nevertheless, the motivation of Japanese high students to study on their own can certainly not be considered very high.

Other findings pertaining to learning motivation have come from the TIMSS 2003. Like OECD/PISA, TIMSS also surveyed extra-curricular study time and motivation to study. Limited only to time devoted to homework while at home, Japanese eighth-graders ranked at the bottom of the 46 participating countries at 1 hour, much less than the international average of 1.7 hours. Likewise, fourth-graders spent less than 1 hour on homework, at 0.9 hours. This was 30 minutes less than the international average of 1.4 hours. In contrast, Japanese middle and elementary school students spent a greater amount of time watching television and videos. Eighth-graders had an average of 2.7 hours, 0.8 hours more than the international average of 1.9 hours; fourth-graders also clocked in at 2.7 hours, 1 hour longer than the international average 1.7 hours (from the result of the TIMSS 2003 from the web site of the Ministry of Education in Japan, on 19 January 2006). This use of time at home by elementary and middle school students can be said to reflect the lifestyles of adults in the household. Still, compared to other countries, students in Japan are not taking to their studies enthusiastically at home, and they do not appear to be highly motivated.

TIMSS also revealed data on students' motivation to study, although limited to the subjects of science and mathematics. In either subject, Japan was ranked in the bottom countries for the number of eighth-graders who said that learning was fun and that they were motivated to study more. As shown in Tables 1 and 2, the percentage of students who find studying enjoyable was less than the international

Table 1 Percentages of positive attitude to mathematical learning in Japanese students

	Fourth grade of elementary school (%)		Second grade of middle high school (%)	
	2003	1999	2003	1999
JAPAN	29	16	9	6
MEAN[a]	50	46	29	25

[a]Mean percentage of positive response across all countries.

Table 2 Percentages of positive attitude to science learning in Japanese students

	Fourth grade of elementary school (%)		Second grade of middle high school (%)	
	2003	1999	2003	1999
JAPAN	45	38	19	8
MEAN[a]	55	44	44	32

[a]Mean percentage of positive response across all countries.

average for both subjects. It should be noted that the difference was especially large for middle school students.

The OECD/PISA 2003 results revealed that Japanese high school students did not have a high motivation to study, and the results from TIMSS show that this loss of motivation in fact already begins in middle school. This trend towards declining motivation to study actually can be traced from quite early on through surveys conducted by the board of education in Fujisawa-shi, Kanagawa-ken (Education and Culture Centre of Fujisawa, 2000). Beginning in 1965, ninth-graders (third grade at middle high school in the Japanese school system) have been surveyed every 5 years on topics such as their motivation to study, their self-confidence for learning, and so on (Fig. 1). The motivation to study has gradually declined from 1970 (1970: 58.7%, 1975: 45.9%, 1980: 43.4%, 1985: 37.2%, 1990: 36.9%, 1995: 31.4%), reaching 23.8% in 2000. In the Japanese school system, the purpose of middle school studies is to prepare for high school entrance exams, and for many students, it is hardly grounded in an independent desire to learn. Over 97% of middle high school students have entered high school in Japan, and in the Japanese educational system students and pupils can select freely one school which they wish to go to from some schools in the district. To enter high school, there are severe entrance examination tests and the ranking and the ordering among the high schools in the district are based on the results of the entrance exam. Learning becomes centred on an almost robotic memorization in preparation for exams, and it is not based on any sort of intellectual interest. Most middle schools in Japan must focus on high school entrance exams out of necessity, and there is very little flexibility with time that

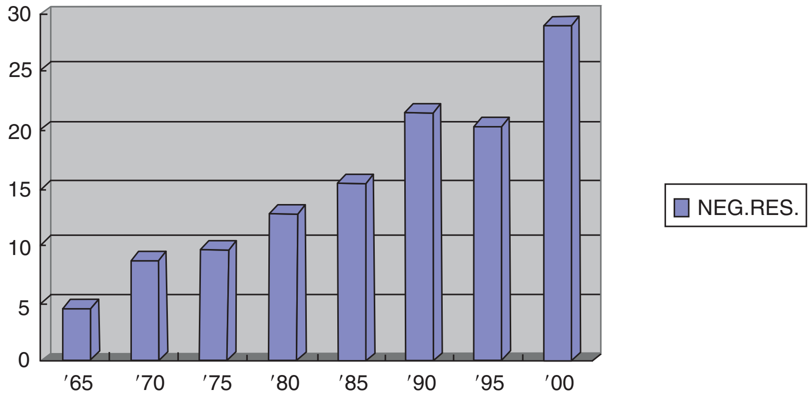

Fig. 1 Percentage of third-graders' negative response to school learning during the past 35 years (Fujisawa Educational and Cultural Center 1990–2004)

could be formally put towards drawing out the intellectual curiosity of students. Therefore, teachers' motivation to create these types of classes has also declined.

According to the TIMSS 2003 survey, students in many East Asian countries such as Korea, Taiwan, and Hong Kong also had low motivation to learn, even though they ranked highly in international achievement tests (Mullis et al., 2004). It seems that what Japan and these countries have in common is evidence that, under an exam-focused system, it is not highly difficult to produce students who are independently motivated to study or have positive attitudes towards learning. Surely, this is an important topic for educational reform.

4 Has a Decrease in Learning Material and Time Caused a Decline in Student Achievement?

2005 was a year in which educators hotly debated the cause of the decline in student achievement made so apparent in the results of the OECD/PISA 2003 and TIMSS 2003. Right away, the decrease in school learning time was cited as one reason. Japan adopted the 5-day-week school system in April 2002, naturally decreasing the number of classroom hours. The consequent decrease in the amount of material to be covered was blamed for causing a fall in student ability levels. Actually, the lack of basic knowledge among university students had been decried even before the release of the international assessment results in 2004. Concerns were expressed over the large number of students who had entered universities without having mastered the basic knowledge they should have learned in school and a crisis situation was declared in Japan's high school education. Kazuo Nishimura's book (1999) titled Bunsuu ga dekinai daigakusei (The College Student Who Can't Do Fractions) received widespread attention, and news media carried many opinions calling the class time-reducing educational reforms of the Ministry of Education a mistake. Most of these assertions from university professors were in the science and engineering fields which, comparatively speaking; require a built-up base of specialized knowledge. Their fear was that if basic knowledge was lacking among the department and graduate students associated with a research laboratory, the quality level of research in the laboratory as a whole was put in jeopardy. Finally, the insecurity of the Japanese public was fanned by warnings from Kazuo Nishimura and others (Wada, 2003) that if the level of scientific technology declined in Japan, it could affect national interests and power.

However, it should be remembered that the university students that Nishimura and others speak of all attended junior and senior high school before the time when Saturdays were a holiday and before learning material was decreased. Therefore, the decline in student achievement cannot be directly linked to a decrease in class content. Likewise, the students taking the OECD/PISA 2003 and TIMSS 2003 had completed their curriculum before content was reduced. In this case as well, a direct link cannot be established to the decline in student achievement.

The fact that the length of classroom instruction time is not directly related to achievement can be easily determined from a comparison between Finland and Japan. At every grade level, top-ranking Finland (OECD/PISA 2003) had less instruction hours than Japan. As shown in the comparison between Japan and Finland in Table 3, instruction hours per year for upper elementary grades and middle school in Finland were 88% and 93% shorter than those in Japan respectively. In the lower elementary grades, Japan had 709 instruction hours per year compared to only 530 hours in Finland, a difference of 25%.

In this way, it would be incorrect to assume that the decline in student achievement is linked to decreasing instruction hours, the addition of the Saturday holiday in 2002, or the consequent decrease in curriculum material to be covered. Rather, I would argue that the problem with schools in Japan is that the fierce competition of high school entrance exams has forced memorization-focused, cram-style learning on students, and they are given little opportunity to experience the joy of learning or solve problems with their own inquisitive spirit. Furthermore, as the next section will discuss, Japanese high schools are strictly ranked according to student performance on their entrance exams. This has caused major disparities in academic levels between schools, as well as in the proportion of students who go on to higher education. This school ranking at the high school level has come to govern both junior and senior high school students' will and motivation to study.

Table 3 Total time of school learning in Japan and Finland (*Asahi-Shinbun* 20 February 2005)

AGE	JAPAN (h)	FINLAND (h)
7–8	706	530
9–11	761	673
12–14	875	815

4.1 High School Student Achievement and the Disparity Between Schools

The results of the OECD/PISA 2003 hint at the problems that schools in Japan are currently facing. The score distribution by school for high school mathematics literacy was significantly more that the OECD average (Table 4), and the score difference by school was also greatest out of all participating countries. The smallest differences between schools were found in Finland; large differences similar to Japan also occurred in Germany and Hong Kong.

Although Japan has a reputation for ensuring a comparatively uniform level of student ability in academic achievement, in the case of high school students, the differences between schools have grown increasingly large compared to other countries. This difference between schools can also be linked to socio-economic disparities between households (Table 5). In a regression analysis, only 11.6% of the score distribution for mathematics literacy can be linked to socio-economic status; neither household economic status nor the education level of parents provides much of an explanation. However, in the analysis of score distributions between schools, socio-economic variable is linked by 67.4%. This means that the disparities between schools in achievement levels are strongly tied to socio-economic disparity. This is obviously the result of filtering

Table 4 Score of mathematical literacy and distribution score among schools in some countries

Country	Score of mathematics literacy	Distribution score among schools
Japan	534.1	62.1
Australia	524.3	22.0
Finland	544.3	3.9
Germany	503.0	56.4
Korea	542.2	42.0
Hong Kong	550.4	52.8
OECD	500.0	33.6

Table 5 Predictability rate of distribution of mathematical literacy score with students' socio-economical background by multivariate regression analysis

Country	Distribution score among schools (%)	Distribution score within schools (%)
Japan	67.4 (1.4)	0.2 (0.2)
Australia	69.7 (2.6)	5.2 (0.6)
Finland	21.8 (11.6)	10.2 (1.2)
Germany	77.5 (2.6)	4.2 (1.2)
Korea	65.9 (2.5)	1.8 (0.6)
Hong Kong	42.6 (2.6)	0.2 (0.3)
OECD	–	–

Value within parentheses indicates standard error of obtained score.

through high school entrance examinations. It has led to variation in mathematics literacy scores depending on the high school, large differences between scores of high and lower-level high schools, and top-ranking high schools made up of students from households with high socio-economic status. These households are able to invest more resources into ensuring better high school options for their children.

High school entrance examinations have given birth to disparities between high schools and greatly influenced learning in middle schools as well. Middle school education has become nothing more than preparation for high school, with the entrance examination always at the forefront of students' minds. These conditions have continued unchanged in Japan for several decades. Learning in middle school should be something more worthwhile to students.

5 Where To Go from Here: The Direction of Educational Reform

Japanese students, particularly in middle and high school, have lost the motivation to learn. Figure 1 shows how the number of students who do not like to study has grown over the past 10 years. To combat the decline in student achievement levels, should we go back to the basics with cram-style learning and study drills that rely on memorization and robot-like repetition? Or should more importance be given to learning that develops an ability to think and apply knowledge independently?

5.1 Student Achievement in Japan: What To Problematize?

A new 5-day-week school system was adopted in Japan starting in April of 2002. At the same time that instruction hours and content were reduced, a synthetic learning approach was also instituted to promote comprehensive knowledge rather than subject-based knowledge, as well as independent learning activities, comprehension, and problem-solving skills. Although this educational reform was implemented in 2002, in 2000 there were already worries that it might cause a drop in student achievement levels. In 2005, the debate has intensified. At a point when the reforms have hardly begun, there is opposition to this new course of study, and fear that student performance will drop even further.

Wary of complaints that first-year university students in science and engineering departments lack basic abilities, the Ministry of Education has aggressively sought ways to encourage interest in science and mathematics in high schools ('Super Science High School', on the http of the Ministry of Education in Japan). However, as apparent from titles such as 'super science class', these innovations have most often targeted advanced students, with the aim of cultivating an elite. Supporting this approach are the university professors who complain of low student ability levels: they are mostly associated with Japan's elite universities, and they want to recruit top high school students for their departments. Having university instructors teach high school classes or conducting super science classes may succeed in producing an elite group of students, but it seems ineffective in recovering motivation to study mathematics and science for the majority of students.

There is no questioning the value of high academic achievement levels. However, there has been no discussion recently on exactly what level of ability should be required. There has been only an excessive reaction to a slight drop in the world ranking of Japanese high school students. Neither the level of achievement that should be required nor the content of that achievement have been questioned.

Even more than the decline in student achievement, I would argue that it is the loss of motivation to learn among middle and high school students that should be problematized. The reality is that there are more and more students who have lost interest in studying or given up in middle school (Fig. 1, Education and Culture Centre of Fujisawa, 2000). The middle school student population in Japan is small, and since high schools and universities matriculate a constant number of new students, every child can potentially be admitted somewhere. However, in addition to existing differences in the quality of these high schools and universities, competitive entrance examinations have created even more disparities. Middle school students are expected to study with the clear understanding that there are certain high schools they will be able to enter, and others that they will not. While a student with good marks will be motivated by the prospect of entering a good high school, students with lower chances have less motivation to study. In this way, students are divided into two poles because of high school entrance examinations: those who are motivated to learn, and those who are not. Furthermore, even if a student has the good fortune of entering a choice high school or university, children are keenly aware even at the middle school level that Japanese society no longer guarantees success for people simply because they have high academic abilities or have graduated from a top university. In other words, for many students, university status is no longer a motivator for studying.

> Is it possible to recover these students who have lost their understanding of the purpose of learning? How can it be done? Unless this problem is solved, there is not much of a future for Japanese education.

5.2 Nurturing Competencies for Positive Living

The Ministry of Education in Japan has shifted the general direction of education from learning centred on repetition and memorization of basic knowledge to learning based on the development of thinking and problem-solving abilities. The Ministry has summarized this new concept as ‘competencies for positive living’, and introduced it in the new curriculum guidelines in 2002 (execution of new curriculum ‘Zest for living’ *Ikiru chikara*: the ability to identify problems for oneself, think for oneself, make independent judgments and action and solve problems well). After the release of the OECD/PISA 2003 and TIMSS 2003 results though, critics advocating a focus on basic knowledge have questioned having 'competencies for positive living' as the fundamental objective of education.

However, what OECD/PISA measures is not basic knowledge and rote learning achievement, but in fact, 'competencies for positive living' such as thinking and problem-solving abilities. Reading literacy, in which Japanese high school students scored particularly poorly, is one of these competencies. Finland, which has continuously ranked in first place in reading literacy, also ranks number one in the world for reading volume per person. Have middle and high school students in Japan had reading experiences at all like students in Finland, or have they not had the leeway because of having to study for exams? In my own experience staying in Finland for 3 months several years ago and comparing students there to students in Japan, I deeply questioned whether we gave much importance to students' motivation to learn.

One of the effective ways to bring students back to the world of learning, and to have them experience the joy of learning, is to change the structure of participation (Palincsar & Brown, 1984; Herrnkohl & Guerra, 1998). That is, classroom learning activities must put students at the centre, rather than a teacher who simply transmits the necessary knowledge. A comprehensive learning approach places importance on this type of learning activity, but classes should also include cooperative learning activities between students in other subjects as well. A practical trial of this approach to learning was started several years ago at Sapporo Junior High School, associated with the Hokkaido University of Education. At this school, classes centre on students' cooperative problem-solving activities, presentation of the results to classmates, and class discussions. The basis of Vygotsky's development and learning theory (Vygotsky, 1978) is the idea that learning is born out of students' common thirst for knowledge developed within a community of learners through discussion, negotiation, and sharing of differing opinions; the classroom is where this kind of collaborative learning can take place (Wells, 1999). In addition, posing questions that stimulate intellectual curiosity and learning about various scholarly subjects is also encouraged at Sapporo Junior High School. The inclusion of these culturally essential scholarly topics in student learning activities is very important as well, it is not as if subjects are selected indiscriminately. This is because our activities focus on the goal of learning as constantly creating new culture; the experience of discovering knowledge, no matter how small, through one's own creative activity, is at the centre of classroom learning, even at the elementary and junior high school level. Through this project, students have gradually learned how to discuss each other's work and share each other's knowledge effectively, and finally be authentic self-managing learners with effective collaborative learning skills. Teachers have also experienced more deeply that students have become more competent in the collaborative learning activity and learning situations than in the isolated learning situation, through this project.

The content and direction that educational reform must take is clear. Blind memorization and repetition drills of subject material will not be able to recover the motivation to study for students in Japan.

6 Implications for Reforming LearningWithin the Asia-Pacific Region

With the revision of curriculum guidelines in 1998, the Ministry of Education launched educational reforms that were to shift emphasis from learning basic knowledge to fostering better problem-solving, thinking, and independent learning skills. Behind these reforms were changes in the view of learning and the fundamental direction of education policy that had long been held by the Ministry. Since the end of the Second World War, Japanese schools taught basic knowledge which students passively absorbed through rote learning. The acquisition of this basic academic ability by all Japanese citizens served well to raise the level of technology and industrialize Japan in the aftermath of the war, and it is true that Japan became an economic superpower. However, there have been no significant changes to an education system in which learning means studying for high school and university entrance exams. More and more students are losing the desire to learn out of their own intellectual curiosity. While Korea, Taiwan, and other East Asian countries also share this same competitive system of exams and state that it is essential to maintain high national education standards, the motivation to learn is not always high among students. The common task for East Asia is to reform entrance exam-based educational systems.

The aim of curriculum revision in 1998 was to establish the goal of education as the nurturing of creative thinking and curiosity in the children of Japan. Learning in school meant not only memorizing what the teacher taught, but also acquiring the ability to apply this knowledge to daily life and formulate and express one's opinions. This new approach reflects the crucial need to produce creative individuals who can play a role in the growth of Japanese society and development of new scientific technologies. What students need now is not a large quantity of knowledge, but a high quality of education that fosters a creativity for new ideas and a lifelong curiosity for learning. Among the high scorers on the OECD/PISA, neither Finland, nor Canada, nor Australia has a large number of classroom hours. Student performance is attributed to the experience of independent learning activities, not from more time spent in class. As Japan promotes more interdisciplinary learning in the face of strong criticism that it will not lead to high achievement, Finland, Canada, and Australia serve as models for educational reform.

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'Learning for Achievement' as a Collective Goal in Re-culturing Teaching and Learning in Hong Kong Classrooms

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Abstract This chapter discusses the attempt to re-culture learning and teaching in Hong Kong classrooms as part of the initiatives proposed in the comprehensive educational reform the Hong Kong government proposed in 2000. The main challenge in the development of a new culture of teaching and learning lies with articulating a new conception of achievement. The current reform has ignored the sociocultural basis of achievement and narrowly defined it in terms of competitive performance. Based on a sociocultural perspective, this chapter argues that 'learning for achievement' is a legitimate shared motive for schooling within Hong Kong's specific sociopolitical context, and therefore should be acknowledged in a positive way in the educational reform. 'Learning for relative achievement' as one of the possible diverse representations of this collective motive could also be accommodated as a worthwhile strategy to engage all students in learning.

1 Introduction

Teaching and learning are purposeful and contested endeavours. Individuals form their own diverse goals for learning or teaching in the context of collective motives and practices that are forged across time in particular societies. In this chapter, 'learning for achievement' is proposed as a collective motive that stakeholders in the Hong Kong education system might adopt as a means for facing new challenges emerging from economic and social forces of globalization. Taking 'learning for achievement' as a collective goal does not preclude that individual students and teachers negotiate their own goals of schooling and play an active part in constructing their own understanding of learning and teaching within the Hong Kong education system. This chapter, however, focuses on the connection between individual and social planes, and the complex interaction between them in the development of a shared motive for learning in Hong Kong.

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The chapter starts with a description of the current comprehensive education reform in Hong Kong and various conditions that led to its formulation and development. This section ends with a discussion of the crucial issue of whether the reform of Hong Kong classrooms will remove competition as a dominant motive for learning. Based on a sociocultural perspective, the second section explains why ‘learning for achievement’ is a legitimate shared motive for schooling in Hong Kong. ‘Learning for achievement’ is more than outperforming others (ego-enhancement goal). Within the Chinese culture, this collective motive for learning involves other culturally important goals such as valuing academic performance as fulfilling parental expectations (social goal), achieving personal standards (self-actualization goal), and pursuing career development and employment opportunities (utilitarian goal). ‘Learning for achievement’ can be taken as an amalgam of these complex goals for learning. This section argues that there is a need to distinguish between ‘learning for achievement’ and ‘learning for relative achievement’. The current educational reform, however, did not clarify the difference between these two achievement orientations and so proposed to reform the classroom culture by imposing a mastery-focused pedagogy that promotes learning for learning’s sake using a student-centred approach (Education Commission, 2000, pp. 40, 60–64). While it is educationally sound to remove debilitating competition as a motive system from classrooms, denying ‘learning for achievement’ as a legitimate shared motive for education in Hong Kong is unrealistic given the sociocultural context and the investments made by parents and other stakeholders in educational success.

‘Learning for achievement’ should be accorded its rightful place within an achievement-oriented education system such as that found in Hong Kong, as well as in other places like South Korea, Singapore and Taiwan within the Asia-Pacific region. It can be taken as ‘system dualities’ when considered simultaneously with goals such as ‘learning for mastery’ that drives the system to change. As Wenger argued (1998), dualities should not be treated as polar opposites. Rather, to reform successfully, one needs to leverage on the dynamic of system dualities. This chapter suggests that merging both orientations, ‘learning for achievement’ and ‘learning for mastery’ can be a viable way for re-culturing learning and teaching in Hong Kong.

2 Context

Hong Kong has been successfully developed into an international centre for business, finance and communication despite its limited natural resources. Hong Kong enjoyed a sustained period of economic growth and prosperity during the 1980s and 1990s. In explaining this economic miracle, the British-built elite education system has been widely considered as a significant contributing factor. Nevertheless, in the wake of the economic crisis in late 1990s, Hong Kong was plagued with socio-economic problems such as high unemployment, a surge of suicidal incidents, a huge budgetary deficit and difficult economic transformation. The economic down-turn not only weakened the established economic strength of Hong Kong, it also undermined the belief that the existing education system would be effective in producing a labour force ready for the economic challenges brought about by globalization. Educational policy-makers in Hong Kong began to ponder whether the existing educational system would be effective in meeting the new challenges unfolding for the future generations of Hong Kong. The change of sovereignty in 1997 also added new considerations in the educational agenda of this Asian international city. Issues such as citizenship education, Chinese cultural identities and medium of instruction have attracted renewed interest among educators after the political handover. The overhaul of the educational system in 1999 was a way to respond to the economic difficulties and to prepare Hong Kong for future challenges posed by economic and political changes. In particular, the reform proposal (Education Commission, 2000) highlighted the problems associated with learning in an exam-oriented system.

> All in all, despite the huge resources put into education and the heavy workload endured by teachers, learning effectiveness of students remains not very promising; learning is still examination-driven and scant attention is paid to "learning to learn". School life is usually monotonous, students are not given comprehensive learning experiences with little room to think, explore, and create (Education Commission, 2000, p. 4).

2.1 Developing New Culture of Teaching and Learning

In 1999, the Hong Kong government launched a comprehensive review of the whole education system in Hong Kong. A detailed reform proposal (Education Commission, 2000) was put forward subsequently detailing different measures to reform the academic structure, curricula and assessment mechanisms in different educational stages. The principles behind the reform include: student focused, 'no loser', quality, life-wide learning, and society-wide mobilization. The corresponding reform in curriculum expectedly also set its reform principles on learning, helping students learn how to learn, recognizing that all students have the ability to learn, advocating a learner-focused approach, constructing development strategies on the strength of students, teachers, schools and wider communities (Curriculum Development Council, 2001).

During the public consultation processes, the detrimental effect on student learning of competition in tests and examinations has been commonly acknowledged. Teachers, students and parents have been over-concerned about the grades and achievement levels. In general, an agreed discourse on the adverse effects of competition on learning emerged from the consultation processes; teaching and learning practices such as teacher-centred pedagogy, examination-driven curriculum, homework overload, rote learning, superficial understanding and overlapping curriculum were recognized as problems that needed to be addressed in the education reform. To learn for the sake of getting good grades in examinations, sometimes summarized as 'learning for achievement' has been criticized heavily as a major cause for robbing students of their motivation to develop creativity, problem-solving and other important skills and attributes. One of the main concerns is to reform classroom learning and teaching with an aim to move away for an examination-oriented pedagogy towards a pedagogy promoting learning and engagement. A paradigm shift was called for in order to develop a new culture of teaching and learning to help students learn how to learn and develop a solid foundation for lifelong learning. The paradigm shift (Education Commission, 2000, pp. 61–62) includes:

1. From knowledge transmission to learning how to learn
2. From overemphasizing academic development to focusing on whole-person development
3. From compartmentalized subject-based curriculum to integrated learning
4. From textbook-based learning to diversified learning and teaching materials
5. From classroom-based learning to community support and learning beyond the confines of classroom
6. From traditional timetabling to an integrated and flexible use of learning time
7. Abolishing premature streaming and providing more opportunities for students to explore their aptitudes and potentials

In effect, this paradigm shift called for a renewed understanding of knowledge, learning and achievement. Prior to the current education reform, knowledge was confined to the classroom, teachers were considered the main source of knowledge and had authority over what counts or does not count as knowledge. Textbooks were used as if the curriculum unfolded in front of both students and teachers. Promoting academic development was considered the most predominant goal for schooling.

In the language of current education reform, learning is not confined to classroom, textbooks and curriculum. Teachers are no longer considered as the only knowledge authority in classroom but more as facilitators of knowledge construction. Knowledge is no longer compartmentalized; but should be integrated across curriculum.

Different strategies have been used to assist this paradigm shift in teaching and learning (life-wide learning, curriculum reform, curriculum restructuring and school system restructuring; assessment for learning) in order to create more room for students to construct and create their knowledge together with their teachers. A TV advertisement was also broadcast in order to convey the message that learning is not for the sake of getting high marks. Overall, the main goal of these reformative efforts has been to shift the focus of learning from achievement to mastery in order to prepare Hong Kong children for a knowledge-based economy, and equip them with the abilities required for lifelong learning.

3 The Problem

The main problem in the development of a new culture of teaching and learning lies with the conception of achievement. The current educational reform focuses mainly on one of the many facets of achievement – relative performance – and has overlooked that academic achievement in the Chinese culture has been tied up with important concerns like knowledge development, career development, personal striving, which are in turn linked with significant cultural values such as filial piety and altruism. In other words, the current reform has ignored the sociocultural basis of achievement and narrowly defined it in terms of competitive performance. Undoubtedly, entrenched practices such as excessive drilling, testing, streaming and examinations stifle the development of learning and creativity in many children, especially for those who do not immediately achieve well at school. The introduction of some structural changes, such as the removal of a major public examination and the reduction of school banding (i.e. classification of schools according to students' collective achievement levels in a school) has removed some of the undesirable effects of competition and examination pressure. However, these measures do not guarantee the development of a culture or learning environment 'that will induce students to be curious, to question and to explore', and 'exhibit their abilities in independent thinking and creativity' (Education Commission, 2000, p. 34).

I am not arguing against the detrimental nature of competition or learning for the sake of simply outperforming others. A plethora of research has demonstrated that competition induces negative emotions, ego-defensive responses and behaviours in learning (e.g. Lam et al., 2004). The education reform proposal (Education Commission, 2000) has rightly pointed out the problems associated with teaching and learning in a highly competitive learning environment. I agree with the proposal that these problems need to be addressed in the reform. My concern, however, is the extent to which one can completely uproot an educational orientation that has grown out of a long history of emphasis on achievement (and competition), and the extent to which one can radically change the overall goal of an educational system that has functioned as a selection device for centuries.

