Chapter 4-1

COMPARING PRIMARY AND SECONDARY MATHEMATICS TEACHERS' BELIEFS ABOUT MATHEMATICS, MATHEMATICS LEARNING AND MATHEMATICS TEACHING IN HONG KONG AND AUSTRALIA[1]

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1. TEACHERS' BELIEFS ABOUT MATHEMATICS, AND ITS LEARNING AND TEACHING

In both Eastern and Western cultures, teachers' beliefs about mathematics, mathematics learning and mathematics teaching play a critical role in determining how teachers help their students learn mathematics (Ma, 1999; Pajares, 1992; van Zoest, Jones & Thornton, 1994). It is recognised that a student's prime, but by no means only, source of mathematical experiences is the classroom (National Council of Teachers of Mathematics, 2000) and what occurs in the mathematics classroom influences student beliefs (Relich, 1995). The teacher and, in particular, the beliefs of the teacher, are critical to

[1] In New South Wales, Australia, primary teachers are generalist teachers working with students in the age range of approximately 4 years 6 months to 12 years 6 months. Secondary mathematics teachers are specialist teachers working with students in the age range of approximately 11 years 6 months to 18 years. In Hong Kong, primary teachers are generalist teachers working with students in the age range of approximately 6 to 12 years. Secondary mathematics teachers are specialist teachers working with students in the age range of approximately 12 to 17 years.

the classroom implementation of mathematics learning and teaching (McLeod, 1992, Wong, Lam, & Wong, 1998) although exactly how this occurs and to what extent one influences the other has been questioned (Beswick, 2002; Sosniak, Ethington, & Varelas, 1991). All teachers of mathematics hold beliefs about mathematics learning and teaching. These beliefs are developed within the cultural contexts, community and student expectations in which teachers are taught as children, participate in teacher education and continue their professional development. Over this time span, cultural values and community expectations combine to influence teachers in the development of their personal beliefs about mathematics, mathematics learning and mathematics teaching. These beliefs influence and guide teachers in their decision making and implementation of teaching strategies. Indeed, it has been suggested that the investigation of beliefs about learning and teaching may well be the most critical factor in educational research (Pajares, 1992).

2. COMPARATIVE STUDY OF BELIEFS

In their book *The Teaching Gap*, Stigler and Hiebert (1999, pp. 87-88) make the following point about the importance of teacher beliefs and the cultures in which they are embedded:

> Cultural activities, such as teaching, are not invented full-blown but rather evolve over long periods of time in ways that are consistent with the stable web of beliefs and assumptions that are part of the culture. The scripts for teaching in each country appear to rest on a relatively small and tacit set of core beliefs about the nature of the subject, about how students learn, and about the role that a teacher should play in the classroom. These beliefs, often implicit, serve to maintain the stability of cultural systems over time. ... these systems of teaching, because they are cultural, must be understood in relation to the cultural beliefs and assumptions that surround them.

It seems clear that, in order to gain an appreciation of differences and similarities in the learning and teaching of mathematics across cultures, it is essential that the beliefs of both students and teachers be studied. The focus within this chapter compares the beliefs of both primary and secondary mathematics teachers from Hong Kong and New South Wales, Australia about mathematics, mathematics learning and mathematics teaching and seeks to explain similarities and differences in terms of the dominant cultures within the communities and the mathematics curriculum in schools.

This chapter has grown from the long term commitment of the authors – both nationally and internationally – to the study of the impact of teachers' beliefs on their teaching and their students' learning of mathematics (see, for example: Conroy & Perry, 1997; Howard, Perry, & Fong, 2000; Perry, Howard, & Tracey, 1999; Perry, Tracey, & Howard, 1998; Perry, Vistro-Yu, Howard, Wong, & Fong, 2002; Wong, Lam, Leung, Mok, & Wong, 1999). It continues this commitment through an in-depth bilateral comparison of these beliefs in Hong Kong and New South Wales, Australia. Data from both qualitative and quantitative instruments are analysed in order that possible links among the beliefs espoused by the four groups of teachers can be discussed in terms of the different educational and cultural contexts in which the teachers work.

