

*Research in Mathematics Education in the Past Twenty-Five Years in Hong Kong*¹

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This paper attempts to paint a picture of research in mathematics education in Hong Kong in the past twenty-five years. The purpose of painting this picture is not to trace all the fine details as it is impractical to do so; rather it aims to outline an emerging shape of a local community of mathematics education. The multifaceted interests of Hong Kong scholars in mathematics education have produced research in diverse areas such as teaching and learning, social factors and belief, curriculum and assessment, and the pedagogical use of technology. This body of research established for Hong Kong's local community of mathematics education a foundation to extend its

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influences regionally and globally. A few concerns are raised at the end of the paper with respect to the future of mathematics education research in Hong Kong.

Key words: mathematics education, educational research, Hong Kong education

The Emersion of a Local Circle of Academics

The dual nature of mathematics makes it a discipline with a unique universality feature that is very different from other disciplines. This unique feature, however, often poses a challenge to the teaching and learning of mathematics.

On the education side, there is a common belief among stakeholders that mathematics is a good indicator of students' intellectual ability in general and higher order thinking skills in particular (Wong, Lam, Leung, Mok, & Wong, 1999). It is precisely this expectation that exerts intense pressure on students since the compulsory free education era in Hong Kong.

Addressing these enigmas the mathematics education community in Hong Kong has been investing much effort in the betterment of mathematics learning and teaching in the past three decades. Other than the practical work of frontline mathematics teachers and government officials, we have witnessed an emersion of a local circle of academics working on research related to mathematics education largely from the perspectives of psychology, sociology and curriculum theories, which has yielded some fruitful results.

In the past 25 years, we see the emersion of the Hong Kong mathematics education research community. It has not only been developing its local influences, it has extended its influences to other regions (the greater China region in particular). Furthermore, these academics have earned recognitions from international research communities. Local scholars have presented papers, delivered regular and plenary lectures in international conferences and some of them are members of high level committees in international organizations. Looking at the International Congress on Mathematical Education (ICME) alone, the number of Hong Kong participants had gone up from 4 in ICME-7 to 22 in ICME-9. In 2000, a delegate of the Hong Kong frontline teachers attended ICME-9. All these

are evidence that Hong Kong mathematics education is beginning to play an increasing role in the international stage.

In 陸鴻基、馮以淞、黃顯華、鍾宇平(1991) which categorizes Hong Kong's educational research from 1946 to 1982, six publications on mathematics curriculum were identified (not counting internal reports and dissertations).² After the turn of the millennium, the four Teacher Education Institutions (TEIs)³ in Hong Kong were all running higher degree programmes in mathematics education, some of which have already nurtured Hong Kong's own doctoral (either Ph.D. or Ed.D.) graduates. In terms of publication venues, there is an increasing number of local educational periodicals. In addition, since 1996 the Hong Kong Association for Mathematics Education (HKAME) has been organizing conferences regularly⁴ where local mathematics teachers and scholars can share ideas and present research findings. The driving force of this indigenous phenomenon is multi-faceted. In the larger environment, with the start of the Cold War and the advent of worldwide Modern Mathematics Movement, the colonial government began to support and encourage local mathematics educators who were at the same time government officials to study new ideas in the United Kingdom and learn modern pedagogies in overseas conferences since the early 1960s (鄧國俊、黃毅英、霍秉坤、顏明仁、黃家樂, 2006). A strong underlying local reason could be the emergence of a local identity after the 1966/1967 social disturbances. The colonial government probably saw the need to take the move to strengthen the local identity in order to enhance its governance. After all these incidents, Hong Kong residents began to call themselves "Hongkongers" (香港人) for the first time. Another reason lies in the extension of education from primary up to tertiary levels. The launching of six-year and then nine-year compulsory free education in 1972 and 1978 respectively were two milestone events. Despite the keen competition in university entrances, the setting up of university grants and loans enables more students, especially from families of a lower socio-economic status, to have chances to receive higher education. These various social factors consolidated a breeding ground for a community of local academics.

In what follows, we will try to summarise to the best of our knowledge the work of these local mathematics education academics in the past twenty-five years. We hope that this study will enable readers to form an overview of the research activities that have been carried out by the Hong Kong mathematics education research community in the past twenty-five⁵ years.

Source of Information for the Study

We began the task by searching over key local academic/professional journals in the past 25 years. These journals include *Educational Research Journal*, *Education Journal* (formerly *The Chinese University Education Journal*), *Journal of Basic Education* (formerly *Journal of Primary Education*), *Curriculum Forum*, and *Hong Kong Science Teachers Journal*. We have also contacted mathematics educators currently serving in the four TEIs and browsed the publication lists in their web pages.

Furthermore, we confined ourselves to published academic outputs and conference papers that were based on research, i.e., studies that involved systematic collections and analyses of quantitative or qualitative data. Documentary analyses are included but not comments, opinions and personal views since they are outside the scope of this paper, although it is not always easy to distinguish between the two. Master of Education theses and reports are generally not referred to explicitly in this study unless they have been published in academic journals. Local Master of Philosophy and doctorate theses are included. These include subsequent publications of those Hong Kong nurtured academics from the Chinese mainland.

An Overview of Research Activities

Learning

The ultimate purpose of most, if not all, educational research is the betterment of learning and teaching. Naturally, learning and teaching are interrelated, but for clarity, we will first describe those investigations on students' learning of mathematics. We will look into the issue of mathematics teaching in later sections. We identified clusters of local research touching directly upon the learning and teaching of school mathematics, and problem solving seems to be at the centre of this body of work. Earlier research in this area by local scholars include Ki's (1986) study of mathematics problem solving heuristics by using thinking-aloud protocol, Yuen's (1988) thesis on problem solving in connection with spatial representation, and Lee's (1981) investigation on the establishment of a model of problem solving. Though these studies were conducted more than twenty years ago, some of them, in particular the last one, are still cited recently (for instance, Wong, Marton, Wong, & Lam, 2002) It is well stated

in the literature that problem-solving performance can be affected by a number of factors. In particular, affective factor (including classroom learning psycho-social environments) has been studied by Hong Kong academics. We will come back to this area in the sections that follow. The use of open problems and its effects have been studied in a Research Grant Council competitive earmarked research.⁶ Results revealed that, by and large, the performance of mathematics problem solving was enhanced through a systematic introduction of open problems (Wong, Chiu, Wong, & Lam, 2005; Wong, Kong, Lam, & Wong, 2008). In another vein, Lopez-Real was active in the work on problem solving especially from the perspective of teacher training (Lopez-Real & Lee, 2006). Leung, Ling, & Wong (2004) also investigated students' performance in authentic tasks and Cheng (2002a, 2002b) investigated mathematics thinking among primary school pupils.

Studying the learning process of mathematics students has drawn the interest of a few scholars. Cheng, as well as his colleagues and students (Cheng, 1979; Cheng, Das, & Leong, 1984; 鄭勳俊, 1983), conducted studies on the cognitive process of doing mathematics. Wong (1989) proposed the use of concept map (inferred knowledge structure) as an alternative means for assessment. He later turned to a proposal of an ontological shift from "lay mathematics" (realistic/street mathematics) to formal (esoteric) mathematics (黃家鳴, 1995). Implications of his work were later drawn on the issue of realistic mathematics in the curriculum (Wong, 1994, 1997; 黃家鳴, 1997).

Another cluster of research is on understanding. While Wong and Watkins (2001) investigated students' perceptions of mathematical understanding, Law (1994) used mental representation (which has some similarities with the inferred knowledge structure of Wong, 1989) as a means to assess mathematical understanding. Though understanding and misunderstanding (or misconception) may not necessarily be a dichotomy (Wong, 1994), not much was done, to our awareness, on students' mathematical misconception. However, 李芳樂 (1993) did make an exploratory study on mathematical errors made by students. Mok (1987) and Wong (2001) were two other studies that concerned mathematics understanding. Cheung (2004) did a small case study on the effect of peer tutoring in a pure mathematics class. Apart from these, Chiu conducted his Ph.D. study on the use of metaphor and cooperative learning in mathematics (Chiu, 1997) which later generated quite a number of publications (Chiu, 2000, 2004).

All these studies let us know more on how students learn mathematics and what influence their learning. These inform practitioners in mathematics education and accordingly their teaching could be enhanced.