'Learning for achievement' as a collective motive for schooling has been nurtured and grown out of an elite education system established by the British colonial government, which strikes an accord with the Chinese cultural heritage that values achievement. In other words, 'learning for achievement' and the various educational practices it bred are established common threads entangled in Hong Kong's political, cultural and historic milieu for an extended period. It is critical for us to understand that the concern about relative level of achievement is only one of the many ways by which this collective motive can be represented. 'Learning for achievement' is not confined to the striving for relative rank or outperforming others.

Simply identifying over-concern for grades as a form of tension in the implementation of the reform does not provide the necessary momentum for the change (Curriculum Development Council, 2001, p. 5). Neither would it be effective to forge an argument that the problem resides with individual students or teachers who are anxious about their relative achievement levels and grades. The removal of teaching and learning strategies such as cramming for examinations and rote learning may be easy. Nevertheless, the complete uprooting of such a deep-seated educational orientation has been proven problematic in the past few years since the implementation of various facets of the current educational reforms. In January 2006, more than 10,000 teachers in Hong Kong joined a rally protesting against the policies and other problems associated with the implementation of the current education reform. 'Clearly, teachers are protesting against EMB's governmentality (Education and Manpower Bureau) – the way EMB is trying to take control of everything and disregard frontline teachers' plights' (Hong Kong Professional Teachers' Union, 2006). To inject new practices or modify existing practice of teaching and learning without addressing how they should be linked with ingrained beliefs and established practices, such as those associated with the shared motive on achievement, will definitely invite confusion, misunderstanding and rejection. Treating 'problematic teaching and learning strategies' as something separate and removed from their developmental context has been a major irritation in provoking reactionary responses from frontline educators and parents.

The education reform proposal (Education Commission, 2000) did not clarify the conceptual difference between 'competition', 'relative performance' and 'achievement'. In this way, it has failed to establish 'learning for achievement' as a legitimate collective motive for schooling that most stakeholders in Hong Kong education could embrace. Consequently, the development of the new culture of teaching and learning suggested in the educational reform will be problematic, and has been proven difficult in the past few years. Many teachers, students, and parents are still thinking in 'the old way' They are not convinced that the new forms of learning, such as life-wide learning, project learning, and the new curriculum structure, will lead to high achievement. In contrast, educational reformers focus on how to promote learning in general and what can be done to reform practices that have proven to be detrimental to learning. But the embedding of 'the old ways' in historical and cultural systems has seldom been analysed or fully understood. The notion of 'learning for achievement' within the local context of the Hong Kong education system needs to be explicated in such a way that stakeholders and reformers can move forward together in implementing worthwhile reforms (Education Commission, 2000, p. 40). In the next section, the notion of 'learning for achievement' is discussed from a sociocultural perspective. My argument is that 'learning for achievement' is a legitimate shared motive for schooling within Hong Kong's specific sociopolitical context, and therefore should be acknowledged in a positive way in the educational reform. 'Learning for relative achievement' as one of diverse representations of this collective motive should be accommodated effectively.

4 'Learning for Achievement' as Collective Motive

From a sociocultural perspective, learning and development are culturally embedded and constituted by a matrix of social relationships, interactions and contextual processes (Renshaw, 2002). Learning is not just the acquisition of valued knowledge or skills but should be considered as appropriating cultural tools, which will transform the tasks, the requirements to complete them (Crook, 1991), and hence the relationship between individuals and the task as well as the relationship among the members within a learning community. In other words, the appropriation of significant cultural tools mediates one's cognition. Learning can therefore be seen in terms of the changing patterns of engagement in collective activities and social practices (Renshaw, 1998).

Through participating in cultural activities, students gain implicit knowledge, values and norms that enable them to think, perceive and respond in a culturally acceptable manner, and more importantly, to participate in their own cultural group as a legitimate member (Bruner, 1990; Lave & Wenger, 1991). In this sense, 'learning for achievement' as well as other learning-related motives and processes are cultural tools appropriated through participation in the Hong Kong Chinese culture. According to a sociocultural framework, these cultural tools are mediated and appropriated through the help of the more able peer or senior members within the group and that the mediation of these cultural tools affects how and why a specific activity is enacted. In other words, 'learning for achievement' cannot be just a matter of individual construction. It is part of daily interaction among students, teachers and parents, as well as having its root in the culture and history of the Hong Kong education system. It is through a process of interaction with others in various social situations within the Hong Kong education system that 'learning for achievement' has been internalized as a legitimate shared motive for schooling. In Vygotsky's terms 'learning for achievement' as a goal for schooling appeared on the social or interpsychological plane before it could be internalized as part of the individual or intrapsychological plane (Vygotsky, 1978). In this sense, culture is not just present in the external environment as artefacts, language and festivals, but also present within individuals as knowledge, values, beliefs and goals for schooling in subtle ways.

To analyse 'learning for achievement' as a collective motive, it is instrumental to adopt Rogoff's three planes of analysis (1995). Rogoff (1995) proposed that cultural activities can be discerned at three planes of analysis, namely, at the personal, the interpersonal/social and the community/institutional planes. The personal plane refers to cognition, and emotional behaviour of the individual; the social plane involves communication, dialogue, cooperation, assistance and guidance from others; and the community plane is comprised of shared history, norms, rules and beliefs. The most important consideration for these planes is that while each of them can be analysed separately, they are intertwined with each other in a dynamic manner and therefore should be understood as a whole. The following analyses use this framework. 'Learning for achievement' is first analysed as a shared goal within the institutional and cultural background of Hong Kong. Then an analysis of 'learning for achievement' is conducted at the personal level.

In short, 'learning for achievement' is conceptualized as a collective motive embedded in a complex network of practices, knowledge and values systems in Hong Kong. It is embedded in everyday social interaction taking place in different learning settings in and out of school. It also guides and structures cultural practices and actions related to schooling. From a sociocultural perspective, 'learning for achievement' is not just an individual goal, but an established collective goal embedded in cultural activities and practices in different social settings at homes, schools, classes and examination halls. Through daily interaction and exchange between individuals in these diverse social settings, this legitimate collective motive for schooling prevails. Nevertheless, the limit of this chapter impedes a detailed analysis how 'learning for achievement' as a goal is represented, reinforced and perpetuated in different forms of interaction and practice in diverse social settings in Hong Kong. In the following section, I give a broad-brush description of how 'learning for achievement' has established as legitimate collective goal for learning.

4.1 Colonial Regime and Achievement-Oriented Education

The Hong Kong education system had been developed as part of a colonial regime for consolidating and extending the interests of the ruling British elite (Morris & Scott, 2003). As in Britain, children were assigned to 6 years in primary school, 3 years in junior secondary schools, 2 years in senior secondary schools, 2 years in matriculation level and finally 3 years in university studies.[1] The major academic subjects taught in Hong Kong schools resemble the British 'O' and 'A' level syllabuses. The emphasis was on academic development. To qualify for a place in tertiary educational institutions, secondary students had to pass two major public examinations, the Hong Kong Certificate of Education Examination (HKCEE) and Hong Kong Advanced Level Examination (HKAL), which resembles the GCE 'O' and 'A' levels examinations.

The most important feature about these public examinations is that they were designed for selection using norm-referenced criteria. As a result, a limited number of candidates could be rewarded in these competitive tasks. Less than 10% of secondary students had a chance to move into tertiary studies before 1980s. With the expansion of the tertiary sector in 1990s because of the 'brain drain' problem, only around 18% of secondary graduates were able to secure a place in various tertiary institutions. Competing for limited education opportunities as a result has always been keen in Hong Kong.

High grades in tests and examinations have been established as the sole channel for academic promotion and opportunities. Consequently, the examination system defines what is worth learning (Biggs, 1998; Shepherd, 2000). In particular, the examination-driven curriculum and teaching in Hong Kong directs nearly every

[1] In the current education reform, the academic structure of the senior secondary system has been changed. The 2 years of senior secondary schools and the 2 years of matriculation level were merged to a 3-year system. University undergraduate degrees will require 4 years of studies.

aspect of learning – textbooks, learning activities and materials, and most importantly, the goals for learning in and out of school. Assessment is used to provide information regarding a student's relative performance within a class. The effectiveness of schools is judged on the number of students who score straight 'A's in major public examination. From the perspective of teachers, their effectiveness is judged on how many students achieve well in these examinations, so effective teachers spend the majority of their time training students how to handle examination questions successfully.

The eliteness of the educational system remained intact even after 1978 when the government provided compulsory education for children until the age of 15. The current education reform continued the attempt to increase participation by reforming the academic structure in senior secondary school and combining the HKCEE and HKAL into one public examination. While these reform measures should reduce the examination pressure, students are still required to compete for limited places in the higher education institutions. Expectedly, teachers will continue to focus on boosting performance for high-achieving students and avoiding failures for low-achieving ones. Accepted teaching practices such as heavy homework load, high frequency of assessment, and examination-driven pedagogy will remain unchanged in schools in Hong Kong. Students are trained, therefore, to use different adaptive strategies that help them survive keen competition and high pressure for achievement. These strategies include cueing for hints on examination questions, high level of effort expenditure and delayed gratification. The current educational reform can help remove some of the practices and instigate a rethink on some of the undesirable effects associated with them, such as a lack of creativity and critical thinking. However, in light of a lack of overhaul on the selective function of education or formulating new policies that focus more on the developmental functions of schooling, the chance for real change in teaching and learning culture will be difficult.

Ironically, the notions of competitiveness and striving for high performance have been reinforced and introduced back into the education system through new reform initiatives that build upon the principles of marketization of education – free choice, standards and quality. These neo-liberal initiatives have been implemented under various guises and to varying degrees through policies such as school-based management, school assessment, new standardized testing and reporting mechanism. Related to this set of reform initiatives is the movement towards educational diversification as revealed in the mushrooming of independent and private schools. Many established elite schools have taken the opportunity to turn themselves into independent schools in order to maintain their competitiveness, educational quality, and most important of all, the freedom in recruiting high-achieving students. In other words, education reforms in Hong Kong are still struggling with some of the fundamental notions and principles in education. It is highly unlikely that the current reform initiatives can produce the desirable culture of learning and teaching that is supposed to focus overtly on the promotion of mastery or learning how to learn. In addition, the problem of institutionalized competition among schools seems to have been aggravated unintentionally in the current reform process.

The following excerpt was taken from an interview study that examined teachers' professional development in light of the current education reform. The interviewee was discussing his own frustration with the type of teacher professional development he experienced in the past few years during the implementation of the education reform in Hong Kong. Maintaining competitiveness had a strong impact on school management and teachers' everyday work.

> We are exhausted! With this educational reform, our workload seems to have no ends. Most of my colleagues now work more than 10 hours a day. It is common for some to stay up late in order to catch up with their own planning, teaching, and completing all sorts of administrative reports. We are also competing with other schools for achieving students. If school A has a new program and school B put up a new forms of assessment, what we need to do is to tell our parents and students that we are going to have all of them and deliver them in an even better manner. We'll then end up with three new projects in order to keep up with others in the race. We need to craft an image of effective school in order to maintain the enrolment numbers and parents expect us to deliver a program that maintains their kids in high achievement. If we don't do what others are doing, parents will vote with their feet – walk away from your school. This is pretty much the life of every teacher in Hong Kong now. We are trapped! I think it's not fair to ask us to talk about development. We are concerning about survival. (Interviewed, May 2004)

4.2 Cultural Heritage and Academic Achievement

Renshaw (2002) argued that teaching and learning processes cannot be analysed in isolation from the values that are privileged in a culture at any particular historical moment. Salili (1997) also agreed that 'cultural values mediate achievement cognitions and behaviors and that achievement will mean different things and be manifested in different ways in people of different cultures or circumstances (p. 73). 'Learning for achievement' as a collective motive has been closely related to important Chinese cultural values such as perceived importance of education, filial piety, altruism and individuality.

'Learning for achievement' has been highly valued among Chinese since the Han dynasty when public examination was first used for recruiting government officials; success in this public examination led to wealth and status (Lee, 1996). Education is considered to be extremely important for the Chinese. Chinese parents hold high expectations and standards for academic achievement for their children (Salili, 1997). They generally believe that educational achievement is the means for better career prospects and financial rewards (Sue & Okazaki, 1990). As a result, it is common for Chinese parents in Hong Kong and other major Chinese societies to spend two or three hours supervising their children's home work on a daily basis. Seeking extra tutorial help in order that their children remain competitive in the class is also a common practice, despite the fact that private tutorial schools offer no more than supervising the completion of homework. In this sense, it is not surprising that teachers are to a certain extent 'forced' to give homework to their students in order to evade complaints from parents. Parents discourage learning or activities that are not covered in the examination syllabuses or school curriculum, labelling them as useless or a waste of time. In Hong Kong, and other major Chinese societies, academic achievement is still considered the sole pathway for success, which means good jobs, good salaries and better career prospects. Unsurprisingly, the media in Hong Kong assigns good coverage on the results of annual primary school allocation, which is considered as the first step towards academic success if one is accepted into a prestigious school. Children are therefore taught to value education for some utilitarian considerations.

'Learning for achievement' is also a social endeavour. It is tied up with some major ingrained values in the Chinese heritage, which include filial piety, respect for parents and conformity to authority. Shek and Chan (1999) found that Chinese parents considered an ideal Chinese child should first show filial piety to their parents and have good academic achievement. Seeking academic achievement can then be understood as one of the most important culturally appropriate ways for showing filial piety, honouring the parents and bringing glory to one's family (Salili, 1997). Academic success is one of the most important ways for Chinese children to bring 'face' – having socially valued status – for their parents. Chinese children are taught to have respect for their parents, teachers and authorities, which can be traced back to the Confucian teaching on social conduct. There is a strong pressure for children to conform to familial or group norms and put group interest ahead of individual aspirations. Therefore, education is not just for fulfilling personal aspirations but also for altruistic considerations such as societal development or promoting the well-being of others (Lee, 1996). To learn and to achieve is to meet social expectations and earn approval from significant others. Therefore, for individual students, the cultural meaning of academic achievement refers not only to individual's attainment of high level of education, the mastery of knowledge, the development of positive attitudes to learning, getting good results, developing positive attitudes towards learning, and outperforming others, it also refers to the fulfilment of social obligations and the realization of the collective self within the Chinese collectivist culture.

These collectivist values beget corresponding culturally 'correct' ways for learning. Effort expenditure is taught as the major strategy for learning and dealing with failure. Students are expected to work hard, put great effort into their learning, and persevere even after repeated failures. They are expected to put more time on academic development but less on other learning. Students are taught to show great respect for their teachers and accept their teaching. Strict discipline is used to teach children the importance of education and develop critical personal qualities such as perseverance. Praise or positive verbal feedback are seldom used to encourage students because to learn and to achieve are filial duties (Salili, 1996a).

It should be noted that the collectivist nature of achievement among Chinese does not preclude individual aspirations in academic pursuit. As Lee (1996) has pointed out Confucian teaching also emphasizes on individuality, the development of autonomy, and quest for knowledge. Great emphasis is placed on the building of personal character or virtue (Ho, 1981). 'There is no lack of stress on the significance of reflective learning in the process of learning in the

Confucian tradition. The Confucian conception of learning was indeed a process of "studying extensively, inquiring carefully, pondering thoroughly, sifting clearly and practising earnestly"' (Lee, 1996, p. 35). This form of personal achievement emphasizes the intrinsic nature of learning and signifies the importance of mastery, comprehension and the lifelong pursuit of knowledge in the building of one's character.

Taken together, both individually and socially oriented considerations are culturally important components in the conception of achievement among the Chinese. Yu (1994) therefore discussed a dual conceptualization of achievement motivation among the Chinese that involves both individually and socially oriented motives. Chinese students learn to meet standards and expectations set by both themselves and significant others. From a sociocultural perspective, however, Chinese students should be viewed as constantly participating in the collective and their individual behaviours, choices and attitudes towards learning cannot be fully understood without referring to the historic and evolving culture they participate in on a daily basis.

4.3 'Learning for Achievement' as a Cultural Tool

Through participation in cultural activities and practices, students internalize the values, norms, principles and knowledge that are central in a specific culture. 'Learning for achievement' as a shared motive for schooling is internalized through everyday participation in different forms of educational activities and interaction with various members. It can be taken as a cultural tool providing students with different achievement-related goals, scripts and strategies to guide their learning behaviours. In other words, this collective motive for schooling mediates personal construction of scripts, plans, goals, and strategies for learning (cf. De Vos, 1973; Salili, 1997).

It is therefore instrumental to discuss the research on achievement goals among Chinese. From a sociocultural perspective achievement goals, though still defined as the individual's cognitive purposes for achievement, are mediated through cultural values, norms and practice (Salili, 1997), and can be understood as 'cultural construction solidified after internalisation at individual level' (Ng, 2001, p. 98). In other words, it can be argued that students' achievement goals are rooted in the cultural, historical and institutional contexts. This re-conceptualization of achievement goals using a sociocultural perspective is in line with the current development of achievement goal research, which focuses on the impact of various contexts on achievement goals (e.g. Kaplan & Maehr, 2007). The previous research on achievement goals has focused on the study of two single categories of goals, namely mastery goals and different forms of performance goals. Students holding mastery goals learn for the sake of improvement and comprehension. For those holding different forms of performance goals, their main purposes are either to learn for good grades (performance-approach goals), to avoid showing low abilities (performance-avoidance goals) or to outperform others (performance-competitive goals). The past research on achievement goals using Euro-American participants has demonstrated that different goals can set off qualitatively different forms of engagement during the learning processes (e.g. Ames & Archer, 1988; Dweck, 1986; Elliot, McGregor & Gable, 1999; Meece & Holt, 1993). Mastery goals are always associated with an adaptive pattern of learning while performance considerations are associated with a less adaptive pattern. As a result, there have been calls to promote mastery goals over performance goals (e.g. Ames, 1992; Midgley, Kaplan & Middleton, 2001). Nevertheless, more recent research found that performance-approach goals can also be adaptive (e.g. Harackiewicz et al., 2002). In addition, more attention has been given to various forms of social goals, such as getting approval from others (social approval goals) and working together with friends (social affiliative goals), and their effects on learning (e.g. Dowson & McInerney, 2001).

Past studies on achievement goals are mainly conducted with Caucasian participants in Euro-American countries. The findings and the conceptualization of achievement goals are understood as individual differences within an individualistic cultural frame, and hence, the social dimension of learning and achievement prevalent in the collectivist cultures has seldom been considered fully (McInerney, 1995). The Chinese studies on achievement goals (Chen, 2001; Kong & Hau, 1996; Ng, 2000; Ng, 2001; Salili, Chiu & Lai, 2001; Shi et al., 2001; Tao & Hong, 2000; Yip, 1992) have found converging results validating the applicability of the achievement goal concept among Chinese in Mainland China, Taiwan, Hong Kong and Singapore. These studies also concurred with Western research supporting the differential effects between mastery and different forms of performance goals. Nevertheless, compared to Western findings, there are some notable differences in the results of these Chinese studies that merit our attention. These major differences include:

- Mastery and performance-approach goals are always positively correlated (e.g. Chen, 2001; Chang, Wong, & Teo, 2000; Eaton & Dembo, 1997; Ng, 2000; Salili et al., 2001; Tao & Hong, 2000; Xiang, Lee & Solmon, 1997). This can be taken as an indication that 'learning' and 'achievement' are related among Chinese. In other words, learning is not conducted for the sake of learning only, but more for various achievement concerns.
- Chinese students tend to have higher scores in social goals (e.g. Chang et al., 2000; Ng, 2001). This finding is consistent with the Chinese conception that learning serves important social obligations and purposes such as bringing glory to one's family.
- Chinese students tend to score higher in performance-approach goals but lower in mastery goals compared to Western students (e.g. Ng & Renshaw, 2002; Salili et al., 2001). This finding highlights the overarching importance of academic achievement for the Chinese.

In short, these notable differences can be taken as an indication that Chinese students' individual goals are tied with the collectivist culture. Qualitative data derived from a follow-up interview study involving a selected group of Chinese students in Hong Kong (Ng, 1998) shed light on how students' goals are connected with the rich cultural resources. Two different forms of connection between individual and social planes can be derived from the analysis, approaching and avoidance orientations. The interviewees discussed their personal goals for learning mathematics, which include:

- Meeting parental expectation
- Getting good results
- Mastering interest topics
- Competing with other students
- Opening up study options in senior studies
- Getting into desired university programmes
- Opening up career opportunities
- Helping friends to learn
- Benefiting the well-being of others in society

The most striking feature about these goals the interviewees discussed is that they are related to each other or linked with each other, and can be understood as forming a complex web of meaning (cf. Ng, 2001). In other words, these goals were not discussed as discrete personal reasons for achievement. Two distinct orientations can be derived from the interview data. First, interviewees discussed an approaching orientation that takes social concerns such as promoting the well-being of others and meeting parental expectations as the prime motives for getting good results or expending time and efforts in their learning. Their personal aspirations such as securing a place in desired degree programme are also related to these social considerations. Interviewees holding this approaching orientation follow the cultural logics and take effort expenditure as the main strategy for learning. The following excerpts provide vivid description of this approaching orientation:

> My father looks at my marks too. I was not doing well a few years ago and I once got just 10 something. He said to me, "In this family, we have a very good tradition in maths, me, your uncle, and your brother all are doing well in maths, why you are doing that bad!" I was really upset. He cares about the mark I get.

> Cuz' my results was real bad and my parents … I could feel that they were very disappointed … I was ashamed of myself and realised that there's no point wasting your time and doesn't achieve any thing in your life. So I determined to put effort into my studies (sobbing). To study well is the only concern for me for the moment.

> I absolutely think that maths can contribute to the society. Because my father is a maths teacher and my mom is doing some engineering job … I think people around you can help soak you into something; like listening to my father, I can absorb other things easily. So, I think I love maths has something to do with my dad and mom … Because they are so successful, I am more confident of myself too, and I'll never go like, 'oh, this is too hard, can't do it'.

> I think doing maths you need a lot of practice. If you do more, you'll be familiar with it. There's nothing difficult in maths, only if you practise enough … Now I think we have to practise more, and then we can have a better chance to do better in the exam.

> If you put effort into something, you will get good result. I had this experience. You can say I was a bad student a few years ago. I spent, and I quite proud of myself about this, I spent just one year to catch up. You can catch up if you really put effort into it.

> If you have a good result, your maths teacher will be nice to you.

> With a good result, you can get into form 6 and 7 and then university and then you can get the job you want.

Another orientation takes an avoidance approach to achievement. Two of the interviewees talked about how they have failed their parents' expectations, and reluctantly relied on surface strategies and rote learning to survive the examination pressure. While acknowledging the need for effort expenditure, these interviewees ironically refused to spend time on doing revision or preparing for tests and examinations. Cultural values, goals and strategies have played out in a conflicting manner, and hence, contributed to the development of guilt, shame and a sense of failure among these interviewees. The following excerpt was taken from one of the interviewees, Wai, who did not do well in maths in the past few years and refused to put effort into her learning. She admitted that she was lazy because she thought, 'all these revisions and exercises are annoying'. In her own words, she said, 'I know I should be doing these exercises but in reality I won't'. The following excerpt shows how she was trapped in this avoidance orientation, acknowledging the cultural significance of academic achievement reluctantly.

Researcher (R):	So your reason for doing maths is mainly for getting a good result. But why do you want a good result?
Wai (W):	Because it's in your report card. If you can't get a good result, you won't be able to get to form 6 & 7 (year 12 &13). Then if my mom finds it out that I'm not doing well, I'll be in some trouble.
R:	Why?
W:	Because she'll scold me.
R:	she has expectation on you?
W:	yeah.
R:	so you have to meet her expectation?
W:	Right.
R:	What if you fail to meet her expectation?
W:	She'll scold me.
R:	Just some scolding, then why bother?
W:	No, you have to show people your report card. A red mark (fail grade) doesn't look so good.

The discussion above demonstrated how students' perceived purposes for achievement serve both individual aspirations and social obligations. Qualitative data provide some insight as to how students' individual goals and strategies for learning are connected with the collective motive for schooling in a complex way. Certainly, more research is needed in this area to unfold the complex relationship between different forms of social support to learning and teaching.

To sum up, 'learning for achievement' as a collective motive for schooling permeates the institutional, cultural and individual levels. It is inappropriate to reduce this educational orientation to a competition motive residing overtly on outperforming others or getting relatively higher grades. Undoubtedly, the emphasis on the selective function of education using public examinations as the major selective mechanism has bolstered competition goals among Hong Kong students. Nevertheless, 'learning for achievement' within the Chinese culture involves more than outperforming others. It is about fulfilment of important social obligations such as showing filial piety, seeking social approval and meeting parental expectations. It also involves the attainment of individual aspirations such as future opportunities related to university studies, job hunt, career development, and economic well-being. The actualization of this collective motive or any of the goals derived from it requires a high level of comprehension and understanding in the process of learning. Without such a high level of mastery, high achievement standards cannot be attained. Therefore, 'learning for achievement' can be taken as a catalyst goal representing collectively different purposes for learning or as a complex amalgamation of legitimate goals for schooling that thrives in corresponding educational policies, school climate, classroom practices and individual preferences within the Chinese sociocultural milieu. There is certainly a need to understand the cultural complexity behind this collective achievement motive.

Past studies have established the collectivist nature of learning in relation to learning approaches, the standard of success, attribution, individual versus group work (e.g. Biggs, 1992; Salili & Hau, 1994; Yu, 1980). As for achievement goals, the past research in this area demonstrated that individual goals such as mastery and performance considerations are related, supporting the affiliative nature of achievement motivation (e.g. Hong & Tao, 2000; Ng, 2000; Salili & Lai, 2003). Certainly more research is needed to tease out the complex relationship between these different aspects of achievement and their subtle links with each other within the Chinese sociocultural context in order that rich cultural resources made available by the collective achievement motive can be utilized for promoting learning. When reforming the culture of learning and teaching, it is therefore problematic, and virtually impossible, for teachers and students to shift to a new orientation focusing solely on learning, mastery and student-centredness as proposed in the current education reform (Curriculum Development Council, 2001, pp. 10–16; Education Commission, 2000, pp. 60–64) and neglect the collective achievement motive, its diverse goal representations and rich motivational resources. To explore how the proposed mastery orientation can be linked with the collective motive for achievement is needed for successful re-culturing teaching and learning in Hong Kong.

5 Some Suggestions

Teaching and learning is embedded in different social practices and contexts in which teachers and students participate. Students learn to participate in actual social settings on the basis of their understanding of what it demands, values and affords. Though, the current educational reform in Hong Kong acknowledged the need to 'preserve and promote good traditions' in its education system (Education Commission, 2000, p. 29), it has failed to elaborate on these cultural strengths and explain how reform policies and measures should be built on them. In this chapter, it is argued that to reform the culture of teaching and learning successfully in Hong Kong, there is a need to acknowledge 'learning for achievement' as a legitimate goal for schooling and to understand its complex forms of representation in different contexts. It is culturally inappropriate to ignore cultural, historical and political emphasis on 'learning for achievement' and its varied representation in the choice of goals.

While it is important to foreground the importance of learning and mastery in light of the emerging challenges brought about by globalization and economic transformation, there is a need to acknowledge the diverse adaptive goals for learning made available to individuals by the collective achievement motive. Hong Kong students' high performance in various international comparison tests has prompted Western researchers to understand 'the paradox of Chinese learner' (Watkins & Biggs, 1996), that is, what makes it possible to learn and achieve with excellent outcomes based on processes or strategies that from one perspective might be considered as educationally ineffective. The current educational reform, however, paid lip service to preserving fine traditions in the Hong Kong education system and failed to explore the cultural basis of achievement and learning. More research is needed to cultivate an informed discussion of how 'learning for achievement' can be promoted for different groups of students – for those who accepted the cultural logic and approach learning using goals derived from the collective motive for achievement; and more importantly, for those who have experienced failure and resorted to avoidance strategies to survive cultural or social censorship. In other words, the collective motive for achievement can have both facilitative and constraining effects on learning, depending on ones' own experiences, perceptions and understanding.