3. BRIEF BACKGROUND

There are many differences and some similarities between the two research sites selected for this study. The Hong Kong community is deeply rooted in Chinese culture, but has experienced great influences from the west, particularly through the many years of British colonisation which ended in 1997 (Wong et al., 1999). The dominant cultural influence in Australia results from more than 200 years of white Anglo-Saxon control following the British invasion of the country in 1788. However, this has been gradually modified through a steady but consistent move to multiculturalism, influenced over the last 40 years by much immigration from Asian countries. So, both research sites have been British colonies. This is reflected in their school systems, although in both cases local changes have been made.

3.1 Hong Kong

A child growing up in Hong Kong receives nine years' compulsory primary and junior secondary education (from Primary 1 to Secondary 3), with secondary school allocation monitored by the Academic Aptitude Test in between. Although senior secondary education (Secondary 4 & 5) is not compulsory, about 90% of junior secondary school students are eligible for promotion to Secondary 4. These students sit the Hong Kong Certificate of Education Examination at the end of Secondary 5. The promotion rate from Secondary 5 to Secondary 6 in recent years is around 40%. To gain entry into university, sixth-formers sit the Hong Kong Advanced Level and Advanced Supplementary Level Examinations after two years' study.

Similar to many Asian countries, classes in Hong Kong are large, averaging 40 students per class. This is one of the highest among partici-

pating countries at the Third International Mathematics and Science Study (Wong et al., 1999). Hong Kong scored the lowest among Asian countries in the Third International Mathematics and Science Study (Beaton et al., 1996).

3.2 New South Wales, Australia

School education is a state responsibility in Australia so the following statement is specific to the state of New South Wales and is not true of all states of Australia. Children in New South Wales receive ten years' compulsory school education (Kindergarten to Year 6 in primary and Years 7 to 10 in secondary). In general, children progress through these years as part of their age cohort – repetition of classes is unusual. There is no qualifying examination for entry into secondary school. Approximately 85% of students across the state completing Year 10 move into Year 11, again without a qualifying examination. Almost all of these students undertake the Higher School Certificate examination at the end of Year 12 which provides both a school completion qualification and, for those students wishing to attend university, an entry qualification.

Class sizes in New South Wales schools vary from 20 in the early years of primary school and in secondary schools to about 30 in the senior years of primary school. Australia scored in the second major band in The Third International Mathematics and Science Study, significantly higher than the USA, significantly lower than the leading Asian countries and lower than Hong Kong. (Scores for New South Wales students were not significantly different from those for the total Australian sample.) The relevant comparative mathematics scores for eighth grade students in the two countries on TIMSS and TIMSS-R are given in Table 1 (adapted from National Center for Educational Statistics, 2003).

Table 4-1-1. Average scores on the 1995 TIMSS (rescaled) and 1999 TIMSS-R mathematics assessments in Australia and Hong Kong

Country	TIMSS mathematics score		TIMSS-R mathematics score	
	Average	Standard error	Average	Standard error
Hong Kong	569	6.1	582	4.3
Australia	519	3.8	525	4.8

4. METHOD

Data for this study were gathered using a researcher-designed questionnaire containing 20 items dealing with teacher beliefs about mathematics and its learning and teaching. The questionnaire was constructed from numerous

sources (Australian Education Council, 1991; Barnett & Sather, 1992; Wood, Cobb & Yackel, 1992), trialled extensively with both primary and secondary teachers and used in numerous earlier studies (Howard, Perry, & Lindsay, 1997; Perry, et al., 1998, 1999; Tracey, Perry, & Howard, 1998) including cross-cultural studies in Australia, Indonesia, the Philippines and Singapore (Howard et al., 2000; Perry & Howard, 1999; Perry et al., 2002).

In Australia, the questionnaire was administered in English and in Hong Kong, it was translated into Chinese. Respondents completed the questionnaire by indicating on a three point Likert scale – Disagree, Undecided, Agree – to what extent they agreed with each statement. The sample for this implementation of the questionnaire were primary (n=377) and secondary teachers (n=179) in Hong Kong (HK) and primary (n=252) and secondary teachers (n=249) in New South Wales, Australia (NSW) – a total of 1027 teachers.

After the results for the questionnaire had been analysed, focus group interviews with small groups of primary and secondary teachers were held in both Hong Kong and New South Wales. In these interviews, teachers were asked to comment on the results from four specific statements in the questionnaire as well as to provide general comments on the results. The data derived from these interviews are used in this paper to explicate the quantitative findings from the questionnaire as well as to provide a general overview of the orientations of groups of teachers in each jurisdiction.