Affect and Social Factors

After behaviourism passed its peak, attention was drawn on how non-cognitive factors⁷ influence mathematics learning. The notion of affect was re-conceptualised and emotion (formerly regarded as non-researchable) was investigated in depth. There also exists a huge body of research on beliefs and conceptions.⁸

In the last three decades in Hong Kong, there have been a line of research which ranges from traditional studies on the relationship between attitudes, confidence, self-concepts and mathematics learning outcomes (黃毅英、鄭肇楨, 1991a) to more sophisticated statistical analyses using path analysis, structural equation models and reciprocal analysis (Marsh, Hau, & Kong, 2002; Wong, 1992; 黃毅英、鄭肇楨, 1991b). Motivation was an object of study in Chiu's (1999) work on cooperative learning; learning habit, learning difficulty, mathematical anxiety and student engagement were selected as variables in other investigations (Kong, Wong, & Lam, 2003; Wong, 1992; Wong, Lam, & Kong, 2003; Wong et al., 1999; 黃毅英、鄭肇楨, 1991a).

Socio-economic status and indicators, including family income, residential size, parental background (occupation, educational level, expectation) and family support on learning (for instance, whether one has a desk for doing homework), have been considered in mathematics education since the Second International Mathematics Study in the 1980s. These aspects were studied by local scholars (Cheng, 1980; Mok, 1988; 黃毅英、鄭肇楨, 1991b) and later by the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). Family background was studied in Tam and Pun (2006). Inevitably, techniques from social psychology were widely used in these studies in the earlier stages. For instance, Wong (1988) studied the effect of reinforcement and monitoring on mathematics problem solving. To some extent, there was a blend of the "generic" (subject-independent) with the "specific" (mathematically related) in this body of work.

Another line of study was on psycho-social classroom learning environments (classroom atmosphere). This was also the theme of Wong's (1995b) Ph.D. thesis. A number of research output was generated from his

work on this theme (Wong, 1995a; Wong & Watkins, 1996, 1998). In particular, the idea that “preferred-perceived environment congruence enhances learning” was re-confirmed and the local situation was delineated with the development of a ready-for-use instrument (Wong, 1993). In addition, the picture of a mathematics classroom environment as preferred by students was portrayed. In brief, such an environment should be one that is lively and not boring, with order well kept, classmates engaged in learning, with clear explanation furnished by the teacher. Related studies can be found in Wong et al. (1999). 丁銳, Wong’s Ph.D. student, later extended this work to the Chinese mainland and to the constructivistic classroom environment (丁銳, 2007).

Student learning is investigated from another angle besides the cognitive process. Influences from various “non-cognitive factors” were unfolded and studied in depth. These studies allow the circle to become aware of these factors, which were once deemed as intangible, during their process of mathematics teaching.

Beliefs and Related Studies

A body of research was done on students’ and teachers’ beliefs. A research team of the Chinese University of Hong Kong started to investigate students’ and teachers’ conceptions of mathematics and mathematics learning (Wong, Marton, et al., 2002; 黃毅英, 2002). The project was extended to the greater China region and cross-regional comparisons were also conducted (黃毅英、韓繼偉、王倩婷, 2005). It was found that students generally had a limited view of mathematics. Mathematics was identified by content and terminology and was regarded as a subject of “calculables”. It involved thinking and was useful. However, mathematics was segregated from other subject areas (for instance, writing is not mathematics). Geometric concepts were generally underdeveloped. Commonly used tactic in problem solving was to search for routines by identifying mathematical and non-mathematical clues from the questions and to find solutions by applying these routines (Wong, Marton, et al., 2002; 黃毅英、孫旭花, 2002; 黃毅英、黃家鳴、林智中、羅浩源, 2004).

Teachers’ views of effective mathematics learning and teaching were gauged in a couple of studies (Bryan, Wang, Perry, Wong, & Cai, 2007; Wong, 2007). These views actually reflect teachers’ values on mathematics education. It is worth mentioning that there is an advancement of

methodology in the investigation of both students' and teachers' beliefs by the use of hypothetical situations (Wong, Wong, Lam, & Zhang, 2009).

The aforementioned research on beliefs gradually moved to study the notion of "lived space" and the shaping of such a "lived space" (Wong, Lam, & Chan, 2002; Wong, Marton, et al., 2002). A natural question to ask is "how can one change the above 'undesirable' (narrow) beliefs about mathematics?". If we confine to school experience, there are at least two possible origins of students' conceptions of mathematics: teachers' conceptions and the "space" that the students live in, with the "space" referring to the learning environment that shapes students' learning experiences. Teachers' conceptions of mathematics and the "lived space" they shape mutually build on each other. The former guides teachers to shape the latter while the consolidation of teachers' own conceptions is a consequence of their own learning experiences when they were students. To reverse the above vicious circle, variations were introduced to broaden the "lived space". The underlying idea came from phenomenography which suggested that patterns of variation were associated with wider and powerful ways of experiencing phenomena, which would result in deeper learning (Marton & Booth, 1997). There is a body of research by Marton and his colleagues that base on the theory of variation in the Hong Kong context. Since they do not focus on mathematics learning, we will skip the details here. Yet in sum, in this body of research, not only students' and teachers' beliefs were studied, how their beliefs can be changed is also investigated.

Teaching

In the early 1990s, mastery learning was experimented with primary mathematics (鄧廣威、韓孝述、黃顯華、黃毅英, 1995). The notion of *bianshi* (which literally means variation of style) teaching, which has been popular in the Chinese mainland for decades, was translated into mathematics curricula and experimented in both primary and secondary schools, yielding fruitful results (Wong, 2008; 黃毅英、林智中、孫旭花, 2006; 黃毅英、林智中、陳美恩、王豔玲, 2008). There are fundamental connections between *bianshi* teaching and the pedagogy of variations and one can refer to the work of Gu, Marton, and Huang (2004), and those research on "lived space" mentioned in the earlier section.

Research was also conducted on specific topic areas in the mathematics curriculum. Mok, following her M.Ed. study on mathematical induction

(1987), continued to investigate misconceptions of algebraic thinking in her Ph.D. pursuit (Mok, 1996); while P. H. Wong (2001) focused on the interpretation of algebraic knowledge in her Ph.D. thesis. Wong (2005) drew further insights from the above-mentioned work on the history of primary mathematics curriculum on why, how and when algebra should be learned.

Cheung, Lam, Siu, and Wong (1986) did an appraisal of the teaching of statistics in secondary schools of Hong Kong which initiated (at least indirectly) the Hong Kong Statistical Project Competition (see 沈雪明、李金玉、林建，1995 for details), which is in operation until today.

Though it seems that there are but a few publications on the teaching and learning of specific mathematics topics, there have been quite a number of M.Ed. studies in this area.

Around the same time when the International Study Group on the Relations between the History and Pedagogy of Mathematics was set up in 1976, Siu introduced the idea of using history in the Hong Kong mathematics classroom (Siu, 1985; Siu & Siu, 1979). Lit's M.Phil. thesis was the first local research addressing the issue empirically (see Lit, Siu, & Wong, 2001 for details). Lit and Wong (1998) investigated the effectiveness of the use of history in mathematics teaching in secondary schools and teachers' attitude towards the use of history.

The use of games, manipulatives and other hands-on experience in teaching has been advocated since the 1960s with the rise of child-centred mathematics projects (see 鄧國俊等，2006). However, Fisher-Short (1969) and 成子娟 (2007) were the only two publications found on the effectiveness of using teaching materials. As for the hot topic of small class teaching, as far as we know, no empirical studies were done so far on its effectiveness.

Learning and Teaching to Cater for Individual Differences

Learning differences is one of the salient issues in universal education. Experimentation on mastery learning in mathematics⁹ in the early 1990s was one of the earlier systematic attempts to cater for learning differences (鄧廣威等，1995). When the Curriculum Development Institute was first established, there was a unit devoted to mastery learning of which 韓孝述 was in charge. In 2000, the Education Department commissioned a number of studies that further addressed learning differences: "Catering for Individual Differences, Building on Variation", "No One Is Dispensable —

Motivation and Models of Learning among Primary School Students in the Subjects of Chinese, English and Mathematics”, “Use of IT Technology to Cope with Individual Differences” and “Developing Learning Communities in Catering for Individual Differences for Primary School Children”. These studies were conducted respectively by research teams at the University of Hong Kong (HKU), the Chinese University of Hong Kong (CUHK), the Hong Kong Institute of Education and a joint research team comprising members from the Open University of Hong Kong and HKU. All of these studies had mathematics as one of the teaching and learning subjects to research on.

A number of publications were generated from the CUHK project. It is noteworthy to mention that out of the “Catering for Individual Differences, Building on Variation” project, an original Hong Kong based concept of Learning Study, which was a marriage between Lesson Study and Matron’s Theory of Variation (see, e.g., Marton & Booth, 1997), was developed by the HKU research team. In this project, primary mathematics lessons constituted a major component in the pool of collected data. Lo, one of the principal investigators of the project, subsequently established the Centre for Learning-study and School Partnership at the Hong Kong Institute of Education to propagate Learning Study practices and research in Hong Kong schools. A large portion of the learning studies that this Centre produced consisted of primary and secondary mathematics lessons. Currently, research papers and books on mathematics learning study are in the shaping basing on this large pool of data (see Lo, Pong, & Chik, 2005 for some preliminary findings).