It is not desirable, therefore, to approach the re-culturing of the learning and teaching processes in Hong Kong solely by replacing the 'dated orientation' with 'a new one'. This will rob students and teachers of the rich cultural resources that support learning through various social, personal and economic considerations related to the notion of 'learning for achievement'. The promotion of learning for learning's sake may be too 'foreign' a notion for teachers, students, and parents in Hong Kong to accept over a fortnight. Within the Hong Kong educational, cultural and institutional systems, learning has always been taken as a means for other important ends being promoted in the immediate schooling context as well as valued by the wider societal, cultural and economic systems. In other words, it is more advisable to explore how learning and mastery can be promoted alongside with established educational orientations and practices in Hong Kong. Merging the mastery orientation advocated in the current reform with those diverse goals for schooling associated with the collective achievement motive can be a viable way to approach this re-culturing task. To do this, it is important for policy-makers and educational reformers to help students, teachers and parents to understand the possibilities of simultaneously addressing both mastery and various achievement concerns during the learning processes. One way to do this effectively is to build an assessment system based on clear performance standards. Students should be given clear instructions as to what entails a successful completion of a learning task. A clear standard of performance, defined in qualitative terms and levels should be used to assess students' learning and progress. In other words, students should be able to understand what exactly is required for a specific grade, which can be used for assessing one's learning progress against a clear qualitative standard, rather than providing the base for social comparison.

A second viable way of change is to link up the new forms of learning promoted by the current education reform such as project learning with this collective motive for schooling. In other words, at the operation levels, teachers, students and parents should be informed clearly as to how these new forms of learning would contribute to students' achievement and to their future chances for securing good education opportunities. Without such an effort, reformative strategies such as project learning which is supposed to be used to promote deep learning and critical thinking can be completed in a mechanical manner. For example, I have come across several menu-like scripts some teachers prepared for their students to follow mechanically when completing project work. The explanation for the development of such a kind of surface strategy for dealing with a learning task that demands creativity and critical thinking is that teachers and students are still concerned more about the learning product over the processes.

At the structural level, reducing school banding and merging two major examinations are not sufficient for the establishment of a new social practice that values learning and mastery over performance and achievement. The Hong Kong government should endeavour to develop more pathways for success. Persistent efforts and resources are required to forge new socially accepted pathways and establish them as solid, acceptable pathways for success in Hong Kong. To the extent that students, parents and teachers understand and embrace other opportunities for success, the pressure for competing with each other for academic performance would reduce.

Related to the previous point is the creation of diverse pathways to university education. The Hong Kong government should consider financing wholly the associate degree system with the provision of a guaranteed quota for articulation to university degree programmes. This will take the heat away from competitive pressure and create more freedom for development. Without such an effort, 'learning for achievement' will remain skewed towards outperforming others or getting relative higher grades in the Hong Kong education system despite current reformative efforts shifting the focus to learning and mastery.

6 Implication for Reforming Learning in the Asia-Pacific Region

Reforming teaching and learning is not the only concern in Hong Kong. When summarizing the major trends in educational reform within the Asia-Pacific region, Cheng (2003) pointed out that a paradigm shift in teaching, learning and assessment has been one of the common focal points of development among different countries within the region. Other countries within the Asia-Pacific region have experimented with other forms of teaching and learning arrangements or developed new forms of pedagogies that will meet their needs. For example, Singapore's education reform, named 'Thinking School, Thinking Nation', has focused on improving students' creativity and thinking skills using innovative pedagogical tools such as project work (see Yeong & Ng, this volume). Nevertheless, the Singapore educational system has been rooted in a political and cultural regime that emphasizes conformity and obedience. Therefore, the promotion of project learning that demands creative thinking is likely to invite a certain level of resistance from various stakeholders in education. Undoubtedly, the innovative reforms in various countries in the Asia-Pacific region will be able to address some of deficiencies in their respective education systems. Nevertheless, the extent to which the new forms of practice or new educational measures can be successfully implemented at the chalk-face level hinges on how well they are assimilated into the existing system and embraced by various stakeholders. Teachers or other stakeholders may be holding different theories or beliefs about, and goals for, teaching and learning. Finger-pointing at teachers or some other stakeholders in the system will do little to help implement the new practice. The acid test of these reforms is the extent to which they can be transformed into new practices that connect with the sociocultural and historical evolvement of the educational practices in these systems.

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Motivational Implications of the Quality Teaching Model in New South Wales

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Abstract The motivational implications of an educational reform in the Australian state of New South Wales are explored. The quality teaching model has been designed to improve teachers' pedagogical skills. The model is examined from the perspective of achievement-goal theory. I argue that the intention of the authors of the model is that its implementation will encourage students' adoption of a mastery achievement goal. However, there is a danger that the model may be less successful with those students who have been specifically targeted by the authors of the model, namely, under-achieving students from traditionally disadvantaged groups. I suggest that the model does not take into sufficient account the way in which students' social goals, or even a less conscious need to feel related to others, can work simultaneously with academic goals.

1 Introduction

In this chapter I consider the motivational implications of an educational reform currently being implemented in the Australian State of New South Wales. The Quality Teaching Model (QTM) is designed to improve pedagogy. Three aspects of teaching are targeted: the intellectual quality of the work students do; the learning environment established in the classroom; and the significance of academic work to students' lives. This model is examined from the motivational perspective of achievement goals.

I argue that implementation of the QTM should encourage students' adoption of a mastery achievement goal. However, there is a danger that the model may be less successful with the students who have been specifically targeted by the authors of the model, namely, academically under-achieving students from traditionally disadvantaged groups. The model does not take into sufficient account the way in which students' social goals (or even less conscious needs to feel related to others) can

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work simultaneously with academic goals. If teachers are not aware of the social dynamics of their classrooms, and link these dynamics with academic work, then it is unlikely that students' achievement will improve. If teachers become dispirited after genuine attempts to increase students' engagement with their work, then a valuable addition to pedagogical practice may be lost.

The chapter is organised in the following manner: achievement goal theory is presented in its original conception and then with the addition of socially mediated achievement goals and a discussion of the way in which conscious goals may coexist with less conscious needs and motives; the QTM is introduced, and its development from previous models is described; the motivational assumptions of the model are examined; and finally a discussion of the way in which teachers may have to accommodate students' social goals before the model can be implemented successfully.

2 Achievement-Goal Theory

Achievement-goal theory came to prominence in the 1980s as one of several cognitively based models of motivation (McInerney, 2005). Since then the theory has been extended. There has been increasing recognition of the complexity of students' behaviour. One area of development has been the way in which students' academic goals can be intertwined with social goals. Another area of development is the way in which deliberate adoption of goals may coexist with less conscious behaviour. These less conscious behaviours may result from drives or needs such as the need for social affiliation. Less conscious behaviour also may be the result of students not imaging that other behaviour is possible.

Initially, achievement-goal theory identified two major goals (Ames & Archer, 1988; Dweck, 1986). Students who worked at tasks because they wanted to understand or master them were said to have adopted a mastery goal. Students who worked because they wanted others to acknowledge their competence were said to have adopted a performance goal. This is an ego-focused goal, concerned with how one is perceived by others. Originally it was argued that mastery-oriented students should produce better quality work than performance-oriented students because mastery-oriented students focus all attention on their work and seek strategies that will help them to succeed (Ames, 1992). Performance-oriented students are less focused on their work because they remain aware of the other students and the teacher, concerned with how they appear to others.

Harackiewicz and colleagues (Harackiewicz, Barron & Elliot, 1998; Harackiewicz et al., 2000) challenged the view that a performance-orientation was always undesirable. They argued that students who hold both mastery and performance goals simultaneously tend to be successful because they combine interest in the task with the desire to outperform others. Harackiewicz and colleagues distinguished between a performance-approach goal (a goal held by confident high-achieving students who want to look competent in front of others) and a performance-avoid goal (a goal held by anxious students who do not want to look foolish in front of others). Performance-avoid students use a variety of strategies to achieve their goal of not looking incompetent. They may procrastinate (*I would have produced good work if I spent more time on it*), cheat, or publicly claim they did not prepare for examinations. In this way a high mark can be attributed to ability rather than effort, and a low mark can be attributed to lack of effort rather than lack of ability.

Another goal also was identified. This goal was called an academic alienation goal or a work avoidance goal (Ainley, 1993; Archer, 1994, 2001; Dowson & McInerney, 2001; Meece & Holt, 1993; Nicholls, Patashnick & Nolen, 1985). The goal is to do enough work to complete a task but no more. This goal was not considered an achievement goal, more a way of categorising the behaviour of students who did not adopt mastery or performance goals. Academically alienated students may do sufficient work to satisfy minimal requirements but prefer to invest their time and energy elsewhere. Their attitude to school may be positive (*it's interesting work but I've got too many other things going on*) or negative (*it's so boring I can't wait to get away*). Performance-avoid students and academically alienated students can display similar behaviour. Performance-avoid students want to give the impression that, like academically alienated students, they do not care about doing well but in fact they do.

As noted previously, research has demonstrated that students can hold multiple goals (Ames & Archer, 1988; Harackiewicz et al., 2000). For example, a high achieving student simultaneously could be mastery and performance-approach-oriented. Another student could be mastery and performance-avoid-oriented. Students can be encouraged by situational cues to adopt a particular goal (Ames, 1992). For example, setting up a competition encourages students' adoption of performance goals.

2.1 Adding a Social Component to Achievement-Goal Theory

More recent analyses of achievement-goal theory have broadened the scope of the theory, particularly by looking at social aspects of classrooms (e.g., Dowson & McInerney, 2001, 2004; Summers, 2006; Urdan & Maehr, 1995). Classrooms are intensely social places.

The original conception of achievement goals did acknowledge a social dimension to learning. A performance goal requires comparison with others: *I want* others *to see what a good student I am*; *I don't want* others *to see what a poor student I am*. Students' sense of self can be enhanced or diminished by how they think they are perceived by others. A mastery goal also has a social dimension. Mastery-oriented students undertake a task because they see it as interesting or important. Importance is culturally defined. Interest may be culturally defined too. Sociocultural theorists (e.g., Wenger, 1998) have demonstrated how thinking and behaviour are linked inextricably to cultural experience. If achievement-goal theory is to be a useful way of understanding students' behaviour, this complex mix of social and academic endeavours needs to be explored.

Social goals and academic goals can work independently (e.g., Wentzel, 1999; Wentzel, Barry & Caldwall, 2004). Students want to make friends, join a group, and prevent others from joining a group, and so on. Achieving these goals may not impinge on academic work. However, social goals can be achieved via academic work. Students may do their academic work, or not do it, because they want to be accepted within a group. They may work because they like the teacher and want to please him, or they dislike the teacher and refuse to work to annoy him. Students may work or not work to please or annoy parents. Students can engage in work to achieve multiple goals. So a student may work because he finds the work interesting (mastery goal) and because it allows him to spend time with his friends (social goal).

A study I have undertaken (Archer, 2004) provides an example of research looking at how students combine achievement and social goals. I observed 14 high school teachers in the classroom and interviewed them about their perceptions of students' motivation and what occurred in the lessons I observed. Why did they think some students worked while others did not? Their responses were categorised into the following goals. Some of these goals are 'standard' achievement goals while others show an intertwining of achievement and social goals. The goals are divided into two categories: goals of students who engage in academic tasks and goals of students who do not.

I'm doing this task because:

- *It's interesting* (mastery achievement goal – interest)
- *It's important* (mastery achievement goal – important)
- *It will help me get a job* (mastery or performance achievement goal – important)
- *I'll look good when I do it better than the others* (performance-approach achievement goal)
- *I'll look stupid if I don't do it* (performance-avoid achievement goal)
- *My parents want me to do well at school* (social/family goal)
- *My friends are doing it and I want to do what my friends are doing* (social/friends goal)
- *I'll be punished if I don't do it* (social conformity; academic alienation goal)
- *I like the teacher so I'll do what she wants to please her* (social/teacher goal with authority resting with the teacher)
- *We like the teacher so we'll do what she wants to make her look good* (social/teacher goal with authority resting with the students)
- *It's what you do at school* (social conformity, no conscious goal)

I'm not doing this task because:

- *It's boring* (mastery achievement goal – lack of interest)
- *It's not important* (mastery achievement goal – lack of importance)
- *It won't help me get a job* (mastery or performance achievement goal – lack of importance)
- *My parents don't care if I don't work at school* (social/parents goal)
- *My friends aren't doing it and I want to be like my friends* (social/friends goal)

- *I will look stupid if I do the task badly* (performance-avoid achievement goal)
- *There are other things that I would rather do*. (academic alienation goal)
- *I don't like the teacher so I don't want to do what she wants me to do* (social/teacher goal with authority resting with the teacher)
- *We don't like the teacher so we'll make her look incompetent* (social/teacher goal with authority resting with the students)
- *My classmates aren't doing it* (social conformity, no conscious goal)

Of course, this set of goals needs further investigation. Students need to be asked directly about their goals. Younger students are likely to hold different goals from older students. Two goals identified in this research can be linked with the sociological literature on how power or control can shift within a classroom (Gore, 1993). When all students act together (though one can imagine a similar situation with one or two powerful students), they can exert control over teachers. This is evident in the goals of working to make the teacher look good or not working to make the teacher look incompetent. There is a subtle but important distinction here. Students who work to please a teacher have a different motivation from students who work to help a teacher; and students who refuse to work to annoy a teacher have a different motivation from students who refuse to work to humiliate a teacher. A shift in power from teacher to students has occurred.

Another notable finding from the research was teachers' observations that some students did not appear to hold conscious goals at school: they *go through the motions* without consciously setting goals for what they want to achieve at school. This attitude, that there is only one possible course of action and therefore no conception of deliberately adopting a goal, is considered further in the following section.

2.2 Behaviour Not Impelled by Consciously Adopted Goals

Achievement-goal theory was based on the premise of conscious goal adoption, that students deliberately set goals for achievement. However, conscious adoption of a goal may not always characterise what happens in classrooms. Students may assume that there is only one way to behave, that there is no choice available. This thinking has been described as *cognitive availability,* some ideas or behaviours are available to us while others we do not contemplate.

> [O]ne's learning history may make certain options readily available, others not. The culture in which one is raised may have a decisive influence here: To a Mennonite child, stealing is not cognitively available as an option, whereas to an inner-city American youth it may well be. Indeed, society's learning curriculum may try to short-circuit the decision-making process altogether, by making only one alternative cognitively available as the only right or possible thing to do. If this is successful, an actor may 'just do' the socially approved thing, 'mindlessly' if you wish, without really making a decision at all. (Mook, 1996, p. 393)

In Australia young people have no choice but to go to school. What do they see as normal behaviour, or the only possible behaviour? There are some students for whom defiance of school authority is the norm. For other students it is normal to defer to authority, to do the work they are given. There is the threat of punishment if students refuse to work, but for many threat is not necessary. They work because this is what students do in school (Hickey, 2003; Wenger, 1998). Other options are not cognitively available to them. In this case, can students be said consciously to have adopted a goal? One could argue that there is a social motive that impels students to conform, almost unconsciously, to the conventions of their culture, but it is different from the consciously adopted goals specified in achievement-goal theory.

One explanation for lack of conscious goal adoption may be cognitive availability that students do not conceive of another way of behaving. Another explanation for lack of conscious goal adoption may be that students are acting to achieve barely conscious or unconscious needs. In his review of research on student motivation, Pintrich (2003) wrote of a renewed interest in the role of needs in human motivation. There are limitations in cognitive models that explain behaviour in terms of constructs such as goals (consciously articulated), attributions, and evaluations of self-efficacy. Early motivation research by McClelland and Atkinson (e.g., Atkinson, 1964; McClelland et al., 1953) defined motivation in terms of needs, specifically the need for achievement, the need for power, and the need for affiliation. Some of the social goals that I discuss in this chapter may be more accurately described as a need for affiliation, for social connection and acceptance. However, the social goals described in this chapter are more varied than the need for affiliation.

> Needs and motives are assumed to operate at a more implicit or unconscious level, counterbalancing the cognitive and conscious processes stressed in social-cognitive models. It seems clear that future research will attempt to build models that integrate implicit, unconscious processes with more explicit and conscious processes as their relative strengths and weaknesses complement each other. (Pintrich, 2003)

Urdan and Maehr (1995) also make links between the earlier work on needs and motives and the current focus on social goals. They point out that the need to make social connections with one's peers is particularly strong in adolescence. Fredricks, Blumenfeld and Paris (2004) argue that needs have been overlooked in the current focus on cognitive models of motivation. They discuss Connell's self-system model that incorporates a need for relatedness, a need for autonomy, and a need for competence. They argue that students need to feel that they are accepted as members of a school community (the need for relatedness is satisfied) before they are prepared to work.

To conclude, in this section I have provided a brief description of the motivational theory of achievement goals. I have noted research that shows students simultaneously fulfilling achievement goals and social goals as they undertake academic work. Also, I have noted how some students do not appear to adopt goals in a conscious manner. They behave in a way that seems normal to them, not conceiving that alternative behaviour is possible. Recent work also suggests that deliberately adopted goals may coexist with less conscious needs such as the need for affiliation or need for relatedness.

In the following sections, I examine a model of pedagogy from the perspective of achievement-goal theory. The QTM of pedagogy has been endorsed by the Department of Education and Training in New South Wales in an attempt to improve teaching practices and thereby enhance student achievement. First I describe the impetus for endorsing the QTM, and then I outline how the model has reached its current form. I consider the motivational implications of the model. It appears that the intention of the authors is that use of the model will encourage a mastery goal in students. Though this is a laudable intention, I argue that the model does not take sufficiently into account the complex social elements of classrooms. It may be that many of the low-achieving students from disadvantaged backgrounds, whom the authors of the model specifically want to help, will not respond positively to the model.

3 Quality Teaching Model

In 2003, the Department of Education and Training (DET) in the Australian State of New South Wales introduced an initiative to improve the quality of teaching practices in government schools. The impetus for change, at least in part, was a review of initial teacher preparation and continuing development of teachers in New South Wales conducted for the DET by Gregor Ramsay (Ramsay, 2000). Ramsay noted that across employers of teachers in NSW, 'there generally does not appear to be a strong organisational focus on quality teaching' and that 'professional development should be the subject of considerable scrutiny by employers and the profession to determine the extent to which improvement will be achieved in teacher skills and student outcomes, (p. 83).

With academic input from James Ladwig and Jennifer Gore, the Department adopted a model of pedagogy that focused on teaching strategies and assessment tasks. It is described in *Quality Teaching in NSW Public Schools* (DET, 2003) and is designed to apply across all curriculum areas and across all levels of schooling.

> The model has been designed to cater for a wide variety of student and teacher individual differences. That is, across all the individual differences teachers take into account in their teaching, and across all the different styles of and approaches to teaching, this document identifies generic qualities of pedagogy that have been successfully applied in a range of school contexts and are shown to lead to improved student learning. While NSW teachers will continue to cater for individual learners and differences associated with the various groups in our community, this model provides a consistent pedagogical framework within which all NSW teachers and schools can operate. (Quality Teaching in NSW Public Schools, pp. 4–5)

Three dimensions of pedagogy are identified in the model: promoting high levels of intellectual quality; promoting a quality learning environment; and making explicit to students the significance of the work they do. Each dimension is composed of six elements. This description of the elements comes from *Quality Teaching in NSW Public Schools*.

Intellectual quality

- *Deep knowledge*: Key concepts and ideas in the learning area and relationships among the concepts are presented to students.
- *Deep understanding*: Students demonstrate meaningful understanding of these key concepts and the relationships among them.
- *Problematic knowledge*: Students address multiple perspectives or solutions to problems and recognise that knowledge is constructed and therefore is open to question.
- *Higher-order thinking*: Students are engaged in thinking that requires them to organise, reorganise, apply, analyse, synthesise and evaluate knowledge.
- *Metalanguage*: Teachers explicitly name and analyse the specialist language of a learning area and comment on language use and how language is used differently in different contexts.
- *Substantive conversation*: Students regularly engage in sustained conversations (in oral, written, or artistic forms) about the concepts and ideas they are encountering.

Quality learning environment

- *Explicit quality criteria*: Students are provided with explicit criteria for the quality of the work they are to produce.
- *Engagement*: Most students, most of the time, are seriously engaged in the lesson, and display sustained interest in and attention to their work.
- *High expectations*: Teachers communicate high expectations to all students and encourage students to take academic risks.
- *Social support*: Teachers encourage strong positive support for learning, and there is mutual respect among teachers and students. The classroom is free of negative personal comment or put-downs.
- *Students' self-regulation*: Students demonstrate autonomy and initiative so that there is little need to discipline misbehaving students.
- *Student direction*: Students exercise some direction over the activities they undertake and the manner in which they complete these activities.

Significance

- *Background knowledge*: Lessons regularly and explicitly build on students' background knowledge in terms of prior school knowledge as well as aspects of their private lives.
- *Cultural knowledge*: Lessons regularly incorporate the cultural knowledge of diverse social groupings, such as economic class, gender, ethnicity, race, sexuality, disability, language, and religion.
- *Knowledge integration*: Lessons regularly demonstrate links between and within learning areas.
- *Inclusivity*: Lessons include and publicly value the participation of all students across the social and cultural backgrounds represented in the classroom.

- *Connectedness*: Lessons rely on the application of school knowledge to real-life contexts or problems, and provide opportunities for students to share their work with audiences beyond the classroom and the school.
- *Narrative*: Lessons employ narrative accounts within lessons (as content or as a process) to help student understanding.

3.1 Development of the Quality Teaching Model

The Quality Teaching Model (QTM) in NSW was a development of work done in the Australian state of Queensland which in turn was a development of Authentic Pedagogy produced by the Center on the Organization and Restructuring of Schools at the University of Wisconsin-Madison by Newmann and associates (Newmann, Marks & Gamoran, 1996; Newmann & Associates, 1996). Authentic pedagogy focused on classroom features that led to students' production of work of intellectual rigour (Ladwig, 2004). Three features were identified: disciplined inquiry, students' construction of knowledge, and value beyond schools.

In an attempt to improve pedagogical practice in Queensland, the Queensland government funded the *Queensland School Reform Longitudinal Study*. The study produced a model, known as Productive Pedagogy, which extended Newmann's work by considering a greater range of classroom factors that research had linked to students' learning, particularly for students from disadvantaged social backgrounds (Ladwig, 2004). An instrument of 20 items for observing classrooms was developed. Over the three years of the study, 974 observations of classrooms were carried out, though the Productive Pedagogy Model was developed from the 302 observations of the first year of the study. Factor analyses pointed to three relatively strong factors (intellectual quality, connectedness, and a socially supportive environment) and a fourth weaker factor (recognition of difference). The analyses also showed that Newmann's construct of authentic pedagogy was not unidimensional as originally conceived. For example, connectedness emerged as a different factor from intellectual quality.

The QTM incorporates 17 of the 20 items used in the Queensland study. The weak fourth factor was removed. An additional element, High Expectations, was added to the Quality Learning Environment dimension.

4 Motivational Consequences of the QTM

The QTM does not address motivation directly. However, examination of the model shows that the intended motivational outcome is intrinsic motivation or a mastery-goal orientation. Intrinsic motivation is motivation stemming from the task itself, an interesting, absorbing task (Stipek, 2002). A mastery-goal orientation can be generated by intrinsic motivation (*I want to do this task because it's interesting*) or may be the result of perceived importance (*I want to do this task because it's important*). Within the dimension of a Quality Learning Environment is the element of Engagement, defined as: *Most students, most of the time, are seriously engaged in the lesson or the assessment activity, rather than going through the motions. Students display sustained interest and attention*. This reference to interest points to intrinsic motivation and a mastery goal.

More generally, the QTM fits with research on situational cues that encourage the adoption of particular achievement goals. Ames (1992, p. 267) pointed to three aspects of teachers' actions that should encourage students to adopt a mastery goal: the nature of the tasks given to students, the way in which students' work was recognised and evaluated, and the level of control students exercised over their work. Stipek (2002) makes similar arguments.

There is overlap between the QTM and behaviours identified by Ames that encourage students' adoption of a mastery goal. Ames argued that tasks given to students should be interesting, diverse, often novel, and at an appropriate level of challenge such that they can be accomplished with the expenditure of reasonable effort. These aspects overlap with the Quality Teaching elements of Deep Knowledge, Deep Understanding, Higher-order Thinking, and High Expectations. In addition, tasks should be personally meaningful to students. Meaningfulness overlaps with the Quality Teaching elements of Background Knowledge, Inclusivity, and Connectedness. In terms of recognition and evaluation, practices should focus on individual improvement and downplay competition among students. Evaluation should be done privately not publicly, with the understanding that making mistakes is a natural part of learning, and recognising the effort expended by students. Students should be allowed opportunities for improvement. There is no clear overlap here with Quality Teaching elements, though in the element of Social Support there is the suggestion that students help each other rather than compete against each other.

Ames' third aspect is labelled 'authority'. Students should be given opportunities to make significant choices about the tasks they undertake and the way in which they do them. Decisions about tasks should be based on the level of effort required to complete them rather than on teachers' or students' ratings of students' ability. Students should be given opportunities to self-regulate and develop effective study strategies. Here there are clear overlaps with the Quality Teaching elements of Students' Self-regulation and Student Direction.

From a motivational perspective, therefore, the QTM should encourage students' adoption of a mastery goal. This goal is desirable because the focus of attention is the task itself, rather than performance compared to others (a performance-goal orientation). This focus on the task should produce deep engagement and hence higher quality learning. However, it should be noted that few studies have produced significant correlations between a mastery orientation and achievement.

A pedagogical model that encourages students' adoption of a mastery orientation is welcome. As noted earlier, there are advocates for the adoption of performance goals in addition to mastery goals, pointing to high achievement in students who are both mastery and performance-oriented (Harackiewicz et al., 2000). However, there are dangers in establishing strong competitive environments because competition produces winners and losers. Though winners may display desirable performance-approach attitudes and behaviours, losers are likely to adopt maladaptive performance-avoid attitudes and behaviours such as avoiding challenging tasks, anxiety about lack of ability, procrastination, and cheating.

4.1 Impediments to the Success of the Quality Teaching Model

Teachers who change their practices to fit the model may not always achieve the desired outcomes, especially increases in student achievement. The model does not appear to acknowledge sufficiently the highly social nature of classrooms. An impetus for the authors of the model was to improve the learning of students from traditionally disadvantaged groups such as those with lower socio-economic status (SES) backgrounds (Ladwig, 2004). For many of these students, particularly adolescent students, attending school can be essentially a social activity, a place to meet friends, to find girlfriends and boyfriends, and to engage in struggles with teachers. Many students will only do academic work if threatened with punishment or loss of privileges even if teachers try to make the work interesting and relevant for them.

There is ample evidence of the relative under-achievement of Australian students from lower SES backgrounds compared with students from higher SES backgrounds (Lamb et al., 2004; MCEETYA National Report on Schooling in Australia, 2005). Lamb and colleagues (2004) also point out that Australian students are highly segregated along social and academic lines: high-achieving students tend to be in private schools or government schools in prestigious residential areas whereas low-achieving students tend to be in government schools in less desirable residential areas. Data from the OECD (Organisation for Economic Co-operation and Development, 2001) support Lamb and colleagues' description of a highly segregated system of schooling, with a significant gap between the achievement of Australian students from higher SES backgrounds and students from lower SES backgrounds.

To implement the QTM successfully, teachers may have to accept the social dynamics of the classroom and manipulate these dynamics to their advantage. As Fredricks and colleagues (2004) point out, students may need to feel accepted as members of a school community before they are prepared to work. For example, teachers may need to establish cordial relations with student leaders. They need to show that they like the students, and that they can provide students with stability and consistency. If rapport is established, then students may accede to their requests. As I argued earlier, this may represent a shift in power from teachers to students, with the students agreeing to help the teacher do his job because they like him or her. If student leaders attempt tasks then other students will follow. From here it is possible that students may develop an interest in the tasks and a mastery orientation may develop. Cordial relations between teachers and students are not sufficient in themselves, but that they may be the first step towards academic engagement.