5. RESULTS AND ANALYSIS

An important initial result is the confirmation that the questionnaire used in this study is not only relevant in the Australian context (Perry et al., 1999) but also, in its translated version, in the Hong Kong context. In earlier studies (Howard, et al., 1997, 2000; Perry & Howard, 1999; Perry, et al., 1998, 1999; Tracey, et al., 1998), two categories of beliefs – transmission oriented and child-centredness – have been clearly defined. They can be described in the following ways:

transmission: the traditional view of mathematics as a static discipline which is taught and learned through the transmission of mathematical skills and knowledge from the teacher to the learner and where "mathematics [is seen] as a rigid system of externally dictated rules governed by standards of accuracy, speed and memory" (National Research Council, 1989, p.44);

child-centredness: students are actively involved with mathematics through "constructing their own meaning as they are confronted with learning experiences which build on and challenge existing knowledge" (Anderson, 1996, p.31).

Teachers in both Hong Kong and New South Wales reported beliefs across both the transmission and child-centredness factors, and, through factor analysis, measures of how each respondent sees her- or himself as a mixture of a 'transmission' and a 'child-centred' teacher were calculated. For each group of teachers, there were significant differences between the groups' loadings on these two factors with HK primary teachers seeing themselves as more transmission oriented than child-centred while the other three cohorts – HK secondary, NSW primary and NSW secondary teachers – saw themselves as more child-centred than transmission oriented.

By applying independent sample t-tests to the factor scores on the transmission and child-centredness factors for each pair of teacher groups, statistically significant differences in these factor scores across the four different cohorts of teachers were found. Table 2 shows the results of such an analysis for the transmission factor and Table 3 for the child-centredness factor.

Table 4-1-2. Analysis of independent samples t-test using transmission factor scores across teacher cohorts

Teacher cohort	HK Secondary		NSW Primary		NSW Secondary	
HK Primary	t=20.67	p<0.001	t=50.45	p<0.001	t=50.87	p<0.001
HK Secondary			t=62.93	p<0.001	t=64.04	p<0.001
NSW Primary					t=0.55	NS

The rank order of groups on the transmission factor was HK Secondary teachers (most positive), then HK Primary teachers and the two NSW cohorts which are not significantly different.

Table 4-1-3. Analysis of independent samples t-tests using child-centred factor scores across teacher cohorts

Teacher cohort	HK Secondary		NSW Primary		NSW Secondary	
HK Primary	t=59.59	p<0.001	t=27.16	p<0.001	t=27.18	p<0.001
HK Secondary			t=25.09	p<0.001	t=24.34	p<0.001
NSW Primary					t=0.34	NS

The rank order of groups on the child-centred factor was HK Secondary teachers (most positive), followed by the two NSW cohorts – which are not significantly different – and the HK Primary teachers.

The fact that the HK secondary teachers ranked most positively on both the transmission and child-centred factors begs further explanation which is provided later in this chapter.

The four statements highlighted in Tables 4 to 7 have been chosen for inclusion here because they show a clear distinction between the responses of the HK and NSW teachers and because they can represent the two previously identified factors. Statements 6 and 9 load onto the transmission factor and Statements 14 and 15 load onto the child-centred factor.

Table 4-1-4. Questionnaire date for Statement 6: Percentages of each cohort reporting Disagree (D), Undecided (U), Agree (A) for each statement

Statement	Teacher group	D	U	A
6. Right answers are much more important in mathematics than the ways in which you get them	HK Primary	9	57	35
	HK Secondary	0	5	95
	NSW Primary	87	8	6
	NSW Secondary	88	6	6

Table 4-1-5. Questionnaire data for Statement 9: Percentages of each cohort reporting Disagree (D), Undecided (U), Agree (A) for each statement

Statement	Teacher group	D	U	A
9. Mathematics learning is being able to get the right answers quickly	HK Primary	2	52	46
	HK Secondary	6	71	24
	NSW Primary	84	8	8
	NSW Secondary	82	11	7

Table 4-1-6. Questionnaire data for Statement 14: Percentages of each cohort reporting Disagree (D), Undecided (U), Agree (A) for each statement