As for mathematics learning for specific target groups, besides Tse’s (2007) Ed.D. study on measuring students’ mathematical giftedness, no systematic research has been done, to our awareness, on the identification and nurturing of the mathematics talented and of those with learning difficulties, including mathematical dyslexia, though this area of research is receiving increasing attention. However, there were some publications on these issues not necessarily confined to the learning of mathematics.

Gender issue is one of the prominent issues in mathematics education and gender differences are often tapped in local educational research studies (including TIMSS). However, we are not aware of any local research investigating on how boys and girls learn differently (or not differently), not to mention how to maximize learning in the two genders. Similar is true for cultural/racial differences.

The medium of instruction is a much debated issue in Hong Kong, yet not much studies was done on how medium of instruction affects mathematics learning. However, it is worthy to note Lai's exploratory study on linguistic features of teachers who later came up with differences in Piagetian tasks among Chinese (Hong Kong) and English (Australia) speaking children in her Ph.D. study (Lai, 2008). Despite the majority of Hong Kong residents are Chinese, there is a need to study (not just at the policy level) the "minority" ethnic groups and the new immigrants. The work of 陳榮坤 (2004) was an initial attempt in this aspect.

Pre-school learning is an area that has been attracting growing interest. The papers by Oppen (1988) and 吳慧鳴 (1995) are two earlier publications on this topic. 成子娟, a Hong Kong resident who was an expert in this area when she was in the Chinese mainland, completed her Ph.D. study (成子娟, 1999) in Hong Kong and produced a lot of related work. Other publications on pre-school mathematics include Ng (2005) and Ng & Rao (2005).

Information and Communication Technology

Research on using technology in mathematics education in Hong Kong probably went back to Lee and Ip (1981)'s study on the use of calculators. Lee (1996) worked on an intelligent tutoring system in logarithms in his Ph.D. study and subsequently on electronic homework (Lee & Heyworth, 2000). Wong and Tang made a web-based resource package StatNet to facilitate the teaching and learning of statistics in primary and secondary schools in Hong Kong (Wong & Tang, 2000). Later, Tang and Wong (2002) made further enhancement of the existing web-based statistics resource package. Hong and Su (2007) did a preliminary study on a microworld for learning probability; whereas I. K. C. Leung (2008) explored the pedagogical potential of SmartBoard™ to study deductive reasoning in a classroom.

There is a line of studies conducted by Kong at the Hong Kong Institute of Education in which a web-based computational device was developed as a cognitive tool for teaching the addition and subtraction of common fractions. In particular, a graphical partitioning model was used as the basic design of this cognitive tool that intended to meet the diverse needs of learners. Case studies were conducted by observing how primary students understood fractions operations based on knowledge of fraction equivalence in the computational environment simulated by this cognitive tool (Kong &

Kwok, 2002). The cognitive tool was then refined in terms of graphical presentation and hypothesis testing and a model of affordances was developed (Kong & Kwok, 2003, 2005). Furthermore, pedagogical potentials of the cognitive tool were explored under a design-based study.

There is currently an active group of scholars working on Computer Algebra System (CAS) and Dynamic Geometry (DG) environment. Mok, Johnson, Cheung, and Lee (2000) made an attempt to study the use of graphing calculator in secondary classroom via a case study. Leung and Lopez-Real (2000) did a study on secondary school students' problem solving strategies in Cabri™ (a DG environment). This started a research direction probing into the pedagogical potentials of DG environments. In particular, they re-conceptualized the nature of geometrical knowledge and proof in such an Information and Communication Technology (ICT) environment (Leung & Lopez-Real, 2002; Leung & Or, 2007; Lopez-Real & Leung, 2006). Leung (2003) made a pioneering attempt to analyse geometrical exploration in DG environments using Marton's discernment framework of variation, consequently initiated a new approach in DG research (Leung, 2008; Leung & Chan, 2006; Leung, Chan, & Lopez-Real, 2006). As a result of these research initiatives, Chan (2009) completed his Ph.D., the first of its kind done in Hong Kong, studying the experimental-theoretical interplay in DG environments. In another vein, Lee designed an innovative DG e-platform to capture and collect quantitative data on students learning behaviours and consequently opened up another new approach in DG research (Lee, Wong, & Tang, 2004). Together with Wong, Leung, and Tang, an experimental "Geometry Click'n Drag" e-platform (<http://geometry.eclass.hk/>) was developed and installed for access by Hong Kong local school teachers and students (Lee & Leung, 2008; Lee, Wong, & Leung, 2006; Wong, Lee, & Tang, 2005). It is anticipated that ground breaking ICT pedagogical ideas will be generated in this direction of research. Recently, Or has embarked on an original study on the Cabri3D™ environment probing visual reasoning for 3D figures in a dynamic virtual setting (Or & Leung, 2008). Leung is currently working on formalizing proof in DG environment (Leung, 2009).

A natural question to ask is whether the use of ICT enables one to learn mathematics more effectively or one is actually learning a different kind of mathematics (see a discussion in Lopez-Real & Leung, 2006). Wong (2003) gave a comprehensive review on the impact of ICT on mathematics curricula around the world (Hong Kong inclusive).

Curriculum Analyses

Mathematics is delivered basically through the school curriculum, which is implemented in classrooms. Some scholars estimated that students in reality spend as much as fifteen thousand hours in the classroom, despite the fact that family and out-of-school experiences play important roles in learning. Earliest attempts of curriculum and textbook analyses were those conducted by the Professional Teacher Union (教協數學組, 1981) and the Education Action Group (教育行動組, 1975). Textbooks play an important role and are usually regarded as a major component of curriculum documents. However, studies done in this area by Hong Kong academics remain scanty. While 鄧國俊、貝磊 (1994) conducted an analysis on Macau mathematics textbooks, Park and Leung (2006) did a comparative study on mathematics textbooks among different countries including Hong Kong.

An investigation was conducted on students' attitude towards the modern mathematics curriculum in the 1980s (Pun & Cheng, 1981) and a group of scholars conducted an appraisal of the mathematics curriculum in the mid-1990s (Wong, Wong, & Lam, 1995; 黃家鳴、林智中、黃毅英, 1995). With the controversies that were brought about by Target Oriented Curriculum (TOC) (黃毅英、曹錦明, 1997), the Curriculum Development Institute launched a comprehensive holistic review of the mathematics curriculum. Two research studies were commissioned to support the review (Leung, Lam, Mok, Wong, & Wong, 1999; Wong et al., 1999). Furthermore, epistemological analyses of the mathematics curriculum were conducted (黃毅英, 2003). These studies have been influential in bringing about suggestions in the development of the current mathematics curriculum and informative in providing students' attitude towards, and beliefs about, mathematics learning.

Numerous large-scale general education projects involved mathematics teaching and learning (taken as curriculum implementation), though mathematics is not the main focus of study. Some of these projects include the School Effectiveness Project, Review on 9-year Compulsory Education and Medium of Instruction. These studies informed the effectiveness of the mathematics curriculum from broader perspectives and played valuable roles in curriculum analysis.

Hong Kong has participated in cross-regional comparison studies since the 1980s (Brimer & Griffin, 1985; Griffin & Mok, 1990). Analyses of the local curriculum were performed in some international comparative studies. From a cross-cultural perspective, Hong Kong has been actively involved in

different stages of TIMSS. These include the 1992 Third International Mathematics and Science Study, the TIMSS Video Study and the Trends in Mathematics and Science Study since 2003 (see, e.g., Leung, 2005a, b). Furthermore, Hong Kong took part in PISA, another large scale cross-regional study (see, e.g., Ho, 2003, 2005). A spin-off of TIMSS is The Learner's Perspective Study. Several books have been published, which contain extensive contribution by Hong Kong scholars (Clarke, Emanuelsson, Jablonka, & Mok, 2006; Clarke, Keitel, & Shimizu, 2006). As regards local comparative studies on the mathematics curriculum, two important contributions are the Ph.D. theses of Leung (see Leung, 1995) and Huang (2002) (see also Lopez-Real, Mok, Leung, & Marton, 2004).

There are other noteworthy smaller scale comparison studies done by Hong Kong scholars. 馬雲鵬 (1999) completed a Ph.D. thesis in Hong Kong studying mathematics curriculum implementation in China urban and rural areas in the Chinese mainland. Tang's (1999) Ph.D. thesis initiated comparative studies with Macau (甘志強、鄧國俊、顏明仁, 2003). Other comparison studies include those by Huang and Leung (2002), and 馬雲鵬 (1995).