There is some similarity here with the use of rewards. There is a seemingly endless controversy about the use of extrinsic rewards, with critics arguing that extrinsic rewards diminish students' intrinsic motivation to learn (Stipek, 2002). Others argue that there is a place for extrinsic rewards. If students initially do not see a task as interesting, then teachers offer a reward to students for doing it. Once students apply themselves to the task and interest develops, then the rewards might be removed because students will continue to work without rewards (Stipek, 2002). Similarly, teachers may have to devise tasks that initially satisfy students' social goals, anticipating that interest in the tasks themselves will emerge once students have engaged with them.

People's attitudes and behaviour are affected not only by relatively stable personality characteristics but also by situations they experience. When teachers design classroom experiences, they intend to create a powerful situation that will encourage students to act in certain ways. Proponents of problem-based learning in universities, for example, argue that the creation of learning environments will encourage students' adoption of a mastery goal. However, even with problem-based learning which requires major changes to the way courses are conducted and substantial commitment from teaching staff, it has been difficult to document significant improvements in learning as a result of carefully designed and regulated learning environments (Gijbels et al., 2005).

The educational environment is only part of students' lives. Other aspects of their lives may exert a stronger influence on their attitudes and behaviours. In addition, enduring personality characteristics will affect how students behave in schools. Though teachers may see schools as places of learning, many students from lower SES backgrounds may conceive of schools primarily as an extension of their social lives.

5 Conclusion

Teachers working with students from disadvantaged backgrounds voice frustration with their students' lack of motivation to study and their indifference or hostility towards schools. A theory of motivation that incorporates the complex interweaving of students' social and academic goals may help teachers to understand their students' attitude to school and to devise ways of getting them to engage with academic tasks.

Examination of the QTM suggests that teachers' use of effective pedagogical practices should encourage a mastery orientation in students. Though motivational researchers would support this intention, it may be unrealistic to expect that students who have shown little or no interest in schoolwork will move easily from alienation to a desire for mastery. Socially mediated strategies may be more effective, at least initially. A mastery motivation may come later as students experience success and get more involved with their work.

5.1 Implications for Reforming Learning with the Asia-Pacific Region

It is interesting to speculate about Asian students' reasons for undertaking academic work. One would anticipate that social motives and academic motives are intertwined as they are in other parts of the world. The relative strength of these social motives may differ from culture to culture in the same way that the strength of social motives changes at different developmental points. For example, young adolescents can be focused on finding and keeping friends and will work or not work at school so that they keep these friendships. The motives of children would be somewhat different. Like adolescents, they would want to find friends, but they probably are more concerned with connections with their parents or with a teacher so they may work to please a teacher or a parent.

Refusal to do academic work may not be as prevalent in Asian cultures as it is in the Australian culture. Deference to authority may be more the norm in many Asian countries than in Australia. Many Asian students may engage in academic tasks because it is what is expected of them rather than because they are intrinsically motivated to do them. The underlying motivation may be social, to please their family.

Wongsri (2004) investigated the motivation of university students in Thailand. She demonstrated that it is common for Thai students to work hard to please their families and to avoid the public humiliation of their families. To give some examples of students' responses to questions about their achievement goals: *I try to do the best for myself. I also do the best for the expectation of my family. I do not want other people to look down on me and my family* (nursing student*); I want to study for my parents as I am their only child. They do not want me to get into any trouble in the future* (psychology student); *I try to do the best for my mother. In the past, I did not care for her feelings and how hard she works for me, but someone told me how much she loves me. I now understand her and want to do the best thing for her. I also try to do the best for my relatives. They encourage me to be a good person* (nursing student).

Wongsri (2004) argued that working to please others may be part of a collectivist cultural heritage in Thailand that contrasts with a greater emphasis on individual accomplishment in many Western countries (Hwang, Francesco & Kessler, 2003). Similarly, Salili argues that Chinese students work hard at school not only to satisfy their own goals but also to satisfy the goals set by their families (Salili, 1996; Salili et al., 2001). They are concerned about *loss of face* for the family if they fail to achieve.

If social goals in many Asian countries are concerned with maintaining harmonious relationships with others, especially family members, then teachers in these countries may not experience some of difficulties faced by Australian teachers. As argued in this chapter, many Australian students have little intrinsic interest in school work and see school primarily as a social arena. They become detached or difficult students who refuse to work in class. Alienation such as this probably is rarer in Asian countries where students may continue to work, not because they are enthused about the work, but because they feel a social obligation to achieve.

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Reforming Learning for Children with Learning Differences in New Zealand

Kathleen A. Liberty

Abstract This chapter discusses concepts that underpinned a progressive reform of educational provision for children with disabilities and learning difficulties in New Zealand. Reform involved increasing options for parent choice in education and allocation of resources to schools for individual children concurrent with a push for full inclusion of children with learning differences alongside typical children in state primary classrooms. The chapter explores the development and impact of the reform and critically reflects on problems and issues arising from its implementation to date.

1 Introduction

In the 1950s and 1960s, the civil and human rights movements in the USA gained momentum, and ended the legal segregation of public schools along racial lines. During this same period, research challenged commonly held assumptions about the learning capability and educability of children with learning differences by showing that children with the most severe challenges to learning can learn and benefit from education (cf., Stevens & Heber, 1964; Bijou & Cole, 1975). Concurrently, research began showing that special education of children with disabilities in separate classes and schools did not necessarily produce learning – and, if such provision is not effective, assumptions about its efficacy or role in educating children with learning differences must be challenged (Carlberg & Kavale, 1980; Stainback & Stainback, 1984). Parents and advocates for equal opportunities in education for children with learning differences pushed for an end to exclusion and segregation in schooling for all children. In 1975, the USA established that free public education was to be made available to all children, regardless of disability or other difference (Education for All Handicapped Children's Act, Public-Law 94–142) and the UN passed the Declaration of the Rights of Disabled Persons (United Nations, 1975). PL 94–142 contained the provision that children were to be educated in the 'least

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restrictive environment possible' –in the mainstream of schooling, rather than in segregated schooling. In the phrase 'the least restrictive setting', the physical setting of education seems to be the focus. However, the step to inclusion defines an even broader focus.

> Inclusive classrooms start with a philosophy that all children can learn and belong in the mainstream of school and community life (Stainback & Stainback, 1996, p. xi)

The movement to include all children in regular schools and classrooms crossed the Pacific and informed educational change within New Zealand (Philips, Lealand & McDonald, 1989). Interchanges during conferences, through professional journals, and through visitors helped define the changes. However, the changes in New Zealand have resulted in much more radical changes than in the USA, as changes in schools governance, parent choice of schooling, the labelling of children's learning differences and funding of supportive education have resulted in a new approach to education for children with learning differences.

1.1 Modernism to Postmodernism

The concepts underpinning the changes have developed during the rise of postmodernism, and, to a certain extent, reflect postmodern ways of thinking. This chapter considers specific changes in the education of children with learning differences over the past 20 years during a period of rapid change to educational provisions.

Prior to the reform, during a period of what may be called 'modernist' ideas of education (roughly pre-1980), *learning* was synonymous with achievement, and achievement was identified with the contents of a fact-laden national curriculum. When learning is identified as achievement of a set curriculum, it could be empirically identified and precisely measured, and children's *learning* relative to each other could be determined. To further achieve education goals in the modern era, children were divided or streamed by measures either of general intelligence or general academic achievement. *Teaching* was primarily identified as the delivery of the national curriculum. Children were not seen as active participants in their own learning process, but as virtually empty vessels to be filled with knowledge delivered by their elders and betters. In this context, children with learning differences were identified as those whose learning achievement was in the lower percentiles. In addition, some children were considered incapable of learning, and such children were variously labelled 'trainable', 'idiot', 'disturbed', 'intellectually disabled' and 'backward' (Mitchell & Mitchell, 1985). These children were often excluded from schooling, or placed in schools completely different to schools attended by children without learning differences, euphemistically called 'special schools'. Exclusion or segregation was based on assessment of intellectual fitness to achieve curriculum goals, and labels were used to denote the degree of difference.

During the reform period (mid-1980s to present), the fundamental assumptions of the previous period have been replaced with approaches that may be seen to fit within a postmodernist view of education. Postmodernism itself may have no agreed upon definition (indeed, the very idea of such a thing is anti-postmodernism), however, there are some features of postmodernism that can be identified, such as tolerance, embracing of diversity, fusion of styles, and acceptance of ambiguity (Beck, 1993).

Postmodern views of education feature a less definite, more relative, view of what the outcomes of education might be. For example, postmodernists might accept the notion that there would be different outcomes for different children, and that this might be a positive change in education. *Learning* as a process of change, or inquiry, and one in which children can participate, or even lead, fits within the postmodern framework. The acceptance of the role of culture in determining 'facts' and the acceptance of relativism and importance of values have led to the development of new systems of criterion-based assessment, and assignments involving discovery, development, research and reflection, rather than recitation, presentation of facts, and replication of accepted knowledge. The new national curriculum now encompasses social and community values:

> Through their learning experiences, students will
> develop their ability to:
> express their own values;
> explore, with empathy, the values of others;
> critically analyse values and actions based on them;
> discuss disagreements that arise from
> differences in values and negotiate solutions;
> make ethical decisions and act on them. (Ministry of Education, 2007, p. 10)

Children are more apt to conduct experiments and to inquire into the nature of things rather than imitate and regurgitate a set of facts, and it is the learning of the processes of inquiry and experimentation that is emphasized, rather than derivation of a 'correct' answer. Teaching is seen as supporting the learning of diverse individuals, not delivering the same curriculum to all children. Inclusion of all children, regardless of ability or achievement, is viewed as an ideal aspect of the learning process for all children, and inclusion itself is seen as an outcome – the product of change. Acceptance of diversity is a hallmark of postmodernism, and so *inclusion* of children with learning differences can be seen to represent postmodern ideas, and is in contrast to the streaming of children by ability during the modern period.

New Zealand is, at present, perhaps mid-point in a period of reform that began in the mid-1980s. However, the idea of definite periods that can be precisely identified is certainly not postmodernist, and ideas and change seem to evolve naturally and gradually for the most part. It is only in hindsight that one might be able to identify precise periods. The national assessment system and the national curriculum are still undergoing major changes, and postmodern ideas about learning, achievement, assessment, curriculum, teaching, and inclusion are often and fiercely challenged. This indicates that the reforms are not yet embraced or totally accepted.

The most fundamental changes to the education system in New Zealand are those which affect children with learning differences, and these illuminate the reform of learning in New Zealand. These changes include provisions for (a) educating all children, including children with learning differences, within the state education system; (b) the inclusion of children with learning differences within state classrooms; (c) parent choice of educational provision for children with learning differences; (d) change from a deficit model of assessment of children with learning differences to an educational needs-based assessment; and (e) change from a uniform curriculum to an individualized curriculum. These changes are described in this chapter within the context of the introduction of major legislation affecting education in New Zealand.

1.2 Concepts About Children with Learning Differences

Children with learning differences are children with characteristics that significantly alter or impede their ability to experience learning in the way that other children do. These characteristics can include differences in the sensory experiences that contribute to learning – through visual, auditory, and kinesthetic channels, differences in sensory and motor planning and processing, information processing and cognition, and in memory, for example. Through most of the twentieth century, conditions that caused learning differences – such as blindness, deafness, cerebral palsy, and intellectual disability – were attributed to heredity or to diseases such as rubella. Some children might experience multiple learning differences and learning differences are identifiable along a continuum of severity, which can range from characteristics which have minor, or mild, impacts on learning experiences, to those which have major, or severe impacts on the child's learning. Learning differences may also have a temporal continuum, as some characteristics might be temporary while others might be ongoing throughout schooling.

In the latter half of the twentieth century, coinciding with postmodernism, research identified the increasing role of environmental (e.g., toxins, lack of health care) and psychosocial (e.g., abuse and neglect) contributions to the causes of learning differences, and, in particular, the contributions associated with poverty, which might include conditions associated with very low birth weight, maternal alcohol and/or drug use, maternal disease, and prenatal or post-natal trauma, environmental pollution, abuse, accident, and diseases such as meningitis (Atkinson & Hornby, 2002; Batshaw, 2002; Brookes-Gunn & Duncan, 1997). Overall, it has been identified that not only are the actual numbers of children with learning differences increasing as a result of increases in population, but the prevalence of children with learning differences is also increasing, perhaps due to environmental changes (Dolk, 2004; Murray & Lopez, 1997). The increase in numbers and recognition of the contributions of society to children's learning differences has provided an additional foundation to the changes in New Zealand.

2 Children's Learning Experiences Prior to the Education Act of 1989

Children with learning differences were not included in the earliest New Zealand schooling provisions in 1877. By 1920, however, there were state-supported residential institutions and charity organizations providing educational classes. The number, scope, and enrolments in the educational classes increased over the twentieth century. However, learning differences typically have defined the type of learning experiences in which children were permitted to engage in prior to 1985. Experiencing teaching and learning in a school setting is a defining characteristic and memory of childhood in New Zealand and in most Asia-Pacific countries. However, children with learning differences experienced exclusion or segregation.

The denial of the school experience was often one of the earliest or most painful experiences for parents. When parents were told of their child's characteristics, the prognosis was often referenced to the child's presupposed 'educability'. In one study, grandparents described how the diagnosis given by a medical specialist for their 2-year-old grandchild referred explicitly to education.

> [Wil] won't be normal, he won't be going to school. (Timutimu-Thorpe, 1994, p. 105)

Parents of a baby born with Down syndrome and a heart condition were told by a hospital Registrar:

> He'll be able to go to school – you can still send him off to school. (Lambert, 1994)

These statements underline the importance of schooling and concepts of educability to how a child, even as an infant, is categorized. Such concepts shape parental expectations of facilitating the learning of their child with learning differences, and these concepts, shared widely throughout a society, shape the attitudes and expectations of teachers and principals and others in the school community.

Expectations about learning and development naturally affect children's experiences of learning (Mentis, Quinn & Ryba, 2005). Learning experiences for children with learning differences in New Zealand have been shaped by a medical discourse of illness – which sees a child with a learning difference as having an incurable illness – a personal discourse of tragedy – which has devalued the life and experiences of such children as lifelong grieving by their parents – and by a psychological discourse of abnormality, which has focused on the deficit model of learning and development (Ballard, 1991; Neilson, 2005; Rietveld, 1994).

The illness and deficit models of learning differences dominated education prior to the reform period, and were used to justify exclusion of some children with learning differences from the learning and teaching experiences of typical children, including the experiences of learning in groups of children from their own neighbourhood, observational learning from typical children, and experiences of regular schools, such as assemblies, sports days, and school trips. Exclusion also denied typical children experiences of diversity.

Up until the late 1980s, some children with learning differences were considered to be unable to benefit from schooling in New Zealand, and they were often excluded entirely – particularly children identified as 'idiots' or 'imbeciles' (Mitchell & Mitchell, 1985). Some children with learning differences did attend schools, but these were residential schools. These children's experiences of learning involved being taken away from their parents and their siblings, and attending a school that was homogeneous in catering to only children with particular learning differences. Some children with learning differences were able to attend school while living at home with their families, particularly if they lived in larger cities. There were some special classes and special schools for children with characteristics affecting learning such as cerebral palsy, intellectual disability, and emotional problems affecting behaviour. However, these schooling experiences were not those experienced by children regarded as typical learners. Their experience of education was limited to attending special classes or special schools with other children also identified with learning differences.

When children with a learning difference did attend school, their learning experiences were of a different nature to those of children regarded as typical learners. Assessment and teaching were based on one-to-one interactions with a specially trained teacher using particular techniques that were substantively different to the group-oriented instruction and assessment delivered in typical classrooms. Children with learning differences might experience unstructured learning 'activities' or 'sensory experiences' rather than systematic teaching to skills and content identified in the national curriculum (cf., Mitchell & Singh, 1987; Ballard, 1991). Opportunities for academic and social interaction with typical learners were minimized, and the children often did not share play times, lunch, or other school activities with typically learning children. Even within 'integrated settings', learning experiences were segregated. Parents had little or no say in the decisions made about their child's education, and children were segregated or excluded without parent permission, and parents did not have choices about schooling or curriculum.

3 Education Act of 1989

The Education Act of 1989 was influenced by three important reviews conducted in the 1980s. In 1984, the Ministry of Education undertook a review of the national curriculum, which, although it did not purposely invite review of special education provisions, received more than 21,000 submissions including a substantial input around the need for inclusion of children with special needs in the curriculum (O'Brien & Ryba, 2005). In 1987, a 1982 survey of special education services by Panckhurst, Panckhurst, and Elkins, was published. This report incorporated detailed responses from 72 individuals invited to participate in the survey from throughout the education and voluntary sectors. This report considered the provision of education of all children, the integration of children in state schools, parental involvement, and changes to the curriculum and teaching of children with learning differences (Panckhurst, Panckhurst & Elkins, 1987). The Panckhurst,

Panckhurst and Elkins Review was very compelling in its presentation and in its careful examination of issues about integration and assessment of children. Also in 1987, a review of special education conducted by the Ministry of Education (1987) was published in draft form. Based on contributions from hundreds of teachers, parents, and professionals, this report advocated a move towards inclusion, in particular, for children with intellectual disabilities. Public criticism about cost provisions and that the provisions extended segregated schooling followed and the review was not formally adopted as policy (O'Brien & Ryba, 2005); however, its fundamental provisions were later adopted in *SE 2000*.

The principle ideas of equal rights to education for all children, and an overall reform of school governance were incorporated in the Education Act of 1989. The Education Act introduced the policy called 'Tomorrow's Schools', and incorporated values of parent choice (parents could choose the school to which to send their child, and enrolment boundaries were disestablished) and also decentralized schooling. School governance was transformed from a centralized, professional-led management structure to a decentralized, parent–professional partnership model. Each school became much more self-managing, with a Board of Trustees comprised of parents and community members to provide more local control of schools and to support parent choice.

The *Tomorrow's Schools* legislation did not specifically reform special education, but its provisions were essential to later changes. The Board of Trustees model established the parent–professional partnerships in school governance, which were essential for the later development of parent choice and local control of supplemental funding for the education of children with learning differences. It established the Special Education Service to 'provide advice, guidance and support for the benefit of people under 21 with difficulties in learning and development', which supported teachers and schools in the mainstream to open their schools and classrooms to children with learning differences and, by stating that all children have the same right to enrol in any state school, it introduced inclusion as a possibility within the education system.

4 Special Education 2000

The reviews of education during the 1980s by the Ministry of Education (1984; 1987 and, Panckhurst, Panckhurst & Elkins, 1987) provided the basis for the changes in special education. Beginning in 1991, the Ministry announced the intent to reform special education policy to fit within the *Tomorrow's Schools* philosophy as embedded in the Education Act of 1989. The Human Rights Act of 1993 provided another basis for inclusion by legally ending discrimination based on gender, ethnicity, and disability. The *Special Education in New Zealand: Statement of Intent* (Ministry of Education, 1991) provided a preliminary announcement of the decentralization of special education, and also signalled an extended 5-year period of consultation to develop an intensive reform policy.

The challenge of *SE 2000* was to implement the reforms to the education of children with learning differences. The development of *SE 2000* policy was informed by three 'themes':

> The delivery of provisions and resourcing for students with special education needs (including a shift in values toward greater equity for all);
>
> The trend to include all students which has resulted from changes in theoretical understandings of the processes involved in learning; and
>
> The effect of school choice policies. (Davies, 1998, p. 3)

During the period 1991–1996, the Ministry embarked on several rounds of consultations, informed by public submissions, and regional and local meetings and discussions. These meetings affirmed the move toward inclusion of children with learning differences, and also provided information on the nature and types of services needed to support children's learning in schools. The value of parental input into children's education and the need for flexible, individualized curriculum was also a central theme. Finally, the practical aspects of resourcing and costs were debated. When the first policy documents were released in draft form, the main themes of the Education Act of 1989 were affirmed.

The grand aim of the Special Education 2000 (*SE 2000*) reforms was

> to achieve, over the next decade, a world class inclusive education system that provides learning opportunities of equal quality to all students. (Ministry of Education, 1996)

The reforms addressed eligibility, educational provision, and parent choice, coordination of special education and resource allocation and were designed to promote the achievement of inclusion. *SE 2000* challenged traditional arrangements for learning and established a bold new approach for special education. The adoption of inclusion as a national goal for special education changed not only regulations and requirements, but everyday aspects of teaching and learning as well.

4.1 Elimination of a Deficits-Based Model

Eligibility for special education was transformed from a model based on medical diagnoses (e.g., blindness, cerebral palsy, Down syndrome) and/or psychological deficit models (e.g., intellectual disability as recorded by IQ) to a model based on identification of the child's learning in terms of the educational supports needed to access the same curriculum as other students. This was designed to promote inclusion by removing stigmatizing labels from children and by directing attention towards positive concepts of the child's learning experiences.

SE 2000 set out to replace a traditional medically oriented deficit-based model of children with learning differences with an educationally oriented needs-based model. This model was to be operationalized in the ways that students were identified, assessed, and accessed special education resources, and in identifying the types of resources that were available and which type of provision would be resourced. To this end, eligibility was redefined for children requiring ongoing support to access or learn within the national curriculum structure, and assessment for eligibility purposes was changed from one of identifying a child's disability to one identifying the child's need for support to learn. Needs were identified as very high, high, or moderate levels of need for support to access the curriculum. Children with very high, and high needs (conceptualized to apply to 1% of the children attending school) were eligible for support by specialist staff, therapists, teacher aides, and other forms of resourcing – which would be supplied to the school chosen by the parent. A very high level of need might involve the need for an education support worker during instruction, while a moderate level of need might be met through a special series of individualized instruction to promote literacy. Resources for moderate needs to access the curriculum, for 4% of the children, were provided directly to each school based on the number of children enrolled, along with specialist teachers to support children's learning and behaviour, and did not require a centralized assessment process to determine eligibility. It was up to each school to determine eligibility for these resources.

This model is a challenge to an expert-specialist model of the pre-reform period, in which a medical or biological model of deficit learning is seen to require an expert to assess and design instruction, and even to deliver teaching (Davies, 2000). In the postmodern construction of education, diversity is welcomed and anticipated, and every teacher has, or should have, skills to assess and teach all children in terms of their educational needs, with appropriate levels of resourcing and support (Alton-Lee, 2003; Alton-Lee et al., 2000; Moore et al., 1998).

The identification of children according to a deficit model of assessment by specialists, such as paediatricians and clinical psychologists, was no longer required to show that the child was eligible for services, as neurological examinations or individual intelligence tests were not related to the eligibility criteria for high or very high needs. Instead, teachers and schools were to provide descriptions of the child's performances in each of the curriculum areas if they thought the child needed high levels of support in learning. The applications would be reviewed centrally, but not by specialists in disability or by clinical psychologists. The new model of assessments was to focus exclusively on the educational support needs of the child, and was to be conducted by their teachers with input from the parents. This model began the process of changing the way that children with learning differences are 'seen' within the educational system.

In practice, teachers and schools needed to show that a child required one or more of the following:

> total adaptation of all curriculum content;
> special assistance to engage in all face-to-face communications;
> specialist one-to-one intervention at least weekly or specialist monitoring at least once a month, together with daily special education support provided by others … to assist with any or all of: personal care; mobility/positioning/transfers; [and/or] needs arising from severe disorder of both language use and appropriate social communication. (Ministry of Education, 1998, p. 3)

A central process was used to review applications for support and to verify that the child required high levels of support, to ensure equitable provision throughout the country.

4.2 Resources Followed the Child to School

Special education management was to be transformed from a centralized, professional-led management structure to a decentralized, community-based parent–professional partnership model, focusing on school management of resources to support learning. Schools would not be funded as entitlements, but would receive funding only depending on their enrolments, as was the case for typical children. The allocation of the funds to support learning was to be determined by a committee of parents from the school governance Board of Trustees, the principal, and the parent and teacher of the child with learning differences. Resources and funding to support children with high learning needs were to be assigned to the school attended by the child to be individually managed locally under a complex system (Ministry of Education, 1996; Mitchell, 1999). This approach challenges the model of centralized special education and was designed to support the inclusion of children by ensuring that there were sufficient resources to support the child's needs at the school selected by the parent. The way the funds were to be spent was to be determined locally, by the school and parents in partnership with local special education professionals (Mitchell, 1999).

4.3 Education in Inclusive Settings

Educational provision was to be transformed from a model based on exclusion from the educational settings accessed by children without special education needs and/or segregation of children with special education needs in separate schools, units, and classes to a model based on inclusion of all children into typical classroom settings. Parents would be able to choose the school that their children would attend – just as they were able to do for children without learning differences.

SE 2000 called for the development of a 'world-class' inclusive education system, with children with high ongoing needs receiving educational supports to access the national curriculum in typical classrooms. This challenges the tradition of special units and specially trained personnel as the best practice for special education provision, and challenges traditional assumptions about classroom groupings, curriculum, and assessment and individual-education programmes. It also radically changes the child's experiences of learning environments by providing him or her access to the same types of schooling experiences as other children – their siblings, their neighbours, and the children in their community. This change was also designed to address inequities in access – many children had not been able to access special classes and special schools because they were only available in certain locations. Thus, children in small towns or rural areas were less likely to be able to access special schools. The government decided that to improve access to services, all state schools would be resourced to provide services for children with special needs (Varnham, 2002, p. 289). This changed resourcing from special schools to all schools, effectively disestablishing entitlement funding for special schools (Varnham, 2002). Entitlement was replaced with the provision that funding would follow parent choice.

5 Problems in Practice

The broad scope and radical changes of the reforms presented challenges and concerns, and these were evident in a number of ways during the 5 years immediately following the phased introduction of *SE 2000* provisions. The first evaluation of *SE 2000* was commissioned by the Ministry of Education, and conducted nationally through Massey University under the leadership of Roseanne Bourke. It involved interviews and analysis over a 3-year period, at sites across the country, and at each level of resourcing and service provision. The Ministry regarded this as a formative evaluation process, and worked closely with researchers to understand the implications of the evaluative information.(Bourke et al., 1999, 2001, 2002). There were additional concerns raised about the need for an evaluation seen as more independent and a separate evaluation was commissioned by the Minister of Education (Wylie, 2000). Wylie interviewed principals and Boards of Trustees at 78 schools around the country, held 7 public meetings for parents at the main cities, received more than 300 written submissions from parents and teachers, met with more than 100 organizations, reviewed all policy documents and the Bourke and colleagues research (Wylie, 2000). Also during this early period following the introduction of *SE 2000*, a submission regarding difficulties and issues in *SE 2000* was made by NZEI Te Riu Roa, an organization representing some 35,500 teachers, support staff, and specialists (2000). Finally, a High Court judgment in favour of the rights of parents to access equal education in separate settings (Varnham, 2002) also identified the breadth of the problems associated with the reforms (Mitchell, 2005). *Attorney General v. Daniels* also found that the Minister of Education had acted unlawfully when he disestablished special classes and separate schools (Varnham, 2002).

The pattern of enrolments in special schools reflects some of the difficulties experienced. Between 1985 and 2005, the number of special schools declined by almost 50%, from 85 (1985) to 64 (1990), 56 (1994) and 48 (1998) (Data Management & Analysis Division, 1995, 2004, 2005). The first noticeable drop came with the announcement of the Education Act of 1989 that all children were eligible to attend any state school and the second with the phase in of the *SE 2000* policy. The reduction in the number of special schools seems to support the move towards inclusion. However, the information regarding the percentage of children attending special schools shows a slightly different picture: this was 0.32% in 1989, 0.27% in 1998, and 0.35% in 2004, and 0.36% in 2005 (Data Management & Analysis Division, 1990, 1991, 2005). The number of special schools has not continued to drop, and the enrolment in special schools has increased very slightly. The reasons for this are relatively straightforward on the surface, and are a reflection of some of the fundamental problems with the reform.