Statement	Teacher group	D	U	A
14. Mathematics learning is enhanced by challenge within a supportive environment	HK Primary	15	52	34
	HK Secondary	21	64	15
	NSW Primary	0	2	97
	NSW Secondary	1	5	94

Table 4-1-7. Questionnaire data for Statement 15: Percentages of each cohort reporting Disagree (D), Undecided (U), Agree (A) for each statement

Statement	Teacher group	D	U	A
15. Teachers should provide instructional activities which result in problematic situations for learners	HK Primary	48	42	10
	HK Secondary	15	73	12
	NSW Primary	4	9	87
	NSW Secondary	2	15	82

Teachers in the interview groups were asked to provide some comment on the results for each of these statements. Representative responses are given in Tables 8 and 9.

Table 4-1-8. Teacher comments on the results from Statements 6 and 9

Teacher group	Comments
HK Primary	• Exams mainly count the 'answers'. Even in the aptitude test, students get points if their answer is correct. • The pace of living is faster in Hong Kong ... 'faster is better'. • Teachers often assign students to do more math because they want to train their speed.
HK Secondary	• The need to get the right answers quickly might be due to public exams. • Teachers might use ways they learned when they were in school. The need to get the right answers quickly might pass from one generation to the other. • There are two groups of teachers. One asks students to do the questions quickly, so that they have enough time to check the answers. The other group asks students to go slowly and think thoroughly in order to gain accuracy.
NSW Primary	• There has to be a balance of both because if they have the process right but are not getting the right answer, there has to be something wrong. You have to have the right answer and the right process. • You have to identify individual needs but at the same time it comes down to accuracy and memory and learning things off by rote, particularly times tables. There is no other way. It has to work together.
NSW Secondary	• The process is important and questions can have a number of solutions. Maths is about logic and you can't learn that by just getting it right or wrong.

Table 4-1-9. Teacher comments on the results from Statements 14 and 15

Teacher group	Comments
HK Primary	• Hong Kong teachers do not have sufficient time. • I think Westerners are more willing to take risks, while we are more inclined to play safe, and avoid making mistakes and challenges. Obedience and conformity are also important.
HK Secondary	• The teaching schedule in Hong Kong is very tight, especially the classes that have to deal with public exams. There is not enough time for teachers to organise activities. • The ratio of students and teachers is an important factor.
NSW Primary	• I didn't really understand a lot of mathematical concepts until I started to teach them. I was taught through rote and memorisation and I didn't have a good understanding of what I was doing. That's why you have to vary your activities and build upon understanding. • As soon as you get bored with something you lose interest. There has to be challenge.
NSW Secondary	• Because of the way that the syllabus is written, you have to incorporate those types of things into assessment tasks. It is important to build upon students' prior knowledge and to link maths to real life as well. • The teacher education program emphasises constructivism rather than a behaviourist approach. The syllabus is structured on these principles and you have to teach the syllabus.

6. DISCUSSION

The HK primary teachers were less child-centred and less transmission oriented than their secondary colleagues. This might be explained in terms of the importance placed on giving students a sound foundation in the basics in the primary years in Hong Kong (see Table 8). Perhaps the primary teachers feel less empowered than their secondary colleagues to move beyond the obligatory syllabus or the set textbook and so do not feel in a position to form strong opinions of their own about mathematics and its teaching and learning. The looming importance of the Academic Aptitude Test seems to weigh heavily on the HK primary teachers (Wong et al., 1999). When HK primary teachers were asked about this result in the interviews, comments included:

- mathematics teaching in primary schools is less child-centred because that is too time consuming;

- other factors include the requirements of the curriculum and the expectations of high academic results from parents.

On the other hand, HK secondary teachers suggested that:

- the age of the students is a major factor – teachers may respect an older student as an individual;
- there are public exams in secondary school.