These studies provide an overview of the strengths and weaknesses of the Hong Kong mathematics curriculum when compared with the international setting (Leung et al., 1999). 黃毅英、黃家鳴 (1997) investigated the curriculum contents of ten educational regions and drew a East-West contrast in the perspective of the "product-process dichotomy". The issue was re-visited with newer mathematics curricula around the world in Wong, Han, and Lee (2004). It was found that there existed a blurring in the East-West distinction under the new wave of curriculum reform in the turn of the millennium; and the issue of losing one's identity under the wave of globalisation by "copying" too much from other regions became an interesting area of research.

These observations echo the voluminous literature on the Confucian Heritage Culture (CHC) learners' phenomenon (N. Y. Wong, 2004). A number of explanations were drawn on such a cultural phenomenon (Fan, Wong, Cai, & Li, 2004; Leung, 2001, 2008). Based on such a discourse, Wong further proposes the idea of constructing a path from "entering the way" to "transcending the way" as a "teacher led yet student-centred" mode of learning and teaching (Wong, 2008), which is in concord with the Chinese tradition of learning and teaching (Leung, 1998; Wong, 1998).

As for curriculum analyses across time, on top of earlier historical investigations of mathematics education in Hong Kong, Wong and his

colleagues presented a full account of the evolutions of both the primary and secondary mathematics curricula in Hong Kong in the past decades (黃毅英、黃家樂，2001; 鄧國俊等，2006). These accounts not only provide us with a comprehensive and impartial picture of the origins of the existing curriculum,¹⁰ they propose a socio-historical perspective for deeper understandings (particularly for the primary mathematics curriculum). A number of “lessons learned” are given which illuminate the current curriculum and educational reform. These researchers further tried to offer insights on the development of local curriculum in general in other publications.

Assessment

As for assessment of learning, K. M. Wong (Wong, 1989) suggested the use of concept map and S. S. Leung (Leung, 1997) suggested problem posing as alternative means of assessment. Explorations have used open problems to assess students’ problem solving performances (Lopez-Real & Chan, 1999; Wong, Chiu, et al., 2005; Wong et al., 2008); and they differ from previous investigations conducted in normal class settings in its specially designed teaching methods (何兆倫，1974; 陳業江，1983). There has not been much research on the effect or impact of (alternative) assessment on mathematics learning. TOC assessment was the focus of attention when, together with his colleagues published extensively on the SOLO (Structure of the Observed Learning Outcome) taxonomy, and was suggested for use in TOC assessments. Mathematics was used only as examples for illustration in these papers until Li offered a number of SOLO super-items in mathematics (Biggs et al., 1989). However, a full development of such items never materialized with the phasing out of TOC.

Mathematics attainment/aptitude by itself is an under-researched area in Hong Kong though large scale studies often include some of these items. The Education Department developed five series of attainment tests for primary mathematics and two series for junior secondary. The former Education Research Section (under the former Education Department) should have carried out some research on these tests, including calibration of items, but these studies (if exist) were not published. However, the Hong Kong Examinations and Assessment Authority publishes annual reports on the Territory-wide System Assessment since it was administered in 2004. Though the trends of the statistics (mean scores, spread, etc.) are not disclosed, the reports provide information useful for learning and teaching.

TIMSS and PISA items are often used in research studies, however topic-wise mathematics attainment tests developed in local context are still lacking. A recent development relates to assessment from a cultural perspective. Lai (2008), in her Ph.D. study done in Hong Kong, compared Australian and Hong Kong students' spatial sense while F. K. S. Leung (2008) conducted an interesting study on East Asian's cultural perspective on mathematics assessment. It is also worth noticing that there was an analysis of examiners' reports of public examinations included in the research report of Leung et al. (1999).

The Mathematics Teacher

Despite various advocates of student-centred learning, teachers still play a key role in mathematics classroom learning (Wong, 1993). Furthermore, it is the teacher who implements the curriculum. Thus, teachers' professional knowledge is crucial in determining the quality of learning and teaching. Fung (1999) started an investigation in his Ph.D. study on the pedagogical content knowledge of Hong Kong primary school mathematics teachers. 李瓊(2004) and 韓繼偉(2005) completed their theses, done in Hong Kong, studying subject matter knowledge among mathematics teachers in the Chinese mainland. Recently, there have been cross-cultural comparative studies on teachers' professional knowledge. For example, 盧錦玲(2008) studied the professional knowledge among Hong Kong and Shanghai mathematics teachers; as well as the work of Wong, Rowland, Chan, Cheung, and Han (2008) and the on-going study of Leung, Wong, Chan, Cheung, and Han (2008).

Looking Ahead: The Local, Regional and International

Locally, Hong Kong scholars have covered a large range of research agendas in mathematics education. The diverse interests of these scholars outline an emerging shape of a local circle of mathematics education research. Factors contributing to students' learning processes, different aspects of pedagogical arrangements, use of technology, curriculum analyses and assessment practices are at hand, ready to be further developed and integrated into a meaningful whole. Therefore, overarching perspectives are needed to connect the different research agendas. At present, more

research in areas like assessment, teaching of specific topics and learning and teaching with special needs are required to blueprint this bridge.

“External” theories and methodologies (for instance, curriculum theory, psychology and sociology) have been borrowed for use in mathematics education research while mathematically related issues like mathematics problem solving and mathematical literacy (as an indicator of educational success) were “exported”. Thus a paradigm of blending the “generic” and the “specific” is in the shaping in local context for the investigation of mathematics learning phenomena both in Hong Kong and in the greater China region. For instance, this blending brings about the emergence of mathematically specific notions like conceptions of mathematics.

We look forward to having the process develop in another direction; that is, being stimulated by these studies, educational practices are theorized. A mathematics teacher should be a reflective practitioner, a professional as well as an intellectual. It would be an irony for a teacher, who is supposed to deliver knowledge every day, to be scared of theory and knowledge base. To this end, practical pedagogy (in particular, classroom practices) and research need to be synergized. Researchers should go into the mathematics classrooms and mathematics teachers should regard their teaching as a research activity.

The great number of cross-institutional collaborations in mathematics education research at present should be continued with the support from further development of more accessible mathematics education graduate programmes to nurture the next generation of researchers. The self-financed mode in Ed.D. and Master programmes allows more flexibilities in delivering and admitting participants to graduate studies. This is beneficial in cultivating a teacher-as-researcher mentality that encourages the front-line mathematics educators to join the academic research force.

It is clear from above that a local community of mathematics educational research has emerged in Hong Kong. Regionally, with the return of Hong Kong to China, Hong Kong has been able to play a role in contributing to the establishment of a research culture in China in which academic rigour is valued. Research should originate from intellectual curiosity and produce publications for the purpose of initiating academic discourse (and not just for the sake of “publish or perish”). A specific concern is that in order that publications in the Chinese language should receive the reputation it deserves, a mature journal refereeing system is needed. Hong Kong’s community of mathematics educational research could play a more active role in bridging the East and West research

cultures by engaging in more substantive research collaborations with the Chinese mainland in diverse areas of mathematics education.

We see a few impediments that challenge the mathematics education research community. Firstly, on the one hand with the emphases of managerialism and performativity, the larger environment does not seem to be conducive to the nurturing of next generation of local academics. Working at the academia is no longer regarded as a favourable career option. Instability introduced through academic posts on contractual terms is a crucial factor that discourages academic research. On the other hand, in these years, we nurtured more doctorate students (on education in general and mathematics education in particular) from the Chinese mainland than those from Hong Kong. It is encouraging to see our TEI's contributing to the nurturing of graduate students from elsewhere, but the relatively small number of local ones deserves our attention. This may be due to the fact that there is a lack of sustaining research connection between schools and the academia. Mathematics teachers are not exposed to see research as a "feasible practice" to develop their pedagogical content knowledge and classroom practices.

Secondly, the imposition of the "research assessment exercise" added pressure for researchers to publish quickly. Consequently, short-term "publishable" research agendas are favoured over more genuine, high quality academic research that usually involves deep collaboration and a temporal evolution of ideas. The local research community needs to be conscious to overcome the "publish just to avoid becoming perished" mindset and not to refrain from publishing. Opportunities to share research findings constructively in the community of mathematics educational research are needed to sustain the joy of publishing.

Lastly, there is a propensity in Hong Kong educational research that experts in macro-theories (like educational policy, educational psychology and curriculum theory) have a higher status than pedagogical experts in subject areas and expertise in local context is not recognized as "preferred" research in tertiary institutions. Therefore, strong emphases need to be put on mathematics pedagogical content knowledge research to make mathematics education research into a major research enterprise in Hong Kong.