Problems arose when inclusion clashed with parent choice. The assumption embedded in *SE 2000* was that all parents, when given the choice, will opt for placing their child with learning differences in a typical classroom, and that schools, given resourcing and the legal basis for inclusion, would welcome them. But this assumption was problematic. In apparently many instances as the policy was first implemented, parents who approached their local school (their choice), found that the school rejected the child. Cassie (1998) reports Colleen Brown, the mother of a child with Down syndrome, an advocate and coordinator over the period of reform, as saying

> parents may be forced to take legal action amidst reports that 23 intellectually handicapped children had been refused enrolment at their local state school. She said schools blocking mainstreaming blamed a lack of resources when the real problem was often attitude. 'Every time I analyse what has gone wrong it seems to me it is the school leadership which doesn't see [mainstreaming] as part of their plan and have a set belief about children with special needs.' (p. 11)

Wartman (2000) described the stress of a parent trying to find and work with a school for her child. The school used resource decisions to limit the child's access to educational experiences:

> It's been dreadful, very stressful. Decisions to make. Things like: what days will my child be able to go to school, how many teacher aide hours will he get, who will the teacher aide be? There are lots of decisions, a lot of talking and a lot of heartaches. (Wartman, 2000, p. 11)

The presumption here is that a child with high needs will not be able to attend school every day, because the resourcing did not cover a full day's attendance. The school itself did not take any responsibility for working alongside the parent to identify solutions and alternatives to support parent-choice. IHC (2003), a long-standing non-profit organization for the support of families with children with intellectual difficulties, described the dilemma another parent encountered:

> A school in Christchurch is proudly setting up a programme for gifted children, but hasn't got the resources to cater for a child with an intellectual disability. The child has spent 18 months going to school part time – when the school receives over 20 hours teacher aide time and a.10 teacher *[NB: through SE 2000 funding specifically for that child*]. The child achieves goals set in the IEP (thanks to the classroom teacher) but the special needs coordinator says the school can't meet the child's needs and suggests to the parent that they try somewhere else. An IHC advocate recently supported the mother at an IEP meeting and the principal has since stopped talking to the mum.
>
> The principal has told the mother that everyone calls it mainstreaming but he calls it maindumping – without realising that it is up to him to ensure the child has a positive experience at school.
>
> What does the parent do? Does she continue to put her child in the front line in this battle? Does she quietly withdraw her child and send him to a special school where of course he can go all day, and of course there is no quibble about resources? Does she leave the local school to cater for the gifted and clever? (IHC, 2003, p. 1)

The attitude of the principal described in the preceding quotation reflected the attitudes of many interviewed as part of the evaluation conducted by Bourke et al. (1999, 2001, 2002), and the report highlights the dilemma facing parents. Bogard (1994) explained the difficulties a parent experienced when trying to have her daughter included:

> [A]ge five came and went. I cried for her that birthday. All my friends with five year olds were proudly telling me about their child's first days at school. I hassled and negotiated and eventually got permission to send Sallie to the newly established satellite unit at Miramar Central School. … First she was isolated with the other children with intellectual disabilities … but later she joined a [junior class] and spent almost all her day with those very ordinary friendly kids in an ordinary classroom. Her day was shorter though, and she was still regarded as part of the unit – one of those 'handicaps'. (Bogard, 1994, p. 60)

These personal reports were borne out by the data reported from the review commissioned by the Ministry of Education under the leadership of Roseanne Bourke (Bourke et al., 1999, 2001, 2002) which found 70% of parents felt they had not been well informed of the changes. In terms of their child's experiences, 48% were disappointed and 46% were cautious about the policy and the majority of respondents reported no improvement in their involvement in educational decision-making (Bourke et al., 1999, p. 178). These results were confirmed by the more independent Wylie report (Wylie, 2000). In particular, parents of children with physical and sensory learning differences felt that their children had been disadvantaged by the changes to policy, specifically the disestablishment of some special schools and classes.

> What is happening, as in my daughter's case is many schools have been forced to close special needs units and 'dump' these kids in the mainstream or inclusion as they like to call it. … Parents like myself feel frustrated and powerless in the new system. (Wylie, 2000, p. 22)

Schools have had the apparent choice to reject children from their school if they are prepared to state that the school is unable to meet their needs. Despite the fact that this is against the Human Rights Act and *SE 2000*, there is no penalty for doing so (Ministry of Education, 2005c). One principal said:

> I have said they (parents) would have to wait until certain provisions were made – and the parent never returned. (Bourke et al., 2002, p. 239)

And a parent said:

> One principal said we will do everything we can to encourage you to go elsewhere. (Bourke et al., 2002, p. 239)

IHC (2003) reported the reasons given by schools for rejecting children with learning differences:

> Over the years the complaints of schools who view children with disabilities as someone else's problem have a very familiar ring: they blame lack of resources, they blame their lack of expertise (we think your child would better off somewhere else), they blame lack of teacher aide hours. … They blame everyone else for their inability to recognise the right of a child to attend their school. (IHC, 2003)

Schools also reported suspending hundreds of students with special education needs because of their failure to conform to school standards of behaviour or compliance: the percentage of suspended students receiving special education support rose throughout the three phases of the evaluation from 22% to 30% (Bourke et al., 2002, pp. 40–41).

This can indicate a growing intolerance for learning differences, or a frustration at the lack of support.

The reactions of teachers to the placement of children with Down syndrome into their classrooms were similar to the reactions reported by Bogard (1994):

> [I]t will take a lot more expertise [then we have] to realise where the deficiencies are and specialised training to remedy that.
>
> My first question is, 'Am I doing sufficient for the children – the rest of the children in the class? Those we're primarily here for … I mean it's not a special needs school.
>
> I see him moving further and further into a complete special class arrangement because I know its tough on the mainstreamed teacher when for a starter, {name of child with Down syndrome} doesn't communicate. (Bogard, 1994, p. 32)

Many parents ended up feeling that separate schools were the best learning environments for their children in the face of reactions and experiences such as these, or fear of such experiences, or because they felt that the separate school environment was more suited to their child. As reported by Cassie (1998), a mother of a boy with learning differences chose a separate special school from the start of his schooling:

> It's hard when your kid can't communicate and can't come home and say 'mum someone's beaten me up'. She says parents have to rely on gut instinct as to what is best for their child and hers was that the special school environment was right and would teach him life and work skills needed for his adult life. (Cassie, 1998)

Wylie (2000) reported comments of parents who valued the option of special schooling:

> Special Education 2000? Mainstreaming your child. The theory is good, the practice is where you run into trouble. It all hinges on the attitude of the Principal … as to how accessible the school is. (Wylie, 2000, p. 22)
>
> My son is not ready for mainstream education yet. I feel the unit style education is the best option for my son at present. I would hope that as he gained the necessary skills to cope in mainstream we would ease him into it, but in reality that isn't possible yet. As a parent I find it so stressful never knowing if this option will be available for us from year to year. It is hard enough on families to cope with the hardships the disorders bring about in daily life and the uncertainty at school is an added burden. (Wylie, 2000, p. 22)
>
> Because of his disability he isn't able to access the curriculum like the other children – unless he gets the one to one support as needed … It all comes back to the poor teacher in the classroom who has to control and teach 23 new entrants as well as give extra attention and time to *A [name of a pupil]* plus 2 more special needs children in the same class. We see that this is just not possible and feel the whole system is letting us down. We have been utterly frustrated and considered taking A out of school to teach him at home. However, *A* being one of 4 children and with work at home I'm not able to do this. (Wylie, 2000, p. 22)

Schools identified inclusion as the priority in *SE 2000* and cost cutting as the second (hidden) goal and claimed that 'insufficient funds or inaccessibility of service' hindered implementation of the policy (Bourke et al., 1999, p. 2). According to the evaluations by Bourke and colleagues (1999, 2001, 2002) and Wylie (2000), schools and parents were frustrated and confused by the criteria used to determine eligibility for resources for children with very high and high needs, the lack of resourcing for children with moderate needs or high personal health needs, the changes in resourcing, the processes of obtaining resourcing, the options for provision, and virtually every aspect of the policy. Many principals and teachers felt that the workload and paperwork requirements for eligibility and resourcing were excessive. Some principals reported that they had refused to enrol students with special needs, while other principals indicated that their schools were not appropriate for enrolment of children with special needs because of issues related to resources, staff preparedness, and feeling that the child's needs would be better catered for elsewhere (Bourke et al., 2002, p. 238). Davies (2000) reported that 25% of the school principals had admitted denying enrolment to a child because of their learning needs.

When schools were asked if students 'were getting a better deal now than before *SE 2000*', the majority of schools declined to answer the question or said 'don't know' (Bourke et al., 2002, p. 42). Bourke and colleagues reported that the percentage of schools in the evaluation reporting that they were satisfied or very satisfied with the policy increased from 32.6% to 44% over the period of the evaluation, averaged across the various elements of the policy (2002, p. 45). However, it is clear that by 2001, more than half of the schools were still not satisfied with *SE 2000*.

5.1 Missing Out on Professional Development to Support Inclusion

Inclusion is a value- and rights-driven change process, rather than a simple 'outcome'. It is a process of change, from exclusion to inclusion, and is based on developing an attitude of 'welcoming', and it was this attitudinal change that could not simply be mandated (O'Brien, et al., 1989). Schools and teachers may have had difficulties including children with learning differences because many did not receive professional development which was adequate to support inclusion – they felt unready to welcome a child with learning differences.

Initially, inclusion was seen as an outcome or a goal that could be identified by identifying the number of inclusive schools or by counting the number of children in inclusive settings and could be achieved by simply mandating and resourcing it (Davis, 2000; Ministry of Education, 1995). Policy-makers and advocates felt that the struggle was over with the passage of the Education Act in 1989 and the implementation of *SE 2000*. They had not considered that the attitudes of significant numbers of teachers, principals, and other educational professionals about children with learning differences were essential for inclusion to be successfully implemented and which were necessary for all schools to become welcoming (Wylie, 2000; Davies, 2000).

The difficulties reported by parents, teachers, and schools can be understood by recognition of the importance of professional training for successful inclusion (Biklen, 1992).

Principals in New Zealand schools are not required to complete any specialized training before becoming principals, nor are they required to participate in ongoing professional development. Similarly, teachers are not required to participate in ongoing professional development in order to retain their teaching registration. No requirement exists that teacher training include preparation in inclusion or strategies to support the learning or behaviour of children with learning differences in the mainstream. The first degree-level course in a university on inclusion was offered at the University of Canterbury in 1992, and an introduction to inclusion was not made a requirement until 1999, and then apparently at only one teacher-training institution (Christchurch College of Education).

Although some in-service training was initially supplied to schools, the evaluations showed that 25% of teachers surveyed in 743 schools (of the more than 2,600 primary and secondary schools in New Zealand) felt they did not have adequate training to support children with learning differences in their classrooms. In many cases, the training teachers did receive was only about the policy requirements, and did not provide support to help teachers welcome and teach children with learning differences.

> By June 2000, 20% of classroom teachers had not received professional development training in *SE 2000*. Of the 80% who did receive training, 37% received only an overview of the policy. Of those who received more training, 40% of respondents indicated no change in their capacity to cater for learners with special needs. (Bourke et al., 2002, pp. 160; 237)

Deep-seated attitudes about children with learning differences were not addressed by training that focused on information about policy, regulations, and requirements for accessing resources. However, of the 29% who did have training, many felt that training helped make a positive experience of the *SE 2000* policy. Of those who did receive training during subsequent years following the reforms, more than half reported an improvement in their attitude toward children with special needs (Bourke et al., 2002).

Why is the lack of professional development so critical? Because teachers who gave reasons for the exclusion of children did not suggest that schools might change, and principals who denied children access to schools did not suggest that the schools should change, only that the policy was wrong (Rietveld, 1994; Bourke et al., 1999, 2001, 2002; Wylie, 2000). The reasons provided by teachers and schools for excluding children are typical reasons given by individuals who are likely to hold deep-seated prejudices which justify exclusion, and such attitudes are resistant to change (Liberty & Haring, 1995) and are similar at a foundational level to prejudice against individuals based on their ethnicity or gender. The first statements are justifications based on the comparisons of (e.g., ‘You can’t expect children like these to learn like normal children’), dehumanization (‘She doesn’t really notice what’s going on around her’), to condescension (‘She has a mental age of 4 months’) and the use of euphemisms that mask or misrepresent exclusion (e.g., saying ‘The *special class* is right for her’, rather than ‘the *excluded class*’ is right for her and the *included class* is right for these other children). The statements of double standards by teachers and principals recorded in the evaluations and research illustrate the persistence of exclusionary prejudice and thus the failure of professional development to address the beliefs and skills of some of the teachers and principals in regular schools. The training of teachers to support inclusion needs to address attitudes that are barriers to inclusion (Thomson et al., 2003).

6 Adjusting *SE 2000*

The government accepted the findings of the evaluations by Bourke and colleagues (1999, 2001, 2002), Wylie (2000), and the High Court (Varnham, 2002) and restructured the delivery of special education in 2002. Changes included additional resources for children with learning differences whose parents and teachers identified that a level of support was needed between moderate and high, as well as changes in the types of resources and their availability to all children with learning differences. The Ministry of Education also embarked on an intensive period of information gathering to 'facilitate a more collaborative approach to special education, and to local service planning and provision'. A series of public consultation meetings were held around the country, which involved more than 5,000 participants, and reports were commissioned from all local districts to identify the status of educational provision for children with learning differences (Ministry of Education, 2003, 2005b). The aim of the consultation was to establish a more responsive, collaborative relationship with stakeholders, a relationship that was more welcoming of parent, teacher, and school input – and therefore more inclusive. The language used in the consultation meetings was modified from the language of the original *SE 2000* policy. The language of inclusive education was moderated to take account of the values and attitudes of those who felt that special schools and classes were a better educational environment for their child. In addition, as a result of the consultation, more resources were provided for schools to cater for children with learning differences alongside children with typical needs in regular schools. The changes are described by the Ministry as:

> The *SE 2000* policy was based on an international move toward inclusion of all children with special education needs in local educational settings. This approach involves a shift away from a biological categorisation of children with special education needs to an ecological paradigm. This later model focuses on identifying what a child needs to assist him or her to participate in and achieve in education. It has a stronger focus on how the social and physical environment can be adapted to support learning across all domains. The policy is about supporting a child *regardless of context* to maximise their learning. Resourcing decisions are based on a child or young person's learning needs rather than a diagnosis or category of disability. (Ministry of Education, 2005c, p. 13; emphasis added)

The statement above identifies the change in policy from supporting the child with learning differences in inclusive settings to supporting the child regardless of where the child is educated, and recognizes the rights of parents to choose a special school or segregated special unit as best suited to their child's learning needs.

An adjustment to *SE 2000* policy and resourcing also re-established special classes and units – and the percentage of children enrolled in special schools has increased slightly. Additional initiatives have involved working together with schools that had the highest rates of suspension and expulsion to find strategies to reduce suspension and to provide better educational environments for students, an initiative to provide social workers in schools to assist teachers and schools in liaising with families and social services; provision of funding for special school-initiated innovations; and increased funding for children with learning differences associated with mental health needs (Ministry of Education, 2005c).

The Ministry has also adopted an approach that recognizes the need to build capacity in schools for catering to children with learning differences. The Ministry is now providing professional development to teachers and principals by identifying practical strategies teachers can use in schools through literature reviews synthesizing the best research evidence and by funding research into how best to support teachers in inclusive schools. A number of steps have been taken to improve access to professional development and pre-service training in teaching and supporting children with learning differences. One aspect of the policy was not changed, and that was the abandonment of the biological deficit/medical model of labelling children with learning disabilities, and in this step, New Zealand's reforms have exceeded those of the USA, which is still tied to such a model (National Center for Education Statistics, 2006).

The theme of the new stage in *SE 2000* is collaboration and working together. This change represents a valuation of parent choice – and recognition that parents must be valued as knowledgeable about the best learning situation for their child. It also represents an acknowledgement that inclusion is a process that involves welcoming – and until all children are welcomed at every school, parents have a right to choose a school that does welcome their children. By working together, and accepting teacher, school, and parent needs, the Ministry of Education is actually modelling an inclusive approach that is welcoming of differences in the wider educational community.

7 Inclusion Since 2000

Progress in the inclusion of children with learning differences in typical schools can be seen in (a) the stabilization of enrolments in special schools, (b) the development of satellite classes from special schools to regular schools, (c) the education of 62% of children with the highest needs in typical classes, and (d) the increase in the number of schools enrolling children with the highest levels of need for educational support.

7.1 Special Schools and Satellite Classes

Although enrolments in special schools have increased slightly, as discussed in the previous section of this chapter, the increase does not necessarily relate solely to a failure of inclusion for several reasons. First, many regions do not have any special schools (special schools are mostly in the most populated cities and regions) so the increase is mainly in these large urban settings where transportation and other issues affect parent choice. Second, almost all special schools manage satellite classes at typical schools (cf., Ministry of Education, 2004a, b, c). Although enrolled in special schools, children may attend a special satellite class located at a typical school and are able to participate in a range of activities involving interactions with typical children – from social interactions during lunchtime to participating part-time in regular classes. Although far from the 'total inclusion' model, the process of gradual change being evoked through the process of satellite classes may be regarded as a more practical approach to achieving a truly welcoming school, because it provides for teachers, parents, and schools to move at a sustainable pace of change.

7.2 Inclusion of Children with High Needs

A more comprehensive picture of the actual success of inclusion, despite the difficulties and the problems for many individual children and families, may be identified. At the end of the 2004 school year, there were 1,795 very high needs students receiving ongoing resourcing support and 5,157 high needs students (Ministry of Education, 2005c). Thus, there were an identified 6,952 (about 1%) children with the highest level of needs for educational support out of the total school population of 733, 432 attending state primary, secondary, and special schools. However, there were only 2,672 total enrolments in the 47 special schools (Data Management & Analysis Division, 2005). Thus, it appears that 4,280 (62%) of children with the highest levels of learning differences were being educated in typical schools in New Zealand.

The number of schools enrolling children identified as having high or very high needs is increasing. In the 3 years of the evaluation studies the percentage of study schools reporting funding for high and very high needs students increased from 35% in 1999 to 59% in 2001 (Bourke et al., 2002, p. 41). A survey by the New Zealand Principals Federation found that 83% of schools reported at least one child with high or very high needs, and that 64% had between 1–3 children (NZPF, 2003). Thus the number of schools accepting children with high learning needs may have increased from about 39% in 1998 to perhaps 83% of schools in 2003 – truly a change towards an inclusive education system. Finally, it is important to note that the percentage of all children in special schools in New Zealand is 0.36%, far lower than the 3.9% in the USA (National Center for Education Statistics, 2006).

The more consultative model, adopted in 2002, which has incorporated parent choice and provided a wider range of services, as well as increased support for inclusion, has also brought about changes in attitude. Parents and teachers are reporting successful inclusion experiences:

> Overwhelmingly though, many commentators viewed the need for inclusion in the mainstream positively, with the provision that inclusion was supported through adequate funding and resourcing. … When everything came together in a setting, success and joy resulted. (Ministry of Education, 2004b, p. 40)

> Inclusion with fantastic support at an early childhood centre is working well. (Ministry of Education, 2004b, p. 40)

> Enrolling him in a normal school is working well. The awareness level and interest shown by the school and Special Educator at school is amazing. His Teacher and Teacher aide are very understanding and ready to help our son to be come independent. His classmates are wonderful. (Ministry of Education, 2004b, p. 40)

Increasing the number of successful inclusive education experiences and the options available to parents can build a system in which everyone can feel welcome. Additional issues will inevitably need to be addressed, in particular identifying the best system for identification and support of all children. Re-labelling children with disabilities as children with special learning needs (sometimes to children with special needs), still contains the implication that needs are in the child and obscures the meaning that the needs are in the teaching transaction (Wylie, 2002). *All* children have the *same* 'irreducible' needs (Brazelton & Greenspan, 2000). It is the schooling system that has needs to learn and adopt strategies that will enable all children to become competent learners (Alton-Lee, 2003). The system will not be inclusive until each classroom and school is identified as having appropriate support to engage all children in learning, and this support will be attitudinal as well as financial, and involve children, parents, and educators.

7.3 Implications for Reforming Learning in the Asia-Pacific Region

UNESCO has estimated that 10 million primary-school-aged children are excluded from schools in the East Asia-Pacific region and 42 million in South Asia, with India alone having 27 million primary-aged children not in school (UNESCO Institute for Statistics, 2005, p. 18). The World Bank has identified that 'disability may be the single most important factor excluding children from schooling' (World Bank, 2003, p. 2). In Japan, whilst a high number of children are in school, children with disabilities are educated almost exclusively in special schools (OECD, 2006), and, similarly Australia, where there were 397 special schools in 2005, up from 369 in 2000 (Schools, Australian Bureau of Statistics, 2000, 2006). Disability also impacts on the economy of countries, with an estimated loss of up to $192 billion in low-income countries (World Bank, 2003). An estimated 40 million children with disabilities are excluded from school, and disability appears to be one of the most common reasons given for excluding children from school (Peters, 2004).

Education For All (EFA) is an initiative of UNESCO, UNICEF, the World Bank and UNDP, which has the objective of increasing the absolute number of children who begin primary school and are retained in the education system through at least year 6. A monitoring system has been established, and countries are beginning to report and consider their education system (Assessment, Information Systems, Monitoring and Statistics Unit, 2005). Inclusive education has been identified as the single most relevant model by which countries can improve their education system (Assessment, Information Systems, Monitoring and Statistics Unit, 2005; Peters, 2004). Fourteen countries from the sub-region are regularly invited to participate in the annual meeting of the National EFA Coordinators. These are Cambodia, China, Indonesia, Japan, Lao PDR, Republic of Korea, DPR Korea, Malaysia, Mongolia, Myanmar, Philippines, Thailand, Timor-Leste, and Viet Nam. UNESCO also organized the first Pacific Workshop on Inclusive Education in conjunction with the regional meeting of EFA coordinators. One of the recommendations from the meeting was 'the need to review legislation to enforce inclusive education in the Asia-Pacific region'. Peters (2004) has identified issues that are central to achieving the objectives of Education for All. The first issue is decentralization, so that education policies are sensitive to local contexts, within a central government policy for inclusion. The second issue is the way in which resources are allocated so that there is a unified system for the delivery of education. In both of these critical areas, New Zealand's reforms have established a process by which inclusion can be introduced and participation increased through a process of decentralization of decision-making and contextualized local control of resources while respecting parent choice and the changes in attitude that are required to achieve full inclusion. In some countries, excluded children are also girls, minorities, and refugees (Assessment, Information Systems, Monitoring and Statistics Unit, 2005). Processes for establishing inclusive systems as introduced in New Zealand can be applied to all children who are excluded, not only children with learning differences, and the lessons learned in New Zealand can be useful in informing policy and progress in the Asia-Pacific Region.

The *International Convention on the Rights of Persons with Disabilities* was passed unanimously in the General Assembly of the United Nations, 13 December 2006 and will be open for signatures from UN countries from March 2007 (Adams-Spink, 2006). The declaration calls for inclusive education, and calls on signatories to ensure that:

(a) Persons with disabilities are not excluded from the general education system on the basis of disability, and that children with disabilities are not excluded from free and compulsory primary education, or from secondary education, on the basis of disability;
(b) Persons with disabilities can access an inclusive, quality and free primary education and secondary education on an equal basis with others in the communities in which they live;
(c) Reasonable accommodation of the individual's requirements is provided;
(d) Persons with disabilities receive the support required, within the general education system, to facilitate their effective education;
(e) Effective individualized support measures are provided in environments that maximize academic and social development, consistent with the goal of full inclusion.

The reform of learning for children with learning differences in New Zealand can provide a helpful model for the development of inclusive education in other Asia-Pacific countries. Issues of teaching and learning are critical when considering reforming learning for children with learning differences in the Asia-Pacific region. Successful inclusion requires a process that dismantles misconceptions about children with learning differences and supports the construction of positive inclusive conceptions, which can only happen gradually, on a one-to-one basis. Successful inclusion, beginning with acknowledgement of the need for new values, and proceeding one step at a time, will gradually transform schools to inclusive settings in a change process (Biklen, 1992; Liberty & Haring, 1995; Mentis, Quinn & Ryba, 2005). Leadership in the Asia-Pacific region can scaffold and support change, rather than simply mandating and resourcing it, and thus provide a model which transforms inclusive education from an outcome to a process in which everyone is welcome to engage and help to build communities with tolerance and understanding of diversity.

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Technology-Supported Pedagogical Innovations: The Challenge of Sustainability and Transferability in the Information Age

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Abstract Innovation has become an increasingly important theme in education. After the Sputnik I launch in 1957, there has been a mushrooming of systematic education reforms in many countries around the world, resulting in some cases deep changes in the curriculum, the pedagogical activities as well as the roles of teachers and learners that made significant use of information and communication technology. A major challenge in education is how to sustain and scale up innovations. Do technology-supported pedagogical innovations pose similar or different challenges to the problems of sustainability or transferability? This chapter draws on the case studies of innovative pedagogical practices using technology collected in the Second Information Technology in Education Study Module 2 (SITES M2) to explore this question. In particular, it examines the relationship, if any, between the extent of pedagogical innovation and scalability (i.e. sustainability and transferability), as well as contextual and policy impacts on scalability.

1 Introduction

A common underlying theme in education in the contemporary era is the need for change at all levels of education to prepare citizens for life in the knowledge society, which is characterized by increasing globalization, progressively shorter half-lives of knowledge, the increasing importance of knowledge creation in sustaining development, and economic competitiveness which requires increased collaboration in the workplace (Riel, 1998). As a consequence, developing students' problem-solving, lifelong learning, collaboration and communication abilities have

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emerged as important goals for education in the twenty-first century. Furthermore, it has been recognized that to achieve these new learning goals requires significant changes in the learning and teaching process. Such perceived needs for change in terms of the goals and processes of education are shared not only in industrialized countries (see, e.g. ERT, 1997), but also in less developed countries (see, e.g. Gregorio & Byron, 2001; UNESCO, 2003). Undoubtedly, the escalating pace of technological advancement in information and communication technology (ICT) is a key factor contributing to the kind of rapid socio-economic changes that has led to the pressures for educational change worldwide. ICT has also been seen as a key factor that can be leveraged in the learning and teaching process to bring about the desired pedagogical changes and hence the twenty-first-century learning outcomes (ERT, 1997). Policies to encourage widespread integration of ICT in the school curriculum to achieve the above goals can be found in general education policy documents (e.g. Hong Kong Education Commission, 2000) or embedded within master plans for information technology in education (e.g. Singapore Ministry of Education, 1997).

While large-scale education reform efforts linked explicitly to technology is a recent phenomenon that emerged towards the end of the twentieth century; there is a large corpus of literature on educational reform and change management that has accumulated over the past 40 years from studies of reform initiatives at school, regional or national levels. In discussing why the education reform movement is still strong in the USA despite its long history of such efforts of various kinds during the twentieth century, Resnick and Hall (1998) argued that many of the reforms were largely *tinkering with institutional arrangements* (p. 90) without making impacts on the core of education – established patterns of teaching and learning. Much of the educational change literature points out that effective reforms in education require changes in the teachers' epistemological beliefs about knowledge and learning, changes in teachers' roles, students' roles and classroom practices, changes in physical and administrative arrangements of the school, relationships between and among stakeholder groups as well as cultural transformation (Elmore, 1996; Fullan, 1993; Fullan, 2001; Resnick & Hall, 1998). These findings no doubt help to inform and guide efforts currently underway in many countries to bring education into the twenty-first century, leveraging on the potential that ICT brings to the learning and teaching process.