The NSW primary teachers were more child-centred and less transmission oriented in their beliefs about mathematics and its learning and teaching than their Hong Kong counterparts. These results could be a direct consequence of the relative freedom which is afforded primary teachers in NSW to interact with the mathematics syllabus in flexible ways such as integration with other subjects, variability in timetabling, use of teaching based constructivist approaches to learning and only a slight reliance on system-wide testing – although this is currently increasing in frequency (Table 9). There is a cultural expectation that Hong Kong students will reach and achieve particularly high standards of mathematical achievement in the primary years (Wong et al., 1999). This community expectation may well place demands upon teachers to emphasise the transmission of knowledge in their teaching strategies more so than for NSW teachers. When arriving in Australia, Hong Kong parents often state that their children are at a much higher level of mathematics, often meaning the ability to work with numbers, than children of the same age taught in NSW schools. There is a high cultural value placed on HK primary children's ability to calculate with numbers. The emphasis on numeracy skills may lead to an emphasis on a greater transmission orientation in the beliefs of HK primary teachers compared to NSW primary teachers. The HK primary teachers interviewed listed the following pressures on their approaches to mathematics teaching:

- parents' expectations;
- examination results;
- curriculum too tight;
- large classes; and
- amount of homework.

These findings reiterate HK teachers' concerns about the mathematics curriculum which were highlighted by the recent holistic review of the mathematics curriculum (Ad hoc Committee on Holistic Review of the Mathematics Curriculum, 2000). In particular, "most mathematics teachers reflected that it [the mathematics curriculum] was too bulky, lacked flexibility, and was unable to cater for individual differences and to provoke thinking" while "Almost all teachers pointed out that the existing mathe-

matics curriculum was too packed, too boring, impractical and unrelated to real life" (Wong et al., 1999, p. 78). In contrast, the mathematics curriculum used by NSW primary teachers at the time of data collection (NSW Department of School Education, 1989) has been widely recognised by teachers and academics as one of the most usable, practical and teacher-friendly ever devised.

Secondary mathematics teachers in Hong Kong are both more child-centred and more transmission oriented than their counterparts in NSW. This apparent conflict is reflected in the high proportion of 'Undecided' scores given by HK secondary teachers in Statements 9, 14, 15 (see Tables 5, 6, 7). These teachers seem to be expressing beliefs about trying to meet the pragmatic requirements of teaching older – and, therefore, more respected - students and meeting their cultural and educational responsibilities in Hong Kong society. It is not unusual for teachers to express a mixture of beliefs, depending on the circumstances in which they perceive themselves (Beswick, 2002) and it seems that this might be the case with the HK secondary teachers.

HK secondary mathematics teachers experience high levels of community expectation for students to achieve well in mathematics, particularly in an examination-driven climate. The greater transmission orientation among the HK secondary teachers may be related to teachers having to ensure that the mathematics is taught and learnt to meet these expectations which are different from those in NSW (Table 8). At the same time, there is a climate of mutual respect between HK teachers and students which interview data suggest is higher than that in NSW. This may result in the HK secondary teachers focussing more on their students understanding their mathematics and therefore espousing a more child-centred orientation than their NSW counterparts. One NSW secondary teacher explained the dilemma in the following way:

> Sometimes it is easier and quicker to use a transmission approach to get through the maths content, particularly in Years 11 and 12. The amount of content affects the style that we use to teach. You have to have planning – time and effort – to use child-centred approaches while you cover a lot more and it is a lot easier to use transmission approaches but the long-term results are not as good.

7. CONCLUSION

This study has demonstrated a number of important aspects about the need for the consideration of teachers' beliefs about mathematics, mathe-

matics learning and mathematics teaching. Foremost among these is that, as measured on the beliefs instrument used here, teachers in Hong Kong, at both primary and secondary levels, espouse significantly different beliefs from those espoused by their NSW counterparts. If we believe that teachers' beliefs affect their teaching and that teaching affects student outcomes, then it is possible that the differences in beliefs which are highlighted by this study could help explain some of the differences in student achievement which have been reported in international studies.

Teacher beliefs are rooted in, and constrained by, the culture of the society in which the teachers are living and working, in the culture of the education systems and traditions of the society and in their own experiences as school students, teacher education students and members of school communities. As well, teachers must respond to parental, societal and student pressures in terms of examinations and other assessment and pedagogical challenges. These pressures are also rooted in the various cultures of which the education systems are part. Hence, the expectation that cultural norms and patterns might affect teacher beliefs and practices is not surprising. In this paper, these aspects of Hong Kong and New South Wales, Australia cultures have been explored and related to the different responses of these societies to the mathematical education of their children. Of course, beliefs are not the entire story, but they are an essential part of cross-cultural comparisons in mathematics education which deserve greater recognition and research.

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