If we treasure the local community of educational research on mathematics education that has been established in the past 25 years, we must have the courage and the solidarity to turn these obstacles into new

opportunities, making mathematics education research in Hong Kong vibrant and flourishing in the years to come.

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Notes

1. Due to word limitations, some of the details have to be skipped. Please refer to 黃毅英、梁玉麟、鄧國俊、陳詠心 (2009) for a fuller account.
2. Cheng (1979, 1980); Pun & Cheng (1981); Fisher-Short (1969); Lee & Ip (1981); 鄭肇楨 (1980).
3. The Chinese University of Hong Kong, The Hong Kong Baptist University, The Hong Kong Institute of Education and The University of Hong Kong (in alphabetical order).
4. Bi-annual conferences are held basically.
5. Though this paper is dedicated to the 25th anniversary of the HKERA, we do not confine our analysis strictly to that number.
6. “Enhancement of Students’ Mathematics Problem Solving Abilities by the Systematic Introduction of Variations” (2000; principal investigator: N. Y. Wong).
7. Recent academic discourses reveal that it is not easy to make a clear distinction between cognitive and affective factors, for instance, beliefs have its cognitive aspect and whether classroom learning environment should be regarded as cognitive or affective deserves discussion. In this paper, we choose not to draw a clear distinction between the two.
8. Though there have been extensive discussions on the distinctions among terminologies like “conception”, “belief”, “view”, “image”...., in this paper, we use them quite interchangeably.
9. It was the thesis of the study of 韓孝述 to experiment mastery learning in the subject of biology.
10. The accounts trace back to the 1980s for primary curriculum, and the 1970s for secondary curriculum.
11. We will attach English names when it first appears whenever an author’s publication in both languages are cited in this paper.

References

- Biggs, J. B., Holbrook, J. B., Ki, W. W., Lam, R. Y. H., Li, W. O., Pong, W. Y., & Stimpson, P. G. (1989, November). *An objective format for evaluating the quality of learning in various secondary subject*. Paper presented at the 6th Annual Conference of the Hong Kong Educational Research Association, City Polytechnic of Hong Kong.
- Brimer, A., & Griffin, P. (1985). *Mathematics achievement in Hong Kong secondary schools*. Hong Kong: Centre of Asian studies, The University of Hong Kong.
- Bryan, C. A., Wang, T., Perry, B., Wong, N. Y., & Cai, J. (2007). Comparison and contrasts: Similarities and differences of teachers' views of effective mathematics teaching and learning from four regions. *ZDM — The International Journal on Mathematics Education*, 39(4), 329–340.
- Chan, Y. C. (2009). *Experimental-theoretical interplay in dynamic geometry environments*. Unpublished doctoral dissertation, The University of Hong Kong.
- Cheng, L. C. C. (2002a, July). *Investigation of mathematics structure thinking in upper primary pupils in Hong Kong*. Paper presented at the 54th Annual Conference of the International Commission for the Study and Improvement of Mathematics Education, Polytechnic Center in Vilanova i la Geltrú, Barcelona, Spain.
- Cheng, L. C. C. (2002b, August). *Children performance in primary inclusive mathematics competition in Hong Kong*. Paper presented at the 4th Conference of the World Federation of National Mathematics Competitions, an Affiliated Study Group of ICMI, University of Melbourne, Australia.
- Cheng, S. C. (1979). An analysis of the cognitive level of mathematics instruction. *Education Journal*, 7, 53–60.
- Cheng, S. C. (1980). The effect of socio-economic background on mathematics learning. *The Chinese University Education Journal*, 8(1), 53–60.
- Cheng, S. C., Das, K. P., & Leong, C. K. (1984). Arithmetic performance and cognitive processing. *Education Journal*, 12(2), 31–41.
- Cheung, P. H., Lam, K., Siu, M. K., & Wong, N. Y. (1986). An appraisal of the teaching of statistics in secondary schools of Hong Kong. In T. Lietaer, R. Davidson, & J. Swift (Eds.), *Proceedings of the second international conference on teaching mathematics* (pp. 241–244). Canada: University of Victoria.
- Cheung, Q. S. H. (2004). Peer tutoring in pure mathematics subject. *Hong Kong Teachers' Centre Journal*, 3, 116–127.
- Chiu, M. M. (1997). *Building mathematical understanding during collaboration: Students learning functions and graphs in an urban, public high school*. Unpublished doctoral dissertation, The University of California, Berkeley, U.S.A.
- Chiu, M. M. (1999). Teacher effects on student motivation during cooperative learning: Activity level, intervention level, and case study analyses. *Educational Research Journal*, 14(2), 229–252.
- Chiu, M. M. (2000). Metaphorical reasoning: Origins, uses, development, and interactions in mathematics. *Educational Research Journal*, 28(1), 13–46.

- Chiu, M. M. (2004). Adapting teacher interventions to student needs during cooperative learning: How to improve student problem solving and time-on-task. *American Educational Research Journal*, 41, 365–399.
- Clarke, D., Emanuelsson, J., Jablonka, E., & Mok, I. A. C. (Eds.). (2006). *Making connections: Comparing mathematics classrooms around the world*. Rotterdam, the Netherlands: Sense Publishing.
- Clarke, D. J., Keitel, C., & Shimizu, Y. (Eds.). (2006). *Mathematics classrooms in twelve countries: The insider's perspective*. Rotterdam, the Netherlands: Sense Publishing.
- Fan, L., Wong, N. Y., Cai, J., & Li, S. (Eds.). (2004). *How Chinese learn mathematics: Perspectives from insiders*. Singapore: World Scientific.
- Fisher-Short, W. (1969). An experiment on the use of structural apparatus for primary school mathematics teaching in Hong Kong. *Journal of Education*, 26, 34–45.
- Fung, C. I. (1999). *Pedagogical content knowledge versus subject matter knowledge: An illustration in the primary school mathematics context of Hong Kong*. Unpublished doctoral dissertation, The University of Hong Kong.
- Griffin, P. E., & Mok, M. C. (1990). Student gender, home support and achievement in mathematics among Hong Kong secondary students. *Educational Research Journal*, 5, 43–50.
- Gu, L., Marton, F., & Huang, R. (2004). Teaching with variation: A Chinese way of promoting effective mathematics learning. In L. Fan, N. Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 309–347). Singapore: World Scientific.
- Ho, E. S. C. (2003). *The first HKPISA report*. Hong Kong: HKPISA Centre, Hong Kong Institute of Educational Research, CUHK.
- Ho, E. S. C. (2005). *The second HKPISA report*. Hong Kong: HKPISA Centre, Hong Kong Institute of Educational Research, CUHK. Retrieved March 1, 2009, from <http://www.aph.gov.au/house/committee/edt/eofb/>
- Hong, K. S., & Su, D. K. (2007). A preliminary study of a microworld for learning probability. *Educational Research Journal*, 22(2), 151–177.
- Huang, R. (2002). *Mathematics teaching in Hong Kong and Shanghai: A classroom analysis from the perspective of variation*. Unpublished doctoral dissertation, The University of Hong Kong.
- Huang, R., & Leung F. K. S. (2002). How Pythagoras' theorem is taught in Czech Republic, Hong Kong and Shanghai: A case study. *International Reviews on Mathematical Education*, 34(6), 268–277.
- Ki, W. W. (1986). Processes of problem solving in mathematics. *Educational Research Journal*, 1, 49–52.
- Kong, Q. P., Wong, N. Y., & Lam, C. C. (2003). Student engagement in mathematics: Development of instrument and validation of construct. *Mathematics Education Research Journal*, 16, 4–21.
- Kong, S. C., & Kwok, L. F. (2002). Modeling a cognitive tool for teaching the addition/subtraction of common fractions. *International Journal of Cognition and Technology*, 1(2), 327–352.