Instituting change is only the first part of the challenge to education reform. The greatest challenge to education is to create *scalable* change, that is, change that can be sustained and transferred. Unfortunately, as Hargreaves and Fink (2006) pointed out, 'change in education is easy to propose, hard to implement, and extraordinarily difficult to sustain' (p. 1). Datnow (2002) also made observation that 'effectively transferring an innovation across school contexts is said to be difficult at best, and perhaps impossible' (p. 217). However, there is a relative lack of literature on sustainability and transfer of educational change in general and educational change that leverages on technology in particular. Furthermore, much of the existing literature on sustainability and transfer focuses on changes that were led from the top, at the school level or up, and addressed primarily leadership issues related to the scaling-up of educational change (e.g. Hargreaves & Fink, 2004; Hargreaves & Fink, 2006; Datnow, 2002; Datnow, Hubbard & Mehan, 2002). On the other hand, some educational changes, especially pedagogical innovations at the classroom level, may emerge from teachers' efforts on an individual or group basis. Would such innovations face similar or different challenges in terms of scalability (i.e. sustainability or transfer)? Would technology-supported pedagogical innovations pose similar or different issues in scalability? Much of the literature on change emphasizes the importance of learning at individual and organizational levels (e.g. Elmore, 1996; Fullan, 1993; Fullan, 2001). In technology-supported pedagogical innovations, the learning gap that has to be crossed by teachers and students are arguably greater than non-technology-using ones. Would the challenge for scalability be different when technology use is integral to the learning and teaching process? Would the challenge of scalability depend on the extent of innovativeness involved? This chapter reports on a study that explores these questions using a set of case studies of innovative pedagogical practices using ICT collected from 28 countries in the Second Information Technology in Education Study Module 2 (SITES M2), an international comparative study conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA).

This chapter will begin with an introduction to the SITES M2 study, highlighting how the features of the case studies collected in this study will provide a unique opportunity for explorations on scalability of technology-supported educational change. It then describes a six-dimensional framework for comparing the extent of innovativeness of these case studies of ICT using pedagogical practices, followed by a quantitative exploration of the relationship between innovativeness, sustainability and transferability. Some in-depth description and discussion of a few selected cases will be presented to gain a better understanding of the findings from the initial quantitative explorations. This chapter will conclude with a discussion of the conditions for scalability of technology-supported pedagogical innovations and their policy implications.

2 SITES M2 – An International Comparative Study of Technology-Supported Pedagogical Innovations

An earlier phase of the SITES study (SITES M1) found evidence of a worldwide shift towards more collaborative student-directed inquiry-based learning with associated changes in the teachers' role and the type of classroom practice. These characteristics were referred to as belonging to an *emerging pedagogical paradigm* (Pelgrum & Anderson, 1999). Based on the belief that in-depth studies of emergent pedagogical innovations found in different countries will provide important insight on schooling of the future, the SITES M2 study was designed to 'identify and provide rich descriptions for innovations that are considered valuable by each country and that might be considered for large-scale implementation or adoption by schools in other countries' (Kozma, 2003, p. 9). The selection of these cases is a key design component of this study. A national panel of experts in each participating country selected candidate cases of innovative pedagogical practices using technology for in-depth study during the 2000/2001 academic year. The criteria used for case selection were that the pedagogical practice should be one where: (1) technology played a substantial role; (2) significant changes were involved in the roles of teachers and students, the goals of the curriculum, assessment practices, and/or the educational materials or infrastructure; (3) evidence of measurable positive student outcomes could be recorded; and (4) sustainability and transferability were demonstrated. There was an additional criterion that the cases selected had to be considered innovative such that the cases would have pedagogical characteristics that were important in preparing students for lifelong learning, which was considered a very important ability for effective functioning in the information society. However, what constituted key innovation characteristics were defined by individual participating countries so as to accommodate local circumstances and cultural differences. Details about the design of the study are described in the Study Prospectus, available from http://www.sitesm2.org/.

The SITES M2 was designed as a comparative study of in-depth case studies using multiple sources and data types including interviews with principals, administrators, technology coordinators and innovation teachers as well as classroom observations and school documents such as project proposals curriculum guides, etc. (Kozma, 2003) The case studies were conducted by the national research teams under the leadership of the National Research Coordinators (NRCs) in the respective countries using a common set of instruments and administration protocols. The national research teams were also responsible for the writing-up of the case reports following a highly structured narrative report template which included sections on classroom contexts (curriculum content and goals, teacher and students practices and outcomes, the ways ICT was used, problems encountered, sustainability and transferability), school contexts (school background and culture, ICT infrastructure and support in the school) and national/regional contexts (such as policies related to educational reform and ICT). The recommended length of each narrative report was 10 pages (about 5,000 words). These case reports became the data that the international research team – referred to in the study as the International Coordinating Centre (ICC) – used for analysis when they wrote their international study report (Kozma, 2003). These case reports were also used as data in the present study.

Thematic coding is a common technique in qualitative data analysis and was used by the ICC in the analysis of the SITES M2 case reports. A coding scheme based on the research questions and conceptual framework was devised to code each of the case reports (referred to in the international report as the 'cover sheet coding scheme' by Kozma, 2003, Appendix B.2). The coding guidelines and the codes for each country's cases were shared with the NRCs to seek their reactions on the accuracy of the coding. In cases of discrepant views, a process of clarification and meaning negotiation was carried out such that changes were made to the codes if they were warranted by the NRCs' comments or additional data. Some of the codes derived from the cover sheet coding scheme are also used in the present study.

It is important to note that in the SITES M2 study, the criteria for case selection did not specify the origins of the innovations. Thus the selected cases might have resulted from top-down reform initiatives at the national or international levels, or they might have been bottom-up cases of innovation initiated by classroom teachers. Furthermore, all of the cases were selected because they were considered to have involved substantial changes to classroom practices involving changes in the roles played by teachers and students, and technology had played a substantial role in them. These cases may not represent innovations reaching school-wide implementation but were all considered to be among the pedagogically most innovative according to their own locally defined criteria. Furthermore, one of the selection criteria was that the pedagogical practice had the potential to be sustainable and transferable. Therefore, these cases present a unique and rich data set for us to explore issues related to the scalability of pedagogical innovations that make use of ICT.

3 Scalability and Extent of Pedagogical Innovation

3.1 Comparing Innovativeness

One of the research questions addressed in this study is whether scalability of a pedagogical innovation is related in any way to its extent of innovativeness. Law, Chow and Yuen (2005) developed a methodology for comparing the extent of innovativeness of pedagogical innovations with the level of ICT sophistication as one of the dimensions of comparison, and applied it to the analysis of the SITES M2 cases (Law, Yuen & Chow, 2003). This framework identified six important dimensions that need to be included in the comparison of innovativeness of ICT-using pedagogical practices:

- Intended curriculum goals of the innovative practices
- Pedagogical role(s) of the teachers
- Role(s) of the students
- Nature and sophistication of the ICT used
- Multi-dimensionality of the learning outcomes exhibited
- Connectedness of the classroom

Six scales of innovativeness were developed to reflect the magnitude of change along each of the above six dimensions of analysis, taking the ‘traditional’ classroom to be typically one that is isolated, knowledge-focused and teacher-centred, does not use ICT and only assesses students on cognitive learning outcomes. A seven-point Likert Scale was used to score each of the cases using the scoring rubric reported in Law (2003) and http://sitesdatabase.cite.hku.hk/i_classroom/

P_3_1.htm, with one point given to practices at the most traditional end of the scale, four points given to those at the mid-point of the scale and demonstrating emergence while seven points were given to practices at the most innovative end of the scale. Therefore, six innovation scores could be assigned to each case based on the specific pedagogical situations described in the case report on the above six dimensions: the curriculum goal score (G_score), the teacher's role score (T_score), students' role score (S_score), ICT sophistication score (ICT_score), multi-dimensionality of learning outcome score (M_score) and connectedness score (C_score). In order to complete the coding for the large number of lengthy case reports, altogether four coders were trained to use the scoring rubric to score the cases. The Cronbach alpha for the four coders when coding the same case was 0.819, which was considered satisfactory. There were altogether 174 case reports collected in the SITES M2 study. However, it was found during the coding process that many of the reports did not contain enough details at the classroom level for the coders to score reliably on all six dimensions. In the end, the research team was only able to score 83 of the cases on all six dimensions. These 83 cases came from 25 of the 28 countries participating in SITES M2.

In order to gain an overview of the innovation profiles of the analysed cases across the six dimensions, the mean innovation score and some dispersion statistics are presented in Table 1.

It was observed that most of the case studies were only innovative in some but not all dimensions, and cases that were scored as highly innovative along all the 6 dimensions were rare among the 83 cases analysed (Law, 2003). On the other hand, these six innovation scores were nonetheless also interrelated. Some important observations can be found from the correlation matrix of the six innovation scores presented in Table 2. Firstly, the ICT sophistication score has the lowest correlation with all the other innovation scores, and it was only significantly correlated with the teacher's role scores and the classroom connectedness scores. This means that the sophistication of ICT used has a relatively weak influence on the overall pedagogical innovativeness of the cases

Table 1 The mean innovation score and related descriptive statistics along each of the six dimensions of innovation for the 83 cases analysed by Law et al. (2003)

Dimension of innovation	Mean innovation score	Minimum score	Maximum score	Standard deviation
Curriculum goals (G_score)	4.18	1	6	1.30
Teacher's roles (T_ score)	4.34	2	7	1.35
Students' roles (S_ score)	4.31	2	7	1.61
ICT sophistication (ICT_ score)	5.71	5	7	0.74
Multi-dimensionality of learning outcomes (M_ score)	4.13	1	7	1.66
Connectedness of the classroom (C_ score)	4.16	1	7	2.06

Table 2 Correlation matrix of the innovation scores of the 83 cases analysed

	G_score	T_score	S_score	ICT_score	M_score	C_score
G_score	1.00					
T_score	0.74**	1.00				
S_score	0.67**	0.77**	1.00			
ICT_score	0.14	0.22*	0.06	1.00		
M_score	0.56**	0.59**	0.72**	0.07	1.00	
C_score	0.21	0.31**	0.26*	0.31**	0.28**	1.00

* Significant at $p < 0.05$; ** Significant at $p < 0.01$

analysed. On the other hand, the teachers' role scores was the only dimension that showed significant and mostly very high correlation coefficients with all the other five dimensions, indicating that teachers' roles had the strongest influence on the overall level of innovation for the cases analysed. This is an important finding that will be referred to in the further analysis reported later in this chapter.

3.2 Sustainability and Transferability of the Pedagogical Innovations

The SITES M2 case report template required each case report to include a section on the sustainability and transferability of the case and the researcher had to provide evidence for the claims they made in that section. The ICC cover sheet coding scheme also included two codes in this regard: whether the case has been sustained for more than a year (sustainability) and whether it has been transferred to other classes within the same school or other schools (transferability). The coding conducted by the ICC and released to the NRCs is used here as indicators of sustainability and transferability.

As mentioned earlier, sustainability and transferability are the greatest challenges for significant changes in education to move from the status of a successful project to a systemic change. Table 3 cross-tabulates the sustainability and transferability status of the 83 cases that were scored for their innovativeness along the 6 dimensions as described above. The results indicate that transfer was more difficult than sustaining an innovation, though there were a few innovations which were already transferred to other classrooms within the first year of their implementation.

It is important to note here that although only 83 of the 174 cases collected in SITES M2 were scored and analysed in this study, the proportion of sustained and transferred cases in the scored sample is similar to that found in the entire collection of cases by comparing the respective percentages in Tables 3 and 4.

Table 3 The distributions of the sustainability and transferability status of 83 of the SITES M2 case studies analysed and reported in this paper

	Transferred	Not yet transferred	Total
Sustained > 1 year	36	29	65 (78.3%)
Not yet sustained	5	13	18 (21.7%)
Total	41 (49.4%)	42 (50.6%)	83

Table 4 The distributions of the sustainability and transferability status of all the 174 cases collected in the SITES M2 study

	Transferred	Not yet transferred	Total
Sustained > 1 year	65	71	136 (78.2%)
Not yet sustained	11	27	38 (21.8%)
Total	76 (43.7%)	98 (56.3%)	174

3.3 Innovativeness and Sustainability

An analysis of variance was conducted to find out among these 83 cases if there is any significant difference in innovativeness as scored on the 6 dimensions of innovation between cases that had been sustained over a year and those that had not. The results of the analysis are presented in Table 5.

Examining the results from Table 5, it is very intriguing to note that the mean innovation scores for the practices that had not been sustained for more than a year scored higher on all the six dimensions of comparison, with the greatest difference being observed in the teachers' role and students' role scores, although the difference was statistically significant only for the teachers' role score. Apparently, the more innovative the change, the more difficult it is to sustain. Furthermore, the biggest and statistically significant difference between the innovation scores in the sustained and not yet sustained case studies was found in teachers' roles, the most pedagogically important dimension identified earlier in Section 3.1. In other words, within the scored sample of 83 SITES M2 innovation case studies collected from around the world, it was significantly less probable for an innovation to be sustained if it involved major changes in the teacher's role away from a traditional instructional and didactic role towards that of facilitating collaborative inquiry. Furthermore, there is essentially no difference between the sustained and the not-yet sustained cases in terms of their ICT sophistication score. This indicates that whether the pedagogical practices adopted advanced technology or only simple everyday ICT applications made no difference to the likelihood of the practice to be sustained.

In order to shed further light on these findings, three cases are selected and discussed in the next section to explore the nuances that may underpin the sustainability of technology-supported pedagogical innovations.

Table 5 Comparisons of the innovation scores for sustained and not yet sustained innovations

	Innovations sustained > 1 year ($N = 65$)		Innovations sustained < 1 year ($N = 18$)		ANOVA
Innovation dimension	Mean	SD	Mean	SD	F
Curriculum goal score	4.09	1.26	4.50	1.42	1.40
Teachers' role score	4.17	1.34	4.94	1.21	4.90*
Students' role score	4.17	1.61	4.83	1.58	2.43
ICT sophistication score	5.69	0.73	5.78	0.81	0.19
Outcome dimensionality score	4.05	1.73	4.44	1.38	0.81
Connectedness score	4.05	2.06	4.56	2.04	0.86

* Significant at $p < 0.05$.

3.4 Innovativeness and Transferability

Transferability is another important aspect of making innovations scalable. An analysis of variance was conducted to find out if there was any significant difference between the innovative pedagogical practices that had been transferred to at least one other classroom whether within the same or in another school and those that had not. The results of the analysis are presented in Table 6.

The results are very different from those found in the sustainability analysis reported in the above section. First of all, none of the observed differences between the transferred and the non-transferred cases were statistically significant. Furthermore, while scores in the teachers' role, students' role and outcome dimensionality were still higher in the non-transferred cases, those concerning connectedness and ICT sophistication were in fact higher in the sample of cases that were already transferred to other classrooms. This seems to indicate that the mechanisms and/or factors required for sustainability and transfer may not be the same. One of the most successful cases in transfer is selected for discussion in a later section to explore further the conditions influencing transferability.

3.5 Other Factors Influencing Sustainability and Transferability

The cover sheet coding scheme used by the ICC contained four codes pertaining to school and system level factors that are potential candidate factors for having significant impacts on the scalability of pedagogical innovations. These four codes were:

- Whether the case report suggested a link to a school ICT policy or plan
- The leadership style of the school principal in relation to the innovation

Table 6 Comparisons of the innovation scores for transferred and not yet transferred innovations

	Transferred cases ($N = 41$)		Non-transferred cases($N = 42$)		ANOVA
Innovation dimension	Mean	SD	Mean	SD	F
Curriculum goal score	4.17	1.30	4.19	1.31	0.00
Teachers' role score	4.24	1.39	4.43	1.31	0.39
Students' role score	4.17	1.63	4.45	1.61	0.63
ICT sophistication score	5.80	0.75	5.62	0.73	1.31
Multi-dimensionality of learning outcomes score	3.95	1.67	4.31	1.65	0.97
Connectedness score	4.34	2.19	3.98	1.93	0.65

- Whether the case report suggested a link to a national/regional education policy or plan (other than ICT)
- Whether the case report suggested a link to a national/regional education ICT policy or plan

Analysis was conducted to explore whether any of the above four factors were related in anyway to the sustainability and/or transferability of the pedagogical innovations. A chi-square test found that only the leadership style of the principal in relation to the innovation had marginally significant relationship to the sustainability of an innovation, and the findings are presented in Table 7.

On the other hand, there was no significant relationship found between the leadership styles of the principal with whether an innovation was transferred. Rather, there was evidence that transfer was influenced by policies at the school and systems level. Transferability was found to be significantly related to whether the case report suggested a link to a school ICT policy or plan and whether the case report suggested a link to a national/regional education ICT policy or plan. The results are presented in Tables 8 and 9.

4 Sustainability and Mechanisms To Support Professional Learning

In order to understand better the conditions that influenced the sustainability of the pedagogical innovations, three of the Hong Kong cases are selected for further examination of the contextual factors that might have influenced sustainability: a sustained case where the teacher played a relatively traditional role, a case where the teacher played a highly innovative role but was not sustained in subsequent years after the case study was conducted, and a case where the teachers played a relatively innovative role that had been successfully sustained for more than a year.

Table 7 A cross-tabulation of the leadership style of the principal with the sustainability of the pedagogical innovations

	Innovations sustained > 1 year ($N = 65$)	Innovations sustained < 1 year ($N = 18$)	Total
Active involvement in the innovation	20	4	24
Supportive but not directly involved	39	13	52
Neutral	6	0	6
Against the innovation	0	1	1
Total	65	18	83

Table 8 A cross-tabulation of the transferability of the pedagogical innovations with whether the innovation was linked to a school ICT policy or plan

Innovation linked to school ICT plan?	Transferred ($N = 41$)	Not yet transferred ($N = 42$)	Total
Yes	32	23	55
No	9	19	28
Total	41	42	83

$p = 0.022$ for the chi-square test calculated using the Fisher's exact test.

Table 9 A cross-tabulation of the transferability of the pedagogical innovations with whether the innovation was linked to a national/regional ICT policy or plan

Innovation linked to national/regional plan?	Transferred ($N = 41$)	Not yet transferred ($N = 42$)	Total
Yes	36	24	60
No	5	18	23
Total	41	42	83

$p = 0.002$ for the chi-square test calculated using the Fisher's exact test.

4.1 Sustaining a Less Innovative Practice

One of the case studies collected in Hong Kong that was sustained for more than a year was titled *Chinese Punctuation*.[1] This pedagogical practice was implemented in a primary 6 classroom as part of the Chinese language curriculum. In this practice, the teachers created presentations as well as drill-and-practice exercises designed to help pupils learn Chinese punctuation using a suite of customizable

[1] This is case id CN010 and the full case report for this can be found at http://sitesdatabase.cite.hku.hk/M2/case2/CN010/Index.asp?case_ID=CN010

learning software developed at The University of Hong Kong. Three teachers were involved in designing the learning activities in this innovation, with the aims of teaching students the usage of punctuation at the sentence level for improving the cohesion of a passage, and promoting self-learning with ICT. These teachers were given professional support by a consultant from The University of Hong Kong who was involved in the design of the learning software. The curriculum goals involved in this practice were simple – to develop a good understanding of punctuation and the ability to use them appropriately. The customizable presentations enhanced the effectiveness of the teachers in fulfilling their information presentation role, while the customizable drill-and-practice exercises further supported them in their roles of administering exercises and giving feedback to students on the correctness of their work. The most innovative dimension in this practice was the sophistication of the technology involved – the sophisticated software was designed on the basis of rich cognitive research findings in Chinese language learning.

Given that there was no real change in the roles played by the teachers or the students in this case study, sustaining this pedagogical practice should not pose serious challenges. Indeed, the teachers did not report any difficulties in sustaining the practice and the practice was already in its third year of implementation when the case study was conducted. The main difficulty reported by the teachers was the time and effort needed to develop the learning materials (i.e. customize by inputting the appropriate content materials into the software templates) for other grade levels in the school.

4.2 A Highly Innovative Practice that Was Not Sustained

One of the Hong Kong case studies which involved major changes in the nature of the curriculum goals as well as in the roles of the students and teachers involved was titled *Problem Based Learning: Computer Assisted Scientific Investigations*.[2] The three teachers teaching biology, chemistry and physics respectively in the senior secondary section of the school collaborated to develop and pioneer school-based curriculum components to enhance students' scientific investigation ability. The innovation was designed for students studying any of the science subjects at the Secondary 4–6-grade levels. Instead of following cookbook-like instructions to complete a prescribed set of experiments, which the teachers decided was not conducive to fostering students' interests and abilities in science, the students were asked to set up their own investigation problems based on their everyday life observations. The use of data-logging equipment and associated graphing and analysis software was incorporated in this innovation to extend the range of experiments that could be conducted and to reduce the tedium of data collection and analysis so that the students

[2] This is case id CN010 and the full case report for this can be found at http://sitesdatabase.cite.hku.hk/M2/case2/CN008/Index.asp?case_ID=CN008

could focus their attention on the design of scientific investigations and the interpretation of data. This innovation stressed the importance of engaging students in finding explanations to problems generated from everyday observations through designing scientific experiments as well as collecting and interpreting data using technology.

Each investigation was composed of three phases: pre-laboratory discussion, laboratory session and post-laboratory discussion. This innovation required both teachers and students to take on roles that were very different from traditional ones. As one of the teachers remarked: 'For me, the greatest impact of this practice is on pedagogy. This does not only refer to the use of technology but [the practice] also provides room for students to solve problems.' Many of the students also commented on the role changes involved in the innovation. For example, one of the biology students commented:

> I think this way of learning is better than what we were used to before. It really required us to think about the whole process and the experimental set up instead of the teacher giving us the instructions, procedures and then we just follow it. Also it has become more exciting to do this experiment because we may fail, but when we become successful, we feel happier.

The project was initiated by the teachers themselves and funded by the Hong Kong Quality Education Fund. It received excellent publicity and feedback from the community. However, it also faced serious challenges. The three teachers differed in how far each of them was comfortable in allowing students to explore and make mistakes. There were occasions where the teacher gave strong hints and guidance to ensure that the students would not go astray. This innovation was only a pilot in its first year of implementation when the case study was conducted. The scientific investigations were only organized as an extracurricular activity for the students to participate in on a voluntary basis on Saturdays. When the school was contacted 3 years later, it was found that the school subsequently continued its use of data-loggers in conducting science experiments. A set of laboratory manuals had been developed based on the experiments designed by the students in the first year of this innovation. This set of experiments and manuals was then adopted as regular experiments in the science curriculum to replace the standard experiments in the textbooks. However, the kind of open-ended scientific investigations that had been reported in the case study during SITES M2 was no longer practised in the school. The pedagogical vision which stimulated this innovation in the first place was replaced by an institutionalization of technology integration into teaching practices while the pedagogical roles played by the students remained traditional.

This innovation started with a clear educational vision to change established pedagogical roles and practices. It received support from the school leadership to solicit funding from the Government to purchase the required dataloggers and associated hardware and software equipment, to allocate some computers for use in the science laboratories and to facilitate the various logistical and technical support arrangements. On the other hand, there was little evidence of awareness at the leadership level that the most significant and challenging change was not the use of sophisticated and advanced technology, but the deep changes in pedagogical roles and learning goals which were significantly different from what was prevalent in the school. The innovation was initiated by the biology teacher who was keen to give the students the opportunity to really engage in scientific investigations. The other two collaborating teachers were much less comfortable or confident about the new approach. Given the context, the achievement in the first year was impressive and could have flourished if efforts were made to ensure that the teachers involved had opportunities to share views, experience and expertise in designing and implementing the innovation and to build up a professional learning community among the science teachers. Unfortunately, the learning opportunity was missed and the innovation became fossilized to maintain the surface characteristics of technology-supported scientific investigations but without retaining the innovative roles originally played by the teachers and students. In this innovation, the technology used was relatively advanced and the students and teachers had to spend sometime to become familiar and competent with the technology. However, this was not found to pose any obstacle to the sustainability of the innovation. In fact, it was the technology use rather than the pedagogical role changes that was sustained.

4.3 A Highly Innovative Practice that Was Sustained

Of the nine innovation case studies collected in Hong Kong for the SITES M2 study, there were three that had been sustained for over a year and had been transferred to at least one other classroom within the same school. One of these was the Chinese Punctuation case study described earlier in Section 4.1. The second one involved the use of an online discussion forum to supplement learning in the formal school curriculum and thus had a relatively low impact on the formal school curriculum. The third sustained innovation was titled *My Pocket Money*,[3] *a* 4-month cross-curricular project covering the subjects of General Studies, Mathematics and Chinese conducted in a primary 6 classroom. In this innovation, the pupils designed and conducted a study involving a survey of fellow students to understand how much pocket money children in the school generally received, how they spent it and whether there were gender and age differences in the amount and use of pocket money. The project also incorporated a service component in which a fund-raising bazaar was organized in the school to encourage fellow students to donate part of their pocket money for the organization of a service day for the old people from a home for the elderly near to the school.

In order to conduct this project, the responsible teacher, Teacher B, had to rearrange the normal timetable so that he could spend a lesson each week with the class to discuss project progress and to give advice and support to the pupils when necessary. The goals of this innovation went beyond the learning of subject-matter knowledge to focus

[3] This is case id CN001 and the full case report for this can be found at http://sitesdatabase.cite.hku.hk/M2/case2/CN001/Index.asp?case_ID=CN001

on the fostering of appropriate values and attitudes, organizational skills and skills of cooperation. Technology was used in the production and data entry of the survey as well as in searching, organizing, analysing and presenting information.

While this case study was conducted during the academic year 2000/2001, it had its roots in the pioneering work which started in 1998 when the school experimented with the introduction of project-based learning in extra-curricular activity groups. In the following school year, one of the two teachers (Teacher A) piloted project-based learning in the formal school curriculum in two of the classes she taught, and 'My Pocket Money' was one of the two projects she developed for use with the grade 5 students. Teacher A shared her experience with other teachers in the school. Subsequently, two of her colleagues, Teachers B and C, modified and adopted these two project plans into their teaching in the year 2000/2001. Teacher B was the teacher involved in the *My Pocket Money* case study.

The sustainability and transferability of this pedagogical innovation was not an accidental achievement, but the outcome of successful leadership. The principal of this school was a visionary leader who was committed to changing the pedagogical culture in the school towards a more facilitative and empowering one. He also believed firmly that the priority in introducing ICT in teaching and learning should be to support pedagogical change. In order to promote change and to equip teachers with the necessary skills and knowledge, he held staff development sessions twice a month during which the teachers could share their ideas and experiences with one another. The principal did not mandate how project-based learning should be designed and implemented and teachers were not forced to adopt this new approach until they felt ready for the challenge. On the other hand, the principal had created supportive mechanisms to minimize the innovation hurdle that teachers would need to face. Teacher C described what it took to adopt an ICT-supported project-based learning approach in their teaching:

> Firstly, it is the understanding of the teachers. The teachers have to recognize and appreciate the impact of project work on students' learning. Secondly, teachers have to possess pedagogical competencies to facilitate project work. … In terms of ICT resources, the schools have to consider the number of computers in school, time and space. Moreover, the ICT competence of students is very important too. We do not need to spend much time on teaching students IT skills (for the project work). This is because students [now] have computer courses from the time they are in Primary 1. They are quite competent in using computers.

The bi-weekly staff development sessions contributed to the establishment of a collaboration culture in the school which helped to overcome the first two hurdles described by Teacher C. The sharing of curriculum design and teaching resources among teachers also reduced the pedagogical hurdle for teachers who might not have the confidence or expertise to develop project-based curriculum units by themselves. In short, the principal set up mechanisms that led to the establishment of a community of practice for pioneering innovations. The school's ICT infrastructure and technical support was organized to facilitate the use of ICT for project-based learning. When the IT literacy curriculum was first introduced in the school in 1998, a mechanism was put in place so that subject teachers who wanted students to have mastered particular IT skills for the purpose of doing project work could liaise with the IT literacy teacher to ensure that the requisite IT skills would have been mastered by the students by the time the project work was to begin.