- Kong, S. C., & Kwok, L. F. (2003). A graphical partitioning model for learning common fraction: Designing affordances on a web-supported learning environment. *Computers and Education, 40*(2), 137–155.
- Kong, S. C., & Kwok, L. F. (2005). A cognitive tool for teaching the addition/subtraction of common fractions: A model of affordances. *Computers and Education, 45*(2), 245–265.
- Lai, M. Y. (2008). *An exploratory study into Chinese and English speaking children's visual perception and their spatial and geometric conceptions in Piagetian tasks*. Unpublished doctoral dissertation, The University of Hong Kong.
- Law, H. Y. (1994). *The use of mental representation of conceptual knowledge for assessing mathematical understanding*. Unpublished master's thesis, The Chinese University of Hong Kong.
- Lee, A. M. S., & Leung, A. (2008, July). *Variational tasks in dynamic geometry environment*. Paper presented at the 11th International Congress on Mathematical Education, Monterrey, Mexico.
- Lee, A. M. S., Wong, K. L., & Leung, A. (2006). Developing learning and assessment tasks in a dynamic geometry environment. In L. H. Son, N. Sinclair, J. B. Lagrange, & C. Hoyles (Eds.), *Proceedings of the ICMI 17 Study Conference: Background papers for the ICMI 17 study* (Part 2, pp. 334–341). Hanoi, Vietnam: Hanoi University of Technology.
- Lee, A. M. S., Wong, K. L., & Tang, K. C. (2004). Exploring the use of dynamic geometry manipulative tasks for assessment. In W. C. Yang, C. C. Sung, T. Alwis, & K. C. Ang (Eds.), *Proceedings of the Ninth Asian Technology Conference In Mathematics* (pp. 252–261). Singapore: National Institute of Education.
- Lee, F. L. (1981). Analysis of cognitive strategies of problem solving process in *mathematics and physics*. Unpublished master's thesis, The Chinese University of Hong Kong.
- Lee, F. L. (1996). Logex: An intelligent tutoring system in logarithms. *Educational Research Journal, 11*(1), 24–31.
- Lee, F. L., & Heyworth, R. M. (2000). Electronic homework. *Journal of Educational Computing Research, 22*(2), 171–186.
- Lee, P. L. M., & Ip, C. K. (1981). Attitudes towards calculator usage by pupils: A survey of mathematics teachers. *Hong Kong Science Teachers Journal, 9*, 89–102.
- Leung, A. (2003). Dynamic geometry and the theory of variation. In N. A. Pateman, B. J. Dougherty, & J. Zilliox (Eds.), *Proceedings of the 27th Conference of the International Study Group on the Psychology of Mathematics Education* (Vol. 3, pp. 197–204). Honolulu, Hawaii: College of Education, University of Hawaii.
- Leung, A. (2008). Dragging in a dynamic geometry environment through the lens of variation. *International Journal of Computers for Mathematical Learning, 13*, 135–157.
- Leung, A. (2009, May). *Written proof in dynamic geometry environment: Inspiration from a student's work*. Paper presented at the ICMI 19 Study Conference: Proof and Proving in Mathematics Education, Taipei, Taiwan.

- Leung, A., & Chan, Y. C. (2006). Exploring necessary and sufficient conditions in dynamic geometry environment. *International Journal for Technology in Mathematics Education*, 13(1), 37–44.
- Leung, A., Chan, Y. C., & Lopez-Real, F. (2006). Instrumental genesis in dynamic geometry environments. In L. H. Son, N. Sinclair, J. B. Lagrange, & C. Hoyles (Eds.), *Proceedings of the ICMI 17 study conference: Background papers for the ICMI 17 study* (Part 2, pp. 346–353). Hanoi, Vietnam: Hanoi University of Technology.
- Leung, A., & Lopez-Real, F. (2000). An analysis of students' explorations and constructions using Cabri geometry. In M. A. Clements, H. Tairab, & W. K. Yoong (Eds.), *Science, mathematics and technical education in the 20th and 21st centuries* (pp. 144–154). Brunei: Universiti Brunei Darussalam.
- Leung, A., & Lopez-Real, F. (2002). Theorem justification and acquisition in dynamic geometry: A case of proof by contradiction. *International Journal of Computers for Mathematical Learning*, 7, 145–165.
- Leung, A., & Or, C. M. (2007). From construction to proof: Explanations in dynamic geometry environment. In J. Woo, H. Lew, K. Park, & D. Seo (Eds.), *Proceedings of the 31st Conference of the International Study group on the Psychology of Mathematics Education* (Vol. 3, pp. 177–184). Seoul: The Korea Society of Educational Studies in Mathematics.
- Leung, F. K. S. (1995). The mathematics classroom in Beijing, Hong Kong and London. *Educational Studies in Mathematics*, 29, 297–325.
- Leung, F. K. S. (1998). The implications of Confucianism for education today. *Journal of Thought*, 33(2), 25–36.
- Leung, F. K. S. (2001). In search of an East Asian identity in mathematics education. *Educational Studies in Mathematics*, 47, 35–51.
- Leung, F. K. S. (2005a). Some characteristics of East Asian mathematics classrooms based on data from the TIMSS 1999 video study. *Educational Studies in Mathematics*, 60(2), 199–215.
- Leung, F. K. S. (2005b). The implications of the third international mathematics and science study for mathematics curriculum reform in Chinese communities. In N. Y. Wong (Ed.), *Revisiting mathematics education in Hong Kong for the new millennium* (pp. 226–253). Hong Kong: Hong Kong Association for Mathematics Education.
- Leung, F. K. S. (2008). In the books there are golden houses: Mathematics assessment in East Asia. *ZDM — The International Journal on Mathematics Education*, 40, 983–992.
- Leung, F. K. S., Lam, C. C., Mok, I. A. C., Wong, K. M., & Wong, N. Y. (1999). *Comparative study of the mathematics curricula of major Asian and Western countries*. Final report of a research commissioned by the Education Department, Hong Kong. Retrieved March 1, 2009, from http://cd1.edb.hkedcity.net/cd/maths/en/ref_res/document/Research1.htm

- Leung, H. K., Man, Y. K., & Leung, C. K. (2000). Preservice teachers' perception of difficulties in teaching primary school mathematics. In H. K. Leung (Ed.), *Proceedings of the Hong Kong Mathematics Education Conference 2000* (pp. 532–537). Hong Kong: Department of Mathematics, Hong Kong Institute of Education; Hong Kong Association for Mathematics Education.
- Leung, I. K. C. (2008). Teaching and learning of inclusive and transitive properties among quadrilaterals by deductive reasoning with the aid of SmartBoard. *ZDM — The International Journal on Mathematics Education*, *40*, 1007–1021.
- Leung, I. K. C., Ling, S. H., & Wong, M. F. R. (2004, July). *Students' mathematics performance in authentic problems*. Paper presented at the 10th International Congress of Mathematics Education, Copenhagen, Denmark.
- Leung, I. K. C., Wong, N. Y., Chan, W. S., Cheung, K. L., & Han, N. S. (2008, July). *The competence of potential mathematics teachers of Hong Kong: A comparative study*. Paper presented at the 11th International Congress on Mathematical Education, Monterrey, Mexico.
- Leung, S. S. (1997). On the open-ended nature in mathematical problem posing. In E. Pehkonen (Ed.), *Use of open-ended problems in mathematics classroom* (Research Report 176) (pp. 26–33). Helsinki, Finland: Department of Education, University of Helsinki.
- Lit, C. K., Siu, M. K., & Wong, N. Y. (2001). The use of history in the teaching of mathematics: Theory, practice, and evaluation of effectiveness. *Education Journal*, *29*(1), 17–31.
- Lit, C. K., & Wong, N. Y. (1998). A study on the use of history of mathematics in mathematical instruction among Hong Kong secondary school teachers. *Curriculum Forum*, *8*(1), 50–65.
- Lo, M., Pong, W., & Chik, P. (Eds.). (2005). *For each and everyone: Catering for individual differences through learning studies*. Hong Kong: Hong Kong University Press.
- Lopez-Real, F., & Chan, Y. P. (1999). Peer Assessment of a group project in a primary mathematics education course. *Assessment & Evaluation in Higher Education*, *24*(1), 67–79.
- Lopez-Real, F., & Lee, A. M. S. (2006). Encouraging the use of technology in problem solving: Some examples from an initial teacher education programme. *The International Journal for Technology in Mathematics Education*, *13*(1), 23–29.
- Lopez-Real, F., & Leung, A. (2006). Dragging as a conceptual tool in dynamic geometry. *International Journal of Mathematical Education in Science and Technology*, *37*(6), 665–679.
- Lopez-Real, F. J., Mok, I. A. C., Leung, F. K. S., & Marton, F. (2004). Identifying a pattern of teaching: An analysis of a Shanghai teacher's lesson. In L. Fan, N. Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 382–412). Singapore: World Scientific.

- Marsh, H. W., Hau, K. T., & Kong, C. K. (2002). Multilevel causal ordering of academic self-concept and achievement: Influence of language of instruction (English compared with Chinese) for Hong Kong students. *American Educational Research Journal*, 39(3), 727–763.
- Marton, F., & Booth, S. (1997). *Learning and awareness*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Mok, I. A. C. (1987). *The learning of mathematical induction*. Unpublished master's thesis, The University of Hong Kong.
- Mok, I. A. C. (1996). *Progression of students' algebraic thinking in relation to the distributive properties*. Unpublished doctoral dissertation, King's College, London University.
- Mok, I. A. C., Johnson, D. C., Cheung, J. Y. H., & Lee, A. M. S. (2000). Introducing technology in algebra in Hong Kong: Addressing issues in learning. *International Journal of Mathematics Education in Science and Technology*, 31(4), 553–567.
- Mok, M. C. (1988). *The relationship of family educational environment and mathematics achievement of Hong Kong students*. Unpublished doctoral dissertation, The University of Hong Kong.
- Ng, S. S. N. (2005). *Early mathematics teaching: Contextual differences in the pre-primary and early primary years*. Unpublished doctoral dissertation, The University of Hong Kong.
- Ng, S. S. N., & Rao, N. (2005). *Teaching mathematics in Hong Kong: A comparison between the pre-primary and early primary years*. *Hong Kong Journal of Early Childhood*, 4(1), 30–36.
- Opper, S. (1988). Preschool maths development in Hong Kong children. *Educational Research Journal*, 3, 61–65.
- Or, C. M., & Leung, A. (2008, July). *Designing teaching units of 3D Geometry using Cabri 3D for Hong Kong math curriculum*. Paper presented at the 11th International Congress of Mathematics Education, Monterrey, Mexico.
- Park, K., & Leung, F. K. S. (2006). A comparison of the mathematics textbooks in China, Hong Kong, Japan, Korea, United Kingdom, and the United States. In F. K. S. Leung, G.-D. Graf, & F. J. Lopez-Real (Eds.), *Mathematics education in different cultural traditions: A comparative study of East Asia and the West* (The 13th ICMI Study) (pp. 227–238). New York: Springer Verlag.
- Pun, S. W., & Cheng, S. C. (1981). Hong Kong Form 3 pupils' attitude towards "modern mathematics". *Education Journal*, 9(1), 28–46.
- Siu, F. K., & Siu, M. K. (1979). History of mathematics and its relation to mathematical education. *International Journal of Mathematics Education for Science and Technology*, 10(4), 561–567.
- Siu, M. K. (1985). History of (mathematics) teachers (in French). *Bulletin de l'Association des Professeurs de Mathématiques*, 354, 309–319.
- Tam, W. M., & Pun, S. H. (2006). The school community as a mediating factor in the relationship between family processes and mathematics performance. *Educational Research Journal*, 21(2), 175–194.

- Tang, K. C. (1999). *Stability and change in school mathematics: A socio-cultural case study of secondary mathematics in Macau*. Unpublished doctoral dissertation, The University of Hong Kong.
- Tang, K. C., & Wong, K. L. (2002). Building a web-based statistics calculator and exploring new opportunities for learning bivariate analysis. In W. C. Yang, S. C. Chu, T. Alwis, & F. M. Bhatti (Eds.), *Proceedings of the Seventh Asian Technology Conference in Mathematics* (pp. 542–551). Melaka, Malaysia: Multimedia University.
- Tse, K. O. (2007). *The design of two instruments to reveal the psychology of mathematical giftedness in school children: Their mathematical creativity and attitude*. Unpublished master's thesis, The University of Hong Kong.
- Wong, K. L., & Tang, K. C. (2000, July). *Weaving the web into teaching and learning of statistics: The case of primary and secondary schools in Hong Kong*. Paper presented at the Second International Mathematics Enrichment with Communications Technology, University of Cambridge, U.K.
- Wong, K. L., Lee, A. M. S., & Tang, K. C. (2005). Analyzing the performance of Grade 6 students in dynamic geometry manipulative tasks: A quantitative approach. In S. C. Chu, H. C. Lew, & W. C. Yang (Eds.), *Proceedings of the Tenth Asian Technology Conference in Mathematics* (pp. 145–154). Cheong-Ju, South Korea: Korea National University of Education.
- Wong, K. M. (1989). *The effects of structural diagrams on the acquisition of knowledge structure and problem-solving performance in mathematics*. Unpublished master's thesis, The Chinese University of Hong Kong.
- Wong, K. M. (1994). Can mathematical rules and procedures be taught without conceptual understanding? *Journal of Primary Education*, 5(1), 33–41.
- Wong, K. M. (1997). Do real-world situations necessarily constitute “authentic” mathematical tasks in the mathematics classroom? *Curriculum Forum*, 6(2), 1–15.
- Wong, K. M., Wong N. Y., & Lam, C. C. (1995). Towards an appraisal of the Hong Kong mathematics curriculum. *Curriculum Forum*, 5(1), 49–66.
- Wong, N. Y. (1988). Effects of self-monitoring and reinforcement on problem solving performance. *Educational Psychology*, 8, 153–159.
- Wong, N. Y. (1992). The relationship among mathematics achievement, affective variables and home background. *Mathematics Education Research Journal*, 4(3), 32–42.
- Wong, N. Y. (1993). The psychosocial environment in the Hong Kong mathematics classroom. *The Journal of Mathematical Behavior*, 12, 303–309.
- Wong, N. Y. (1995a). Discrepancies between preferred and actual mathematics classroom environment as perceived by students and teachers in Hong Kong. *Psychologia*, 38, 124–131.
- Wong, N. Y. (1995b). *The relationship between Hong Kong students' perception of their mathematics classroom environment and their approaches to learning: A longitudinal study*. Unpublished doctoral dissertation, The University of Hong Kong.
- Wong, N. Y. (1998). The gradual and sudden paths of Tibetan and Chan Buddhism: A pedagogical perspective. *Journal of Thought*, 33(2), 9–23.

- Wong, N. Y. (2003). The influence of technology on the mathematics curriculum. In A. J. Bishop, M. A. Clements, C. Keitel, J. Kilpatrick, & F. K. S. Leung (Eds.), *Second International Handbook of Mathematics Education* (Vol. 1, pp. 271–321). Dordrecht, the Netherlands: Kluwer Academic.
- Wong, N. Y. (2004). The CHC learner's phenomenon: Its implications on mathematics education. In L. Fan, N. Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 503–534). Singapore: World Scientific.
- Wong, N. Y. (2005). The positioning of algebraic topics in the Hong Kong elementary school mathematics curriculum. *Zentralblatt für Didaktik der Mathematik*, 37(1), 23–33.
- Wong, N. Y. (2007). The conceptions of mathematics and of effective mathematics learning/teaching among Hong Kong elementary mathematics teachers. *ZDM — The International Journal on Mathematics Education*, 39(4), 301–314.
- Wong, N. Y. (2008). Confucian heritage culture learner's phenomenon: From “exploring the middle zone” to “constructing a bridge”. *ZDM — The International Journal on Mathematics Education*, 40, 973–981.
- Wong, N. Y., Chiu, M. M., Wong, K. M., & Lam, C. C. (2005). The lived space of mathematics learning: An attempt for change. *Journal of the Korea Society of Mathematical Education Series D: Research in Mathematical Education*, 9(1), 25–45.
- Wong, N. Y., Han, J. W., & Lee, P. Y. (2004). The mathematics curriculum: Towards globalisation or westernisation? In L. Fan, N. Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 27–70). Singapore: World Scientific.
- Wong, N. Y., Kong, C. K., Lam, C. C., & Wong, K. M. (2008). *Changing students' conceptions of mathematics through the introduction of variation*. Manuscript submitted for publication.
- Wong, N. Y., Lam, C. C., & Chan, C. S. (2002). The current state of the “lived space” of mathematics learning. *Hiroshima Journal of Mathematics Education*, 10, 27–52.
- Wong, N. Y., Lam, C. C., & Kong, Q. P. (2003). The relationship between student engagement and learning outcomes in mathematics. *Curriculum and Teaching*, 18(1), 81–95.
- Wong, N. Y., Lam, C. C., Leung, F. K. S., Mok, I. A. C., & Wong, K. M. (1999). *An analysis of the views of various sectors on the mathematics curriculum*. Final report of a research commissioned by the Education Department, Hong Kong. Retrieved March 1, 2009, from http://cd1.edb.hkedcity.net/cd/maths/en/ref_res/document/Research2.htm
- Wong, N. Y., Marton, F., Wong, K. M., & Lam, C. C. (2002). The lived space of mathematics learning. *Journal of Mathematical Behavior*, 21, 25–47.
- Wong, N. Y., Rowland, T., Chan, W. S., Cheung, K. L., & Han, N. S. (2008, July). *To what extent are our mathematics teachers equipped with adequate mathematics to teach? A comparative perspective*. Paper presented at the 11th International Congress on Mathematical Education, Monterrey, Mexico.