4.4 Sustaining Pedagogical Innovations Requires a Focus on and Mechanisms for Continuing Professional Learning

The SITES M2 case studies indicate that more innovative pedagogical practices are more difficult to sustain. Greater the extent of innovation from prevalent 'traditional' practice, the greater the change and adjustments required of the teachers concerned as well as the physical and institutional infrastructure. An innovation is, by definition, a fledgling practice which is vulnerable to setbacks and premature death. To sustain an innovation that impinges on the core of educational practice – the roles of the teachers and the learners as well as the goals of learning – requires deep learning at individual and organizational levels. Resnick and Hall (1998) argued that to achieve reform goals that impinge on the core of educational practice in a school requires a new level of instructional expertise throughout the school, which can only be developed if the school succeeds in becoming a learning organization that is capable of improving its performance by creating new ways of working and developing new capabilities for that work.

Effective organization learning cannot happen without the conscious and dedicated efforts of the school leadership, particularly that of the principal. In fact, how to build a culture of learning is the greatest challenge to leading change in a school (Fullan, 1993; Fullan, 2001). As we can see from the case study *My Pocket Money* described above, this innovation was able to be sustained (and transferred to other classrooms in the same school) even though it involved deep changes in many core pedagogical aspects: the roles played by teachers and learners, the organization for learning, the activities involved, the duration over which the practice spanned and the inclusion of the parents and the local community in the practice. A core success factor was the role played by the principal. He set up the bi-weekly staff development meetings as a mechanism to promote a culture of professional sharing and experimentation which helped to ensure that innovations started by a single teacher were not just the efforts of a courageous, committed individual. The innovations were shared, discussed, improved on and tried out by other teachers. In short, they became artefacts in the public professional space of the school for scaffolding knowledge building in the teacher community. It is thus not surprising to note the finding reported earlier in this chapter that the style of leadership was the only factor identified to have a significant impact on the sustainability of the pedagogical innovations.

5 Transferability and the Establishment of Systemic Learning Networks

Based on our discussions above, the fundamental challenge to transfer should also be that of learning: whether the learning that took place in the initial innovation site can *spread*. Studies by researchers on numerous reform efforts have arrived at the conclusion that transferring an innovation effectively across school contexts rarely happens (Fullan, 1999; Hargreaves & Fink, 2006). Transfer cannot be a simple process of transplantation (Datnow, 2002; Elmore, 1996), but rather a process of adaptation according to the local contexts and culture. Therefore, the most important condition for 'transfer' or spread is not the accumulation of knowledge or skills, but the formation of a network of professionals engaged in innovation-related learning.

As reported earlier in Section 3.2, analysis of the SITES M2 case studies also indicates that it was more difficult to transfer a pedagogical innovation than to sustain it. It is important to note here that the criteria for an innovation to be classified as having been transferred had a very low threshold: that the innovation had been adopted by at least one other classroom within the same or a different school. The results also showed that unlike the case of sustainability, the challenge to transferability did not appear to be related to the extent of innovativeness of the practices concerned, but rather, to policies at school and system levels. Of the 83 cases analysed, Finland had the highest number of cases that was transferred to classrooms in other schools. In fact, five out of the seven innovative cases in Finland were actually part of larger *networked projects* within local, regional or national contexts. A networked project was one in which similar ICT-supported pedagogical practices were implemented in several schools.

Law, Kankaanranta and Chow (2005) conducted an in-depth comparison of the case studies collected in Finland and Hong Kong, which found major differences between the pedagogical innovations collected from the two systems in terms of the kinds of ICT used and the roles played by ICT. They further identified the Finnish national information strategy, which put strong emphasis on collaboration and teamwork, as a main contributing factor to the high scalability of the Finnish innovations. In this section, one of the Finnish cases that was most successful in transfer, Netlibris, is described in some detail here to illustrate the characteristics common across the Finnish innovations that was found to have contributed significantly to their transferability.

Netlibris (Netlibris, n.d.) was a literature project that aimed to encourage students to read more books, share their reading experience with peers, and to encourage girls to use ICT. It started as one teacher's idea to combine reading, use of computers, collaborative learning and individual development; but its initial implementation was not confined to a single teacher or even a single school. Perhaps inspired by the national strategic emphasis of networked and collaborative use of ICT in instruction, the innovation began with six schools, four teachers and 32 students from the city of Espoo. It was initially designed for gifted students who loved reading. Students chose books to read from common bookplates in the Netlibris website, kept a reading diary and discussed about books in the web-based environment and face-to-face meetings. It soon developed into a project with three literature circles catering for primary, lower and upper secondary school students of all ability levels.

The initiators sought and gained community support from the beginning of the innovation in terms of both expertise and funding support. Netlibris was coordinated by a development group consisting of a project coordinator and teachers involved in the innovation to plan with librarians, students and several experts (authors, etc.), activities such as face-to-face meetings with peers and virtual 'author visits'. The teachers also participated in web-based literature discussions and modelled literature discussions and interaction skills. This project received half of its funding from the National Board of Education (NBE), which required the municipalities to commit themselves to a similar amount of their own funding.

There are several features of this innovation which notably contributed to its high transferability. First of all, there were national and municipal policies in place which encouraged and supported the realization of innovative ideas even though it originated from a primary school teacher in a small municipality. Secondly, the 'transferability' was built-in from the start of the innovation, rather than as a second 'stage of innovation development'. Thirdly, there was the establishment of a network of 'innovation agents' comprising teachers and other supporters from the community to take on the challenge of further conceptualization and implementation. This network was also a learning network that lay at the core of the *nested learning communities*, which according to Resnick and Hall (1998) needs to be in place for the innovation to evolve and extend. As the coordinator of the Netlibris commented, 'The biggest resource and capital is the huge know-how we currently have in our network. A special richness is the "infinity" of our project – the teacher network transcends the limits of municipalities and school levels' (Law, Kankaanranta & Chow, 2005, p. 189). Fourthly, the use of ICT played a crucial role in supporting both the innovation and its scalability by providing the connectivity for the learning activities as well as the learning network that underpinned the success and continual development of the innovation. By 2005, 7 years after the initial launch, there were more than 100 teachers and over 2,000 students participating in Netlibris, which had been extended to include literature circles for struggling readers as well.

The above characteristics of the Netlibris project that contributed to its transferability was not unique to this innovation, but was reported in Law, Kankaanranta and Chow (2005) as shared by most of the Finnish case studies. In terms of initiation, which includes both the generation of the innovation ideas and taking the initial ideas forward to the formulation of an innovation plan, the Finnish cases involved a very broad group of contributors. The initial ideas for the seven Finnish cases were various, including classroom teachers, the principal, the teachers and the principals in the local area or personnel external to the school, such as university researchers. Further, multiparty collaborations were often established from the initial planning stage, which also ensured that the innovation could be steered to satisfy the intertwined concerns of the various stakeholders involved.

Soliciting collaborators and the establishment of a network of technological, subject matter and/or pedagogical expertise from the initiation stage of the innovation was a common characteristic of all the Finnish cases. Five of the seven Finnish innovations extended beyond a single school to become a networked project at the local, regional or national levels. Such a network not only reduced the burden of innovation on the initiators and contributed greatly to the success of the initial implementation, but also provided the technological and socio-institutional infrastructure conducive to the sustainability and transferability of the innovations. The networks evolved together with the innovations. In some sense, transfer was not a problem that these innovations had to tackle. Given that the innovations were started as networked projects, multi-site, multiparty involvement, adaptation to local contexts and needs were challenges that the innovation had to tackle right from the beginning. The challenges of sustainability were similar to those of transferability for networked projects. The different contextual adaptations of the same innovation provided a rich knowledge base, expertise and resilience that contributed to the chance of its successful evolution. The capacity to evolve into different varieties of the same innovation is possibly the best supporting condition for sustainability and transferability. Much of the change literature (e.g. Datnow, 2002; Elmore, 1996) point to the fact that innovations cannot be transplanted and the transfer process is in itself a process of innovation. In fact, to sustain an innovation also requires successful adaptation in order that the new practices can become mainstreamed or institutionalized.

The characteristics associated with the change process of the Finnish innovations did not emerge serendipitously but were related to the national information and education policies in Finland (Law, Kankaanranta & Chow, 2005). The ICT implementation policy of the Finnish NBE, 'Information Finland' provided broad policy directives and technology infrastructure to link to information networks, support for the development of learning and teaching materials as well as the policy imperative that by 2002 every Finnish school would have developed its own strategy for the implementation and use of ICT in teaching and learning compatible with its contextual characteristics and needs (Kankaanranta & Linnakyla, 2003). Most importantly, the policy included an in-service professional development programme on the pedagogical use of ICT called'Finland as an Information Society', which focused on collaborative teaching and learning, networking, and teamwork. This contributed greatly to the wide adoption and research-based development of networked and collaborative use of ICT in instruction in Finnish schools and the building of virtual schools. Furthermore, all of the Finnish innovations adopted online learning environments, some of which were developed by University research teams to address the specific needs of the innovations concerned. These online environments formed an important information and communication infrastructure to scaffold the learning activities and the collaborative interactions between the various parties involved in the innovations.

6 Connectedness, Network Technology, Learning Network and Scalability of Pedagogical Innovations

This chapter set out to explore the challenges associated with the sustainability and transferability of technology-supported pedagogical innovations by examining 83 of the case studies collected in the SITES M2 international comparative study of innovative pedagogical practices using technology. The cases were scored on a six-dimensional innovativeness scale. It was found that the teachers' role was the dimension with the strongest influence on the overall level of innovation and the ICT sophistication score had the lowest correlation with the other five innovation scores. It was also found that innovations that were sustained for more than a year had lower innovation scores on all six innovation dimensions. However, the difference was only significant for the teachers' role score, indicating that pedagogically more innovative cases involving more significant changes in the teaching and learning practices and roles were more difficult to sustain.

Sustainability was found to relate significantly with leadership style. A principal who thoughtfully set up mechanisms to establish a community of practice for pioneering and extending the impact of the innovation helped teachers to bridge the learning gap between established practice and the innovation, making the sustainability of a highly innovative practice achievable. These observations were consistent with the emphasis on the need to support learning at individual and organizational levels (e.g. Elmore, 1996; Fullan, 1993; Fullan, 2001) in the educational change literature.

While there is no direct comparison between ICT-using and non-ICT-using pedagogical innovations in the present study, it can still shed light on ICT-use and sustainability. Though all the SITES M2 case studies made significant use of technology, the sophistication and complexity of the ICT used differed widely across the different cases. As reported earlier, ICT sophistication had no impact on sustainability, indicating that it is unlikely for ICT-supported pedagogical innovations to be more difficult to sustain than pedagogical innovations that do not make use of technology.

Transferability of the SITES M2 innovations appeared to be influenced by another set of factors different from those impacting on sustainability. First of all, the extent of innovation on any of the six dimensions had no statistically significant influence on transferability. ICT sophistication score had the highest correlation with the connectedness score of the innovations and was mildly positively correlated with transferability. Transferability was also found to be significantly influenced by two contextual factors, the ICT policy at school level and the educational policy at the systems level. Further explorations revealed that innovations found in a system where the educational policies encouraged and supported the establishment of multi-site, multiparty collaborative networks to take on the conceptualization and implementation of innovations stood a much better chance of transfer. Such networks were in fact learning communities which provided the agency and expertise for evolution and adaptation of the innovations, processes that lie at the core of transferability and sustainability. This study also found that ICT contributed positively to the transferability of some of the innovations through the connectedness afforded by the use of online learning environments to support the learning and collaborative interactions of nested learning communities of students, teachers and other contributing stakeholders.

The present study was carried out on 83 cases of pedagogical innovation collected from 25 countries around the world. The findings indicate that the core challenge for scalability of ICT-supported pedagogical innovations is the successful establishment of professional learning communities for the innovations, which holds also for the scalability of non-technology-using innovations. What is most heartening, however, are the preliminary findings that the integration of ICT into the pedagogical practice does not make the innovation any more difficult to sustain, and that network technologies can be positively exploited to enhance transferability. Further studies should be conducted to provide further evidence for the above findings and to seek better understanding of the contribution that ICT can make to the scalability of pedagogical innovations.

7 Implications for Reforming Learning Within the Asia-Pacific Region

Altogether 28 countries participated in the SITES M2 study, resulting in the collection of 174 case studies of ICT-supported pedagogical innovation. As mentioned earlier in this chapter, only 83 of the cases were analysed at the level of detail required for the present study. These 83 analysed cases were collected from 25 countries/educational systems, including 8 from the Asia-Pacific region (see Table 10 for details).

As the average number of case studies analysed per education system was less than five and the number of cases from each country varied enormously from one

Table 10 Countries/educational systems included in the 83 analysed SITES M2 cases listed by region

Region	Countries/education systems included*
West Europe (WE)	Germany (6), Denmark (3), Spain Catalonia (4), Finland (5), France (1), Israel (2), Italy (1), Netherlands (6), Norway (6), Portugal (2), UK (2)
America (AM)	Canada (1), Chile (5), USA (2)
Asia-Pacific (AP)	Australia (4), Hong Kong (9), Korea (1), Philippines (5), Singapore (4), Thailand (4), Chinese Taipei (2)
East Europe (EE)	Czech Republic (1), Latvia (2), Slovakia (3)
South Africa (ZA)	South Africa (2)

* Figures in brackets are the number of cases from the country/education system included in the analysis.

Table 11 Comparisons of the proportion of sustained and transferred cases in the Asia-Pacific with the total sample of innovations analszed

	Sustained > 1 year	Not yet sustained	Percentage sustained	Transferred	Not yet transferred	Percentage transferred
Asia-Pacific (N = 29)	23	6	79.3	16	13	55.2
All analysed cases (N = 83)	65	18	78.3	41	42	49.4

to nine, it was not possible to examine cross-national differences. On the other hand, although there are differences among countries within the same region as well as across different regions, it is expected that the former differences are smaller than the latter. The remainder of this chapter thus reports on explorations of whether there were regional differences around the world in terms of the pedagogical characteristics and scalability of the SITES M2 case studies and how the Asia-Pacific region compares with countries in other parts of the world.

Table 11 presents that proportion of the innovations that were sustained and transferred respectively in the Asia-Pacific region in comparison to the total sample of innovations analysed. It is evident from the figures presented that the proportions are very similar, indicating that the challenges faced by countries in the region in sustaining and transferring ICT-supported pedagogical innovations are possibly very similar. On the other hand, the analysis presented earlier in this chapter reveals that the challenges to sustainability and transferability are greater for more innovative pedagogical practices. There is a huge body of literature that studies cultural differences in education between different countries and it is generally accepted that Asians classrooms tend to be more teacher-led and knowledge-focused. Does this regional difference still hold out for the ICT-supported pedagogical innovations or would such regional differences disappear in this highly selective sample? A further comparison of the extent of innovativeness of the cases collected across different geographical regions is reported below to shed further light on this.

While the number of cases in each category for each region is too small to claim any statistical significance, the results in Table 12 provide very interesting and noteworthy patterns that could be explored in further studies. First of all, there is great variability in the innovativeness of the cases collected from the different regions on all the dimensions except that of the ICT sophistication score. Secondly, cases collected from the Asia-Pacific region scored the lowest in four out of the six dimensions of innovation, including the two pedagogically most important ones, the teachers' role score and students' role score. This may indicate that even among the most innovative examples of ICT-using pedagogical practices, those found in the Asia-Pacific region were more teacher-directed, less student-centred and less connected than those found in other parts of the world. As explained in Section 3, the innovativeness was scored on a seven-point scale with one point

Table 12 Comparisons of the innovation scores for the analszed cases collected from the different regions

Region	WE	AM	AP	EE	ZA	F	sig.
Curriculum goal score	4.53	4.25	3.72	3.67	5.50	2.50	0.05
Teachers' role score	4.68	4.13	3.86	4.00	6.50	3.30	0.01
Students' role score	4.58	4.13	3.86	4.50	6.00	1.45	0.23
ICT sophistication score	5.74	6.00	5.62	5.50	6.00	0.61	0.66
Outcome dimen. score	4.45	3.88	3.86	3.33	5.50	1.29	0.28
Connectedness score	4.61	4.50	3.45	4.00	5.00	1.50	0.21

Table 13 Distribution of the analszed cases across the different types of pedagogical practice collected from the different regions

Type of pedagogical practice	WE	AM	AP	EE	ZA
Scientific investigations	2	0	4	1	0
Projects	19	3	9	1	2
Media productions	8	3	4	3	0
Virtual schools and online courses	6	2	3	0	0
Task-based learning	2	0	7	1	0
Expository lessons	1	0	2	0	0

given to practices at the most traditional end of the scale, four points given to those at the mid-point of the scale and demonstrating emergence while seven points were given to practices at the most innovative end of the scale. It can be seen from Table 12 that all of the mean innovation scores for the Asia-Pacific cases were below four, with the exception of the ICT sophistication score, meaning that the pedagogical characteristics were generally traditional even among the case studies selected for their pedagogical innovativeness in using ICT.

Table 13 presents the results of further explorations of the possible differences between innovative pedagogical uses of ICT in the Asia-Pacific region compared to other regions around the world. Earlier analysis (Law, 2004) found that the case studies collected can be categorized broadly into six types of pedagogical practices, with expository lessons and task-based learning as the most traditional forms of organization for learning while the other four types, scientific investigations, projects, media productions and virtual schools and online courses are all relatively newer approaches to organizing learning that are more likely to foster student self-directed learning and lifelong learning abilities. These results indicate that about one third of the Asia-Pacific cases analysed belonged to the two traditional pedagogical practice types while such cases only comprised a much smaller proportion (16%) of the entire collection of 83 cases. The results presented in Tables 12 and 13 therefore indicate that there are differences between the SITES M2 innovative cases collected in the Asia-Pacific region and those from other parts of the world and that these differences are possibly linked to the fact that Asian classrooms tend to be more teacher-centred. Hence the regional differences possibly have roots in the cross-regional cultural-historical differences in educational beliefs and practices rather than simply differences in the responses of the educational system to challenges of the twenty-first century. In other words, the cross-regional differences are indicative of continuity even in selected case examples of innovation and change.

There are several important findings from the present study. Firstly, Asia-Pacific countries are making similar efforts to countries in other regions to leverage the potentials of ICT to innovate curriculum and pedagogical change in schools. Secondly, such efforts face challenges of sustainability and transferability and the rates of success in the analysed cases are similar between the Asia-Pacific countries and other parts of the world. On the other hand, taken as a whole (there are wide cross-case differences), the Asia-Pacific cases tend to be more teacher-directed, knowledge-centred, with less focus on collaboration or inquiry and the learning tended to take place in isolated classrooms unconnected to outside communities locally or internationally. What are the implications arising from these findings for reforming learning in the Asia-Pacific region? The interpretation can be various depending on the perspective one prefers to take. In many international comparative studies of student achievement such as TIMSS,[4] PIRLS[5] and PISA,[6] Asia-Pacific countries rank high in these international league tables. Therefore, one may consider the present findings to be a reassuring one, that is, ICT is being integrated successfully into pedagogical practices that are proven to bring about high standards in student achievement. Others may argue that these international achievement tests are not assessing the kinds of abilities such as open-ended inquiry of complex authentic problems, self-directed learning and collaboration, qualities that are most important in the twenty-first century and hence worry that education in Asia-Pacific countries may still not be able to effectively face the challenges of the new era unless deeper changes in educational goals and pedagogical orientations accompany the integration of ICT in the curriculum. Which of these two positions are taken in the interpretation of the above findings will have important consequences on decision-making in educational policies, strategies and practices. It is important, therefore, that educators who care about the future of education in the Asia-Pacific region consider the present findings and decide on their specific interpretations and perspectives when they contemplate educational policies and implementation strategies related to ICT and educational reform.

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[4] The Trends in Mathematics and Science Study (TIMSS) website can be found at http://www.timss.org/

[5] The Progress in Reading Literacy Study (PIRLS) website can be found at http://www.timss.org/

[6] The Programme for International Student Assessment (PISA) website can be found at http://www.pisa.oecd.org/

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Successful Approaches to Innovation that Have Impacted on Student Learning in New Zealand

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Abstract Innovation has become an increasingly important theme in education. Improving student achievement through school-based innovations has been as challenging for New Zealand as many other countries in the Asia-Pacific region. There are few options for state imposition within the self-managing schools framework of New Zealand's education administrative structure. After a period of attempting different approaches with limited success, one approach that is described in this chapter has proved highly promising. We call the approach '*evidence-informed collaborative inquiry*'. Rather than persuading or requiring target schools to adopt innovative programmes that have been developed by external experts, the approach involves those experts collaborating with teachers to develop their expertise to diagnose student achievement problems in their schools and to develop solutions to address those problems. Three case studies are described where this approach has been successful in significantly raising student achievement

1 Successful Approaches to Innovation that Have Impacted on Student Learning in New Zealand

New Zealand, like many other countries in the Asia-Pacific region, has been challenged with how to improve under-performing schools and introduce innovations that impact positively on the achievement of their students. Although the quality of education has always been of concern to central authorities, the focus on school reform and innovation began formally in the mid-1990s after a period of withdrawal of the state from most operational decisions at the school level. Along with other countries over the past decade, there has been the inevitable proliferation of approaches that have had a minimal impact on student achievement. However, a more successful approach to reform and innovation has evolved from these early beginnings of a decade ago. There is now a growing evidence base, gained through

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replication in a number of different contexts, which suggests that one strand of New Zealand's reform efforts, is having a significant impact on teaching practices and student achievement. The purpose of this chapter is to explain the key characteristics of this approach and to illustrate its operation and impact in three separate cases of school reform. Before doing so, however, we begin by situating this New Zealand approach within the wider context of school reform strategies used in OECD jurisdictions.

Internationally, school reform is typically approached through persuading or requiring target schools to adopt innovative programmes or pedagogical styles that have been developed by external experts. The job of the schools, and the teachers within them, is to implement the desired innovation as faithfully as possible. Although this approach has been successful in some instances (Annan & Robinson, 2005; Borman et al., 2002), the school reform literature has many examples of limited successes and outright failures as teachers have continued to practice essentially as they have always done with student achievement remaining relatively static (Borman et al., 2002; Fuhrman, 2002; Kliebard, 2002). Explanations for failure have usually focused on the inadequacies of the administrators and/or teachers responsible for implementation in terms of either their resistance to change or their inadequate knowledge base (Coburn, 2001; Spillane, Reiser & Reimer, 2002). Sometimes the problem is seen to lie with the innovation package offered or the lack of clarity of the messages given (Hargreaves, 2002; Mintrop, 2003). Rarely has it been seen as a problem with the 'external agent as expert' approach to reform. Yet the evidence we are accumulating in New Zealand indicates that a fundamental shift in thinking about this approach is needed, in particular, a rethinking of the relationship between external experts and those responsible for implementing change.

Part of the reason for New Zealand's school-based solutions to school reform and innovation is its highly decentralized administration system, which limits the ability of central authorities to intervene unless certain risks are identified that necessitate it. In general, since school improvement solutions cannot be imposed by external authorities, schools can select, adapt or develop their own innovations. The evidence from the 1990s, however, was that schools' own efforts made little difference to the patterns of school organization and teaching practices that produced low student achievement (Timperley, Robinson & Bullard, 1999). An alternative approach had to be found. More urgency was also required, particularly in schools serving low socio-economic communities, because the achievement profile of New Zealand's students shows a persistent pattern of underachievement for large groups of students in these schools.

In order to understand the imperative to develop a more successful approach to reform, the next section of this chapter will begin with a brief description of the broad achievement patterns of New Zealand students, and of the administrative environment. In the following section, the theory underpinning the new approach to reform and innovation will be outlined and illustrated with three cases of how it has been successfully implemented. Particular emphasis will be placed on identifying the conditions that facilitate or inhibit its success. The chapter will conclude with an analysis of the ways in which the outlined approach to improvement differs from and challenges approaches which rely more heavily on teacher implementation of externally generated reform packages.

2 The New Zealand Context

New Zealand is frequently perceived as not having an achievement problem because our students consistently attain high average scores in literacy and mathematics in international studies (e.g. OECD, 2001). However, a serious problem is revealed when the distribution of achievement is examined, because New Zealand student achievement has the second highest standard deviation in the OECD. Furthermore, the persistent profile of students in the lower achievement bands is that of minority ethnicity and lower social class. The over-represented groups in the lowest bands are New Zealand's indigenous Maori students and first- or second-generation immigrants from the small Pacific Island nations of Samoa, Tonga, Fiji, Nuie and the Cook Islands. Population projections indicate that by 2040, these groups will form the majority of students in the compulsory school sector (Ministry of Education, 2004). The urgent challenge is to change the achievement profile of these groups of students.

The approach of central agencies to doing so, however, has been constrained by the high degree of autonomy afforded schools when self-management was introduced in 1989 (New Zealand Government, 1989). Schools have greater operational autonomy than in all other countries except Ireland, and no administrative body exists to mediate between the central Ministry of Education responsible for policy and the individual schools. Each school is governed by a parent-elected Board of Trustees that includes the principal and a teacher representative. The Board has had authority to govern the school 'as it sees fit' provided that it complies with the law on financial, employment, health and safety, and property matters, and with very broad national education guidelines and the national curriculum. Schools' compliance with these guidelines and regulations is reviewed on regular cycles by the Education Review Office, an independent audit and review agency. Unless this office showed a school to be failing seriously, there was little that the Ministry of Education could require of it. However, the discretion of Boards has reduced and the level of Ministry influence has increased as a range of statutory supports and interventions as well as planning and reporting requirements have been introduced. Typically, approximately 5% of New Zealand's 2,700 schools are under some type of statutory intervention at any one time (McCauley & Roddick, 2001; Sinclair, 1999). These governance arrangements indicate that policy developers have placed high trust in schools to utilize available resources to design, implement and evaluate their reform strategies and approaches.

While Boards are required to implement the national curriculum, the formulation of this curriculum respects the overarching goal of school self-management, in the sense that it describes a set of very broad objectives that deliberately encourage varying interpretations. For the same reason, there is no mandated national assessment system for elementary schools, but rather, a requirement for schools to set their own targets and monitor and report on their success in achieving them (New Zealand Government, 2001). The primary role of the state has been to commission assessment instruments that will assist schools to conduct their own assessments and to offer additional support to schools perceived to be underperforming. Consistent with the high trust environment in which schools operate is the discretion they exercise over which aspects of their educational programme are reviewed by the Education Review Office.

Since 1989, when this highly devolved administrative framework was first put in place, most schools have performed successfully. For the underperforming schools, the Ministry has been searching for ways to intervene without undermining the overall self-managing framework. The Ministry's first interventions occurred in the late 1990s in schools in two disadvantaged urban suburbs in the country. The Education Review Office had identified in an area-wide report (Education Review Office, 1996) that nearly half of these schools (which were unnamed) were deemed to be offering an inadequate education to their predominantly Maori and Pacific Island students. A climate of blame prevailed with different school and community groups openly criticizing each other (Annan, 1999). The schools, community leaders and Ministry officials worked hard with one another to collaborate on developing literacy initiatives that would improve student achievement. The outcome of the considerable additional funding and effort was improved cooperation and relationships among the different factions but no change in teaching practices or student achievement in many schools because few of the initiatives were directly focused on literacy teaching and learning (Timperley et al., 1999). Both Ministry officials and school leaders had assumed that the core teaching technologies needed to be supplemented by additional interventions rather than critically examined and revised. In so doing, they had bypassed the most powerful lever for raising achievement – namely the practices of those teachers responsible for delivering literacy instruction (Alton-Lee, 2003; Nye, Konstantopoulos & Hedges, 2004).

3 The Approach: Developing Evidence-Informed Collaborative Inquiry

After several years of school-initiated interventions that left the fundamentals of their teaching practice intact, an approach evolved that got much closer to the work of classroom teachers while still preserving the schools' autonomy. External researchers and facilitators were made available to school leaders to help them conduct evidence-based reviews of literacy teaching and learning rather than to present predetermined externally developed solutions. They helped the schools to introduce four routine practices for planning, implementing and evaluating their lessons (Annan, 2006). The four practices were: (i) to agree on and use common assessment tools; (ii) to analyse the impact of their own practices on the achievement problems; (iii) to revise their practice to address the achievement problems; and (iv) to evaluate whether their new practices were any more effective. The approach encouraged teachers to work together to complete the assessments, the analyses and the evaluations. Situating those tasks in a social context was fundamental because it was found to be too difficult for individuals to solve complex underachievement problems. In other words, learning together was likely to get better results than struggling on alone.

In the most successful examples external experts assisted the teaching professionals to develop evidence-informed practices and develop the analytical capability to identify and address context-specific problems within their schools. In essence, this approach involved external agents assisting school personnel to set up data collection systems that allowed an in-depth analysis of student learning and of the impact of teaching on that learning. Evidence of student learning ranged from scores on the subtests of a standardized assessment of a particular learning area to individual student responses to a particular lesson. The crucial requirement for such evidence was that the indicators of student learning could be related directly to what and how those same students were taught. Once the links between these teaching and learning patterns had been identified, the school personnel were then assisted to identify the professional learning opportunities they needed to enable them to have greater impact. The final step in the professional development cycle involved the development of evidence-based review systems, so that those involved were able to test whether their new teaching practices had been successful in improving student achievement, and to identify what further adjustments needed to be made. This approach has been used with both single schools and groups of schools. In each case, a strong emphasis was placed on practitioners learning together through a detailed analysis of student outcomes as the basis for improving teaching and learning.

The schools that participated in our three cases had all engaged previously in typical ‘school review’ processes that involved the annual analysis of student achievement data. What was new was the in-depth analysis of the evidence and the focus on the teaching–learning–achievement relationship. While a focus on this relationship was challenging for teachers, it provided the major catalyst for change. We argue that the reason for success in the three cases was the detailed search for linkages between how students were taught and what they learned.

4 Theoretical Principles Underpinning the Evidence-Informed Collaborative Inquiry Approach

When professionals have high levels of operational autonomy, imposed solutions rarely work. Treating school leaders and teachers as passive recipients of others’ expertise, who will faithfully implement what is required, ignores the fact that their theories and emotions will shape how they perceive and utilize this knowledge. The messages contained in externally developed innovations 'are not inert, static ideas that are transmitted unaltered into local actors' minds to be accepted, rejected, or modified to fit local needs and conditions' (Spillane et al., 2002, p. 92). Rather, the theories of outsiders interact with those of insiders in ways that frequently transform the former. Just as students construct the meaning of what they are taught in terms of their prior beliefs and knowledge, so do their teachers. Teachers understand particular innovations, therefore, in terms of their existing professional knowledge and beliefs. New ideas are misunderstood as familiar, ' but we already do this', or become altered in ways that are barely recognized by those promoting change and innovation (Cohen & Hill, 2000; Kennedy, 2004; Spillane et al., 2002).

The challenge for those introducing innovations, therefore, is to create an environment in which the theory underpinning existing practice can be systematically evaluated and compared with the theory that informs the innovation. For this to occur, those involved need to have sustained opportunities to engage with key ideas, to understand their implications for their own practice and to problem-solve the inevitable difficulties that arise (Spillane et al., 2002; Timperley & Robinson, 1998). We do not expect students to be one-trial learners, yet in many change scenarios we expect their teachers and leaders to be just that.

As adult learners, administrators and teachers need to be motivated to engage in this type of sustained learning process. Busy practitioners are typically willing to engage in learning opportunities that will provide helpful hints about what and how to teach but need a much stronger incentive to engage in a learning process that fundamentally challenges prior conceptions about effectiveness and requires them to unlearn and discard much of their current, deeply rooted understandings of teaching, learning and subject matter (Spillane & Zeuli, 1999). Yet it is this level of learning that is needed if entrenched achievement patterns such as those found in New Zealand's education system are to be altered.

We have found that teachers are motivated to engage in this type of learning when they realize it enables them to have more impact on what they care about most – namely their students' learning. While personally challenging, the search for evidence-based links between how they teach and what their students learn, has proven to be a powerful incentive to change. The first step in this process is for teachers to understand the discrepancies between their aspirations for their students and their current levels of achievement. This step is insufficient to motivate change, however, unless a close connection can be made between what is being taught and what the students are learning (or not learning) together with evidence that their current achievement patterns are alterable. Unless teachers have evidence of the latter, they will attribute low achievement to factors outside of their own control. Credible cases of success help teachers develop a sense of self and collective efficacy about their ability to influence student achievement. Once the connections between teaching and learning are made, then the teachers and their leaders are in a position to examine the adequacy of current practice, to consider how it might need to be changed and to judge whether their changes are having the desired impact.

The change process promotes teacher inquiry and reflection informed by evidence. It assumes that the most powerful school-based influence is teaching but that efforts to improve it through prescription are likely to be counter-productive. Teaching is more complex than this. Rather it is based on the idea that there are no perfect programmes because how they are implemented and their impact is strongly influenced by a range of contextual conditions, including teacher expertise, student learning needs and school organizational arrangements.

It also assumes that teachers are unable to make the needed changes on their own. Social interactions are fundamental to making sense of information on student learning and achievement and determining the process of change (Coburn, 2001). Teachers who evaluate their practice in isolation from colleagues will find it hard to step outside their own frame of reference when evaluating their work. On the other hand, mere interaction with colleagues is no guarantee that an independent perspective will be brought to bear. There is considerable evidence that collegial discussion can serve either to entrench the status quo (Lipman, 1997; Timperley & Robinson, 1998), or to promote engagement with new ideas (Cobb et al., 2003). The success of collegial discussion about learning and teaching, therefore, is crucially dependent on the circumstances under which it occurs including the willingness and ability of participants to act as mutually supportive critics. Collegial discussion needs to provide participants with opportunities to challenge each others' assumptions and to access alternative theories and expertise. Typically, actors within a particular practice context are unable to provide their colleagues with these types of learning opportunities because the evidence on student learning is interpreted from the standpoint of affirmation rather than critique of teaching practice. In addition, the expertise available in the group is usually insufficient for the task at hand – otherwise the group would have addressed the achievement problem earlier. Collaborative relationships with outside experts have been fundamental to the success of the innovations described in our three cases.

5 Expert–Practitioner Collaborations

In this next section, three very different cases of expert–practitioner collaborations are described. All three, however, illustrate the learning process described above. Two took place in economically disadvantaged urban communities in Manukau City in the Auckland region, and a third took place in a small rural school of mid-socio-economic status, in which a large proportion of its students were failing.

The research methodologies associated with each case have not been described in detail here, because each has been separately published with details of procedures outlined in these publications (McNaughton et al., in press; Phillips, McNaughton & MacDonald, 2002; Timperley & Wiseman, 2003; Timperley, 2004; Timperley, Parr & Bertanees, 2005). In all cases, the nature of the collaborations have been closely observed, student achievement has been independently analysed with rigorous checking processes employed, classroom observations have been systematically undertaken and school participants interviewed. Each of the three cases will be structured according to the following headings:

1. The context
2. The nature of the expert–practitioner collaboration
3. Identifying student learning problems, connecting them to teaching practice and establishing an alternative vision
4. Developing the expertise to impact on the learning problem
5. Student outcomes

5.1 Case A: Improving Early Literacy Instruction and Achievement

5.1.1 The Context

This case describes the first of several school improvement initiatives in New Zealand that are starting to produce credible evidence of a significant impact on student achievement. In the first phase of the collaboration between a university-based research team, local schools and a Ministry facilitator, 12 schools in the community volunteered to participate in an intensive programme of professional development in early literacy teaching for teachers and their literacy leaders (Phillips et al., 2002). In a second phase, seven schools agreed to take part in a 2-year follow-up study that examined how successfully the schools had sustained the gains they had made during the professional development programme (Timperley & Wiseman, 2003). This phase showed the students in two of the schools to have much higher achievement as a result of teachers engaging in evidence-informed inquiry practices. In a third phase, the remaining five schools adopted the same practices and achievement gains were analysed for these schools. The professional development was directed at teachers of Year 1 students.

5.1.2 The Nature of the Expert–Practitioner Collaboration

The collaboration involved all the teachers of Year 1 students and their literacy leaders, a research team that included a literacy expert who provided the professional development and Ministry of Education officials. The primary role of the Ministry officials was to support the initiatives in order to inform and develop national policy to help solve underachievement problems. The officials helped design the initial interventions then stepped back to facilitate the relationship between the researchers and teaching professionals and provide funding and monitoring support. The relationship between the schools, the literacy expert and the research team was the least genuinely collaborative of the three cases in that a literacy expert delivered a series of workshops according to a predetermined plan.

However, her approach was consistent with many of the aspects outlined above, in that the professional development began with a detailed analysis of each school's student achievement data and showed how those data reflected their teaching emphases. It also involved assisting the teachers to analyse their own student data in order to determine priorities for the next period of teaching.

At the conclusion of the professional development, a second research team collaborated with the schools by regularly feeding back and discussing research data on student achievement patterns and discussing the implications. These findings identified that those schools that regularly reviewed their student achievement data for teaching implications had higher student achievement than those that focused only on correct programme implementation.

5.1.3 Identifying Student Learning Problems, Connecting Them to Teaching Practice and Establishing an Alternative Vision

The professional development began with a detailed analysis of patterns of student literacy on a profile of six different literacy skills after 1 year of instruction. These patterns of achievement typically showed that students had mastered low-level reading skills, such as identifying letters and sounds, but were significantly below other students of a similar age in higher-level skills, such as reading words and continuous text. Teachers and literacy leaders were then asked to identify why their teaching practices were so successful in helping students master the low-level skills but far less successful in teaching the higher-level skills.

The participants were then shown videos of an alternative way to teach that resulted in rapid gains in students' mastery of the higher-level skills that their students had found so difficult. The teachers reported in follow-up interviews that these videos were very influential in helping them to develop an alternative vision of what might be possible for their students and motivated them to learn new practices.

5.1.4 Developing the Expertise To Impact on the Learning Problem

The expertise in alternative teaching practices was developed through workshops in which groups of teachers tested their beliefs about students and teaching, and critiqued demonstrations of new practice. The sessions were designed to challenge beliefs as well as teach new practice. Despite the intensity of the professional development and the opportunities to process the new information and solve practical problems, many of the participating teachers reported in follow-up interviews that the transition was not easy. In particular, they found it difficult to discard their deeply rooted understandings of teaching and learning and to come to terms with the idea that their previous teaching may have impacted negatively on student achievement. Many clung to old practices while introducing new ones, resulting in literacy instruction taking up most of the school day. The approach advocated in the professional development, for example, integrated handwriting with other literacy teaching. Many teachers feared that the students would not learn to form letters properly if they did not teach handwriting specifically so designated a 20-minute time period to this activity but found that they ran out of time to teach other programme components.

The second phase involved studying how seven of the schools continued their learning once the professional development had finished. Two years later, it was found that in two of the participating schools student achievement was significantly higher than in the other five. After assessing and discounting a range of possible explanations for the difference in scores (e.g. community socio-economic status, student intake scores, teacher motivation to implement the programme and class size), it was apparent that the most plausible explanation for the difference was the process used in these two schools to interrogate their evidence on student achievement. Transcripts of the teachers' discussions showed that they focused on the implications of the achievement evidence for their own teaching and helped one another with strategies to teach those students whom they identified as not making adequate progress. When this information was presented to the other five participating schools in a third phase of the research, they too adopted similar procedures. Their teaching became more targeted and student achievement improved significantly in three of these five schools. No other intervention occurred during this period.

The teachers and their leaders were highly motivated by the progress they made in closing the gap between actual and desired student outcomes. The feedback received through the examination of student progress allowed teachers to adjust their practices in ways that impacted directly on their students' achievement. Responsibility for learning and changing was firmly focused on the professionals themselves.

5.1.5 Student Outcomes

In the first phase, a random sample of students whose teachers were involved in the professional development showed significant achievement gains on a range of early literacy measures including word recognition, hearing and recording sounds in words and text reading (Clay, 1993; Gilmore, Croft & Reid, 1981) with effect sizes ranging from 0.42 to 0.83. In the second phase study, a combined measure of open-ended word recognition and text reading from the earlier assessments was used because the first phase showed that students had greatest difficulty achieving at age-appropriate levels on these measures. Two schools, as noted above, showed much greater gains than others. These two schools were those that regularly interrogated their student achievement data for its implications for teaching practice. The third phase involved an analysis of the student achievement gains for the five schools that adopted the same evidence-informed practices as the other two from the second phase. Student achievement improved in all schools with significant changes ($p < 0.05$) for three of the five schools that introduced evidence-based practice in this phase.

5.2 *Case B: Improving Senior Primary Instruction for Reading Comprehension*

5.2.1 The Context

Although the evidence-based practices and improved achievement in the junior years of these schools was receiving considerable publicity, similar practices had not extended to the senior departments of either the participating schools themselves or their neighbours in the two suburbs. The teachers of the more senior students (years 4–8) had received considerable traditional professional development based on the 'external agent as expert' model over a period of 18 months. This professional development had involved establishing appropriate expectations for students in literacy at different year levels and demonstrating how to teach more effectively. Despite everyone's best efforts, student comprehension of text remained unchanged. Three of the schools involved in the early literacy professional development, together with another five from one of the suburbs, took the initiative to contract some of the researchers involved in the previous case to assist them with improving reading comprehension.

5.2.2 The Nature of the Expert–Practitioner Collaboration

This collaboration was primarily between the schools and some of the researchers involved in the previous work. During the first year, the primary role of the researchers was to analyse and feed back to the schools the students' reading comprehension scores on standardized assessments, observe in classrooms using an observation schedule and work with the schools to identify what changes needed to occur. A second phase based on this preparatory work is planned but the results are not yet published.

5.2.3 Identifying Student Learning Problems, Connecting Them to Teaching Practice and Establishing an Alternative Vision

Baseline achievement information was collected on approximately 2,000 students in years 4–8 and analysed to determine what parts of reading and reading comprehension were problematic (McNaughton et al., 2005). Systematic classroom observations were also undertaken to determine what reading comprehension strategies were taught. Once these data became available, the researchers worked with the practitioners to test the validity of both the teachers' and researchers' beliefs about students' strengths and weaknesses in comprehending text. For example, one long-established belief of the teachers was that students could derive literal meaning from text but not make inferences that were embedded within the text. A close analysis of the students' achievement patterns, however, showed that the scores for these two aspects of comprehension were similar. A related belief was that the students were unable to learn because so many failed to eat breakfast before school. Once again, testing this belief showed that most students did have breakfast and that the achievement patterns for those who did and those who did not were no different.

When the focus turned to a detailed analysis of the student achievement profiles, teachers were provided with the knowledge they needed to adjust their teaching practices to better meet student needs. In particular, a detailed analysis of one test showed that the students typically failed to use contextual information to comprehend text. The observation of teaching practice had shown that teachers taught accepted comprehension strategies, but that these strategies had not focused sufficiently on using contextual information.

5.2.4 Developing the Expertise to Impact on the Learning Problem

The teachers were not given any systematic professional development in teaching reading comprehension during this next phase. The detailed diagnosis of their students' difficulties as well as support from their school literacy leaders was sufficient to allow them to introduce the innovations and adjustments to teaching practice that were needed. Rapid changes in student progress once again proved motivating for teachers to continue to inquire into and adjust their teaching practices.

5.2.5 Student Outcomes

Follow-up evaluations of student performance on the Supplementary Test of Achievement in Reading (Elley, 2003) showed that this preparatory work on its own had a positive and statistically significant impact on the students' reading comprehension (McNaughton et al., 2005). Effect gains for the student year levels (4, 5, 6, 7 & 8) were 0.4 through to 1.1.

5.3 Case C: Improving Senior Elementary School Writing

In the two cases described above, student needs were determined by the analysis of achievement data. However, a range of outcomes can be used in the analysis process, and this case shows how student interviews about their learning can be the catalyst for professional learning.

5.3.1 The Context

This context was very different from the other two in that the school was small (96 students) and situated in a rural town in the south of the country. The staff of five teachers was aware that their students' standard of writing was a problem and so volunteered to participate in a nationally offered professional development contract. The contract was initially for 1 year and involved a facilitator working with the school to determine the school's priorities and preferred approach. This school also participated in the associated research and the data reported here are relevant to the first 4 months of the project (Timperley et al., 2005).

5.3.2 The Nature of the Expert–Practitioner Collaboration

This collaboration involved three parties; the school staff, the facilitator and a researcher. Over the 4-month period of the study, the facilitator visited the school on five occasions, but the researcher was involved in only the first visit and then in a subsequent visit 4 months later. The facilitator's approach involved challenging the staff with evidence of student understanding of observed writing lessons and working with the staff to access the appropriate expertise they identified that they needed to change these outcomes. The researcher questioned the students on their understanding of the writing lessons and constructed a framework to assist the teachers to analyse the relationship between their practice, the student outcomes and what needed to change.

5.3.3 Identifying Student Learning Problems, Connecting Them to Teaching Practice and Establishing an Alternative Vision

On the first visit to the school the researcher and facilitator observed in three classrooms and interviewed students. The teachers faithfully implemented a lesson they had been shown in a recent professional development workshop that was modelled on the 'external agent as expert' approach. During the lesson observation it became apparent that the teachers were so focused on motivating the students to write something that they failed to communicate any lesson objective, to convey the qualities of good writing or to give feedback that provided students with guidance about improvement. The interviewed students did not understand what they were supposed to be learning about writing during the lesson, what an effective form of writing in that genre might look like, or what their teachers wanted them to work on.

When meeting with the teachers on the next visit, the facilitator summarized the observed teaching practices and asked them to articulate their beliefs underpinning their practices. They were hesitant and it became apparent that their theories about teaching writing were relatively limited. She then turned to the students' inability to articulate what they were supposed to be learning about writing or what their teachers wanted them to work on. While some teachers were shocked, others indicated that the problem was with the interviewers or the particular students chosen so, as in the above example, they were invited to test their own theories by interviewing the students themselves. When they did so, the results were no different.

The teachers' goal then became one of teaching in ways that allowed students to understand the content and vision of what they were trying to teach. They believed this understanding was likely to improve the low student achievement.

5.3.4 Developing the Expertise To Impact on the Learning Problem

Having established the problem, the teachers and the facilitator worked out what it was they needed to learn in order to teach in ways that would enable their students to understand the lesson objectives and the teacher's feedback, and to evaluate the quality of their writing. They created their own learning and feedback agenda. For example, they investigated ways to make the learning objectives more explicit to their students and to target their instruction and feedback more precisely. Rather than rely on the facilitator for feedback, they re-interviewed their students to ensure they understood what it was the teachers wanted them to learn. This process evolved through several cycles before the students were able to give the clear answers the teachers were anticipating.

When the researcher returned 4 months later, they requested that the initial research assessment of their students and classroom observations be repeated because they were so positive about the gains made by the students and wanted independent verification of their progress.

5.3.5 Student Outcomes

Over the 4-month period, the effect size for student gains on a standardized writing assessment (Assessment Tools for Learning, 2003) was 1.03. The expected effect size for one year on this assessment was 0.4. In each class, the students' writing scores improved on both surface mechanical features and deep structure features. When re-interviewed by the researcher, the students could explain the features of the text type they were writing, what content should be included in each section and what they were learning to do.

6 Discussion: Successes and Challenges

We do not wish to assert that the approach to innovation described above is invariably successful. No approach that we know of can make such a claim. However, the repeated successes indicate that it has considerable promise. In this section, we examine some of the advantages of the approach, the specific circumstances under which it worked and the associated challenges that put it at risk.

A major advantage of the approach to school improvement illustrated in these three cases, is that it recognizes both the strength of New Zealand's culture of school and professional autonomy by avoiding tight prescription about how to teach and the importance and urgency of government's intention to ensure that underachieving students are taught more effectively.

A second advantage of this approach is that it recognizes that the most powerful school-based influence on student achievement is the classroom teacher, and so it is the teachers' skills and understandings that are the target of the intervention. Promoting their reflection about the adequacy of practice in meeting student outcomes is central. New Zealand achievement patterns show a wide within-school variation, suggesting that the classroom teacher rather than the structural features of schooling need to be the target of change if student achievement is to improve.

A third advantage of the approach to school improvement used in these three cases is the precision of the evidence-based approach. The intervention goes well beyond general calls to examine student achievement data – something that was already happening in many of the participating schools. The key to success was the challenge and support teachers received in forging precise links between what they taught to particular students or groups of students and what the evidence showed about what those same students had learned. Establishing the teaching–learning–achievement link was central to the process. All successful cases engaged in this type of evidence-informed inquiry.

A fourth advantage of the approach was that it recognized the power of teacher theory (Robinson & Lai, 2006). The goal of the facilitators and researchers was not to impose a teaching script but to provide the resources to help the teachers examine the adequacy of their own theories of practice and keep revising them until they had achieved the results they sought. This process was particularly evident in Cases B and C. The capacity of the teachers was developed by showing them how to test their theories and by exposing them to alternatives. As Spillane and Zeuli (1999) put it, the approach allows those involved to unlearn and discard current understandings of teaching and learning and to adopt more effective alternatives.

While these advantages are important, the approach illustrated in our three cases is not without its difficulties. Autonomy to succeed also allows for freedom to fail or disengage. One of the schools that made little improvement in Case A essentially disengaged and continued to blame the community and the children for their limited progress. Schools that are unprepared for the surprises inherent in studying the impact of teaching on learning, or that prefer to reject the question altogether, are unlikely to engage in a sustained way in such a process. On the other hand, many of the schools that were sceptical at the outset became more strongly engaged and motivated when they saw the impact of their new teaching strategies on their students' achievement.

Another difficulty that can arise in the initial stages is that teachers interpret the process of data collection and interrogation as something which they already do. Recent research on teachers' cognition (Cohen & Hill, 2000; Kennedy, 2004; Spillane et al., 2002) has documented how teachers interpret particular innovations in terms of their prior professional knowledge. Since most New Zealand schools currently analyse student achievement information, there is considerable scope for dismissing the features of data analysis and discussion that are a key to the improvements we have reported. Central to the success of the three cases reported here were the skills of evidence-based inquiry. Teachers needed to be able to interpret achievement data in terms of their implications for their own teaching in ways that required a much deeper level of analysis than that often engaged in. To undertake this task required considerable capacity within the school. In one of the schools that failed to make much progress in Case A, internal capacity to understand the teaching implications from examining the data was a serious issue. This school, like many others, was able to aggregate student data, note trends and base innovations on personally valued practices (Annan & Robinson, 2005). Until recently, unless a school was underperforming administratively, New Zealand's self-managing policy legitimated the pursuit of professional preferences, even though they may have been associated with little or no evidence of success. A range of support and intervention strategies are now available to encourage professional preferences to become more evidence-informed.

The depth of skill involved in data-based critique and revision of teachers' theories of practice raises the question of the availability of appropriate external expertise to assist schools to both undertake the analysis and develop and evaluate their own improvement process. In some of the innovations described above, the external experts have learnt alongside the schools about how to be more effective. Those consultants typically had expertise in particular content or pedagogical knowledge and found it difficult to begin with the analysis of the students' needs and to tailor their advice accordingly. Many of them were used to giving advice based on a standardized package or innovation, without checking whether that advice was effective in a specific context.

7 Conclusions

The two approaches to school change and innovation discussed in the introduction to this chapter have both had their successes and failures. The differences between them focus on the teachers' role and agency. The 'external agent as expert' approach asks the teacher to implement a programme developed by others with maximum fidelity. Teacher agency is limited to good programme implementation. The 'evidence-engaged collaborative' approach we have described in more detail in this chapter places the teacher at the centre of the reform. Teachers develop and direct the reform through the analysis of the impact of their teaching on student learning. The role of the external agent is to assist the teachers to analyse their own teaching practice in relation to students' learning and achievement patterns and to make appropriate adjustments.

In neither approach are schools and teachers left to construct their own solutions to the challenges they face. Both require an extensive learning support infrastructure with the 'external agent as expert' model typically requiring the external agent to be present for at least 3–4 years before the alternative practices are sustained. In addition, dependence on external curriculum expertise is likely to mean that what is learnt in one curriculum area will not generalize to improved practice in another.

Rather, each set of new teaching practices is specific to the particular context in which they are learned. The 'evidence-engaged collaborative inquiry' approach also requires considerable infrastructure support to assist teachers to analyse the meaning of their data. To date, we do not have reliable evidence over repeated contexts on the length of time support is required for the practices to become self-sustaining or on the extent of generalization of the process to other curriculum areas. The schools involved, however, have an expectation that they will become independent of additional Ministry funding and support for their improvement initiatives and this expectation may shortly become reality for the first group of schools that engaged in the process. Those schools currently receive minimal additional state funding and are using their operational funding supplemented by research grants to fund their ongoing partnership with their preferred external researchers.

This approach to reform and innovation has not only challenged the particular schools and those who have sought to assist them, but also challenged some of our fundamental ideas about effective school reform and innovation. We are suggesting that practitioner resistance to change and misunderstandings of the intent or practicalities of innovations are almost inevitable in the 'external agent as expert' model. The limited success of so many innovations reliant on external experts has typically led to greater refinement of the specifics of those innovations and further specification by the external agent of what is required, (Borman & Hewes, 2002; Earl et al., 2003; Harwell et al., 2000), rather than consideration of whether the approach itself may be the problem.

Part of the challenge to the 'external agent as expert' model is the assumption that there is some generic 'good' programme or pedagogical approach out there that will improve student learning even in the most challenging circumstances. The New Zealand experience indicates that there are many possibilities for 'good' programmes. The problem is that they are only as good as their implementation in a particular context. The more important requirement is to ensure that teachers have the skills to test whether or not their implementation is working for this particular group of students in this particular class with their current level of teaching skills. We suggest that providing schools with the tools to analyse their own and their students' learning needs and to test whether their efforts are successful is likely to be more effective in the long term than tighter prescriptions about how to teach.

8 Implications for Reforming Learning Within the Asia-Pacific Region

Most countries in the Asia-Pacific are attempting to reform learning, hence the need for a book such as this. The region's economic, political and social survival is strongly influenced by the ability of all the countries within it to maximize the potential of their education systems. Teaching yesterday's knowledge using yesterday's methods will not be sufficient to meet the challenges ahead.

The evidence-informed collaborative inquiry approach we have described in this chapter takes a different approach to moving ahead from that typically adopted in other countries. Teachers and their leaders became part of the knowledge development and reframing process. This knowledge is based on the evidence of 'what works' and is shaped by the realities of teachers' lives. It also uses the knowledge of researchers and policy-makers to inform what teachers do.

The problem with most collaborative knowledge-building processes is that they often remain local and become transitory, inaccessible to other teachers and lost amidst a plethora of fads. Through the involvement of researchers and national policy-makers, the evidence-base becomes more rigorous and provides mutual learning opportunities for policy-makers, researchers, teachers and their leaders. It is strongly focused on what works for our most vulnerable students. Through taking a collaborate approach to learning, all groups learn together, with key strategies for success becoming embedded in national approaches to promoting learning. The three cases described in this chapter have strongly influenced other approaches taken to reform learning in different initiatives throughout the country. To this extent, the approach described has gone beyond creating local knowledge to creating national knowledge. The involvement of policy-makers in the learning collaboration was essential for this process to occur.

This approach is not one that simply trusts teachers to get on with the job of teaching because they should know best how to teach. Nor is it an approach that uses an external agent to tell teachers what to do according to sets of prescribed practices. Rather, it involves collaboration among interested groups where learning participants are mutually accountable to one another for making a difference to their students' learning. Evidence of such learning and the skills to interpret and use it are central to the approach. Evidence-free collaborations are no more effective than non-collaborative efforts. Using the evidence as the touchstone against which to judge the effectiveness of the efforts of any participant in the collaboration has served to build knowledge in the direction of what makes the most difference to traditionally under-served students.

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