- Wong, N. Y., & Watkins, D. (1996). Self-monitoring as a mediator of person-environment fit: An investigation of Hong Kong mathematics classroom environments. *British Journal of Educational Psychology*, 66, 223–229.
- Wong, N. Y., & Watkins, D. (1998). A longitudinal study of the psychosocial environment and learning approaches in the Hong Kong classroom. *Journal of Educational Research*, 91, 247–254.
- Wong, N. Y., & Watkins, D. (2001). Mathematics understanding: Students' perception. *The Asia-Pacific Education Researcher*, 10(1), 41–59.
- Wong, P. H. (2001). *Interpretation of symbols and construction of algebraic knowledge*. Unpublished doctoral dissertation, The University of Hong Kong.
- Wong, Q. T., Wong, N. Y., Lam, C. C., & Zhang, Q. P. (2009). Beliefs about mathematics and mathematics teaching among elementary mathematics teachers in Hong Kong. In J. Cai, G. Kaiser, B. Perry, & N. Y. Wong (Eds.), *Effective mathematics teaching from teachers' perspective: National and cross-national studies* (pp. 237–259). Rotterdam, the Netherlands: Sense Publishing.
- Yuen, K. S. (1988). *Solving mathematical problems: A verification of a spatial representation model*. Unpublished doctoral dissertation, The University of Hong Kong.
- 丁銳 (2007)。《中國大陸小學數學課堂環境探究》。未公開發表哲學博士論文，香港中文大學。
- 甘志強、鄧國俊[Tang, K. C.]¹¹、顏明仁 (2003)。〈澳門小學數學課程的革新〉。載古鼎儀、胡少偉、李小鵬 (編)，《教育發展與課程革新：兩岸四地的視域和經驗》(頁 13–22)。香港：港澳兒童教育國際協會。
- 成子娟 (1999)。《中國學生個人屬性內隱觀的普遍性及特殊性》。未公開發表哲學博士論文，香港中文大學。
- 成子娟 (2007)。〈操作材料對兒童理解加減法關係和選擇計算策略的影響〉。《教育學報》，第 35 卷第 1 期，頁 93–111。
- 何兆倫 (1974)。《根據教師對現有課程標準之評鑑所擬訂之香港改組初級中學核心教學課程標準》。未公開發表教育碩士論文，香港中文大學。
- 吳慧鳴 (1995)。〈操作法的原理及其在幼兒數學教育的應用〉。《學前教育研究》，第 6 期，頁 43–45。
- 李芳樂[Lee, F. L.] (1993)。〈數學錯誤成因的探討〉。《初等教育學報》，第 4 卷第 1 期，頁 77–82。
- 李瓊 (2004)。《小學數學教師的學科知識，教學內容及其與課堂教學的關係》。未公開發表哲學博士論文，香港中文大學。
- 沈雪明、李金玉、林建 (1995)。〈統計學的活動教學法：中學生統計習作比賽〉。載蕭文強 (編)，《香港數學教育的回顧與前瞻：梁鑑添博士榮休文集》(頁 157–165)。香港：香港大學出版社。
- 香港教育專業人員協會教育研究部數學組 [教協數學組] (1981)。《小學數學教學調查報告書》。香港：香港教育專業人員協會。
- 馬雲鵬 (1995)。〈中國大陸與香港小學數學教學大綱的比較〉。《初等教育學報》，第 5 卷第 2 期，頁 67–71。
- 馬雲鵬 (1999)。《中國城鄉小學數學課程實施的個案研究》。未公開發表哲學博士論文，香港中文大學。

- 教育行動組 (1975)。《小學課本質素調查報告》。香港：教育行動組。
- 陳業江 (1983)。《羅氏模式於設計不受試題與考生二者限制的數學試題總庫及比較學生考試成績之應用》。未公開發表教育碩士論文，香港中文大學。
- 陳榮坤 (2004)。《探究新移民學生與本港學生「數學觀」、「數學學習經歷」與「解題策略」間關係之個案比較研究》。未公開發表教育碩士論文，香港中文大學。
- 陸鴻基、馮以滋、黃顯華、鍾宇平 (編) (1991)。〈香港教育研究分類目錄 (1946-1982)〉。香港：中文大學出版社。
- 黃家鳴[Wong, K. M.; Wong, K. M. P.] (1995)。〈數學證明與日常生活論證〉。載蕭文強 (編)，《香港數學教育的回顧與前瞻：梁鑑添博士榮休文集》 (頁 167-187)。香港：香港大學出版社。
- 黃家鳴 (1997)。〈生活情境中的數學與學校的數學學習〉。《基礎教育學報》，第 7 卷第 12 期，頁 161-167。
- 黃家鳴、林智中[Lam, C. C.]、黃毅英[Wong, N. Y.] (1995)。〈香港小學數學教學現況的探討〉。《初等教育學報》，第 5 卷第 2 期，頁 11-17。
- 黃毅英 (2002)。〈數學觀研究綜述〉。《數學教育學報》，第 11 卷第 1 期，頁 1-8。
- 黃毅英 (2003)。〈從認識論的課程分析看現行中小學課程的幾個問題〉。載鄧幹明、曾倫尊 (編)，《學會學習：數學課程改革評析》 (頁 3-24)。香港：香港數學教育學會。
- 黃毅英、林智中、孫旭花 (2006)。《變式教學課程設計原理：數學課程改革的可能出路》。香港：香港中文大學教育學院、香港教育研究所。
- 黃毅英、林智中、陳美恩、王豔玲 (2008)。〈數學變式課程設計——以小學三個課題為例〉。《教育學報》，第 35 卷第 2 期，頁 1-28。
- 黃毅英、孫旭花 (2002)。〈學生數學觀的個案刻畫〉。《基礎教育學報》，第 11 卷第 2 期，頁 15-34。
- 黃毅英、曹錦明 (1997)。〈評論數學科「目標為本課程」的設計〉。載林智中 (編)，《目標為本課程：設計與實施》 (頁 21-41)。香港：天地圖書。
- 黃毅英、梁玉麟、鄧國俊、陳詠心 (2009)。《香港數學教育專業知識基礎的集體追求》。香港：香港數學教育學會。
- 黃毅英、黃家鳴 (1997)。〈十地區數學教育課程標準〉。《數學傳播》，第 82 期，頁 28-44。
- 黃毅英、黃家鳴、林智中、羅浩源[Law, H. Y.] (2004)。〈學生數學問題解決的個案刻劃〉。《數學教育學報》，第 13 期，頁 3-4。
- 黃毅英、黃家樂[Wong, K. L.] (2001)。〈「新數學」運動的過程及對當代數學教育之啟示〉。載黃毅英 (編)，《香港近半世紀漫漫「數教路」：從「新數學」談起》 (頁 9-111)。香港：香港數學教育學會。
- 黃毅英、鄭肇楨[Cheng, S. C.] (1991a)。〈香港中學生的數學學習態度〉。《教育學報》，第 19 卷第 1 期，頁 13-18。
- 黃毅英、鄭肇楨 (1991b)。〈數學學習習慣和成績、父母學歷、居住面積及父母期望及學生期望的關係〉。《教育研究學報》，第 6 卷，頁 86-92。
- 黃毅英、韓繼偉、王倩婷[Wong, Q. T.] (2005)。〈數學觀與數學教育〉。載黃毅英 (編)，《迎接新世紀：重新檢視香港數學教育——蕭文強教授榮休文集》 (頁 77-99)。香港：香港數學教育學會。

- 鄧國俊、貝磊 (1994)。〈多元化課程及進口教科書的影響——中學數學科的類型及發展〉。載古鼎儀、馬慶堂 (編), 《澳門教育——抉擇與自由》(頁 70-86)。澳門: 澳門基金會。
- 鄧國俊、黃毅英、霍秉坤、顏明仁、黃家樂 (2006)。《香港近半世紀漫漫「小學數教路」: 現代化、本土化、普及化、規範化與專業化》。香港: 香港數學教育學會。
- 鄭肇楨 (1980)。〈數學學習之智性行為鏈研究〉。《教育學報》, 第 8 卷第 2 期, 頁 1-7。
- 鄧廣威、韓孝述、黃顯華、黃毅英 (1995)。〈通達學習對小三學生學習數學的影響〉。載《「課程發展中的友伴關係: 提高學習效能之路」研討會文集》(頁 200-204)。香港: 香港大學課程學系。
- 鄭勳俊 (1983)。《小學數學學習之智性行為鏈研究》。未公開發表教育碩士論文, 香港中文大學。
- 盧錦玲 (2008)。《「滬港兩地小學數學教師專業知識缺失」的比較研究》。未公開發表博士論文, 上海華東師範大學。
- 韓繼偉 [Han, J. W.] (2005)。《中學數學教師的學科知識》。未公開發表哲學博士論文, 香港中文大學。