Research in Science Education (2006) 36: 85–109
DOI: 10.1007/s11165-005-3915-x

An Investigation of the Metacognitive Orientation of Confucian-Heritage Culture and Non-Confucian-Heritage Culture Science Classroom Learning Environments in Hong Kong

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Abstract

A debate is ongoing in Hong Kong regarding whether local and international schools vary in the extent to which they provide classroom learning environments that support the development of students' higher order thinking and metacognition. This study investigated commonalities and variations in the metacognitive orientation of local and international schools in Hong Kong. Commonalities and substantive differences in the metacognitive orientation of the classroom learning environments were identified and these variations might, to some extent, be explained with reference to cultural variations regarding the purposes and processes of education. This research provides a further example of the value of the concept of learning environments for addressing educational questions that might otherwise be resolved with reference to primarily anecdotal data and hearsay.

Key Words: cultural influences, learning environments, metacognition

Initially this research sought to provide predominantly quantitative insights into variations between the perceptions of local and international school students in Hong Kong in relation to the metacognitive orientation of their science classroom learning environments. This aim emerged as a response to a debate about the need for science education reform as part of broader systemic education change in Hong Kong that has as its focus developing students' learning to learn capacities (Hong Kong Curriculum Development Council, 2000; Hong Kong Education Commission, 2000). However, as the research progressed and was informed by emergent findings and the iterative process of relating these findings to what was already reported in other studies and the literature, it became apparent that deeper issues related to cultural influences on learning environments were important to acknowledge and to investigate so that any findings might be understood more substantially and therefore be potentially of more value in informing the aforementioned debate.

The initial impetus for the study centred around claims from within Hong Kong that the learning environments in local schools, that is, those that follow the Hong Kong curriculum and provide for the predominantly ethnic Chinese population, fail to encourage the development of learning environments that are suitable for stimulating the development of students' higher-order thinking and ability to engage in self-regulated learning (e.g., Ho, 2002; Ho, Peng, & Chan, 2001; Law, 1996; Leung, Yung, & Tso, 2002). While some educators in Western countries (e.g., Stevenson,

1992; Stevenson & Stigler, 1992) have sought answers to their education systems' problems through examining CHC education systems and practices, Hong Kong is currently looking to elements commonly associated with suggested education reform, but not necessarily practice, in Western countries. These elements include an emphasis on developing students' higher order thinking and creativity and the diversification of pedagogy and resource development and use. The review of the teaching of science has been in response to criticisms of low quality student learning and lack of problem-solving ability being leveled from within their own education systems and from the public in response to, for example, the findings of International studies such as Third International Mathematics and Science Study. Indeed, while studies such as The IEA Study of Science II highlight the academic science achievement of Hong Kong students at the upper, selective levels of secondary school, the authors of a report on that study note that "one wonders about the apparent emphasis on the science education of the elite at the expense of mass education lower down the system" (Postlethwaite & Wiley, 1992, p. 140).

In recent years, as a reflection of their concern regarding the local education system, many local (non-expatriate) Hong Kong parents have shown increased interest in sending their children to International schools as an alternative to local Hong Kong schools and the numbers of local ethnic Chinese students attending international schools has increased. This is despite evidence for commonalities and of the learning environments between local and international schools being primarily anecdotal, especially in relation to whether international schools are oriented differently to the development of metacognition and other forms of higher order thinking. The international schools were originally established to serve the needs of the children of expatriates who could not be educated in local schools for a variety of reasons (Yamoto & Bray, 2002). It should be noted that the students in International schools in Hong Kong also sit high-stakes examinations as do their counterparts in the local schools. For example, students attending the English Schools Foundation, the major multi-school provider of non-local primary and secondary schooling in Hong Kong, at present take the high-stakes English GCSE and A-Level examinations and the International Baccalaureate.

There is currently limited empirical research that seeks to understand commonalities and differences between the of CHC and non-CHC science classroom learning environments. There is, however, an increasing level of cross-cultural learning environments research in Asian countries (Fraser, 2003) and this study builds on this emerging trend. Previous cross-cultural studies in the field of learning environments (e.g., Aldridge & Fraser, 2000; She & Fisher, 2000) have compared the learning environments between classrooms in different countries. This study varies from those studies as it investigates classroom environments from schools located within the same country but from different school systems and reflecting different education traditions operating within that country. In this way, in addition to informing the aforementioned debate in Hong Kong it has the potential to:

1. demonstrate another use for learning environments research, and
2. inform considerations of such issues in other countries where similar situations might exist.

Metacognition: Sociocultural Influences on Science Lessons

The development of students' metacognition has been a key educational goal since the pioneering writings of Flavell (1979) and Brown (1978). Metacognition, an individual's knowledge, awareness and control of his/her thinking and learning strategies (Flavell, 1979; Garner & Alexander, 1989), is a key element and mediator of higher-order thinking and self-regulated learning and important for quality learning and problem solving (Brown, 1978; Flavell, 1979; Schraw & Moshman, 1995). Influenced by my own past research (Thomas, 1999a, 1999b; Thomas & McRobbie, 2001) and that of others (e.g., Baird & Mitchell, 1987; Gunstone, 1992), I attempted to locate students' metacognition within their social settings while also noting that the nature of the classroom learning environment is an influential factor on the development of their metacognition (Thomas, 2002a). Students' metacognition is influenced by their classroom learning environments that themselves are not divorced from the social milieu that envelopes and pervades them.

Such a view of the significance of sociocultural influences on metacognition is consistent with the views of situated learning theorists (e.g., Billett, 1996; Lave & Wenger, 1991) and social constructivist views of teaching and learning (e.g., Cobb, 1996; Milne & Taylor, 1995; Tobin, 1993). Further, Moos (1991) has suggested that "to understand fully the determinants and impacts of educational settings, we need to consider their links to other aspects of an individual's life context" (p. 37). The consequences of acknowledging that students' metacognition is influenced by sociocultural factors are that:

1. considering deficit models of individuals' or groups' metacognitive status or performance might be considered problematic, and
2. the nature of classroom environments and the variety of factors influencing those environments should assume greater prominence in attempts to understand how and why students' metacognition develops as it does within and across educational settings.

Drawing on research into metacognition in science education as well as other subject areas I proposed the concept of 'metacognitive orientation' (Thomas, 2002b). This was done to assist in conceptualising and distinguishing between classroom factors related to the development and enhancement of students' metacognition and to assist in exploring the extent to which students' classroom environments support, or otherwise, the development and enhancement of their metacognition. As metacognition is influenced by sociocultural factors it might be expected that there would be variations in the metacognitive orientation of science classroom learning environments across different settings. However, little if any research has directly addressed such a proposition. It is commonalities and variations in the metacognitive orientation of Confucian-heritage culture and non-Confucian-heritage culture science classroom learning environments in Hong Kong that is the focus of this paper. It is important to seek to understand how metacognitive orientation may or may not vary across settings so that science educators are aware of such variation and its possible origins. Further, understanding such variation might lead to a better

understanding of how to improve the metacognitive orientation of science classroom learning environments.

A Hong Kong Perspective on Confucian-Heritage Culture Learning

A substantial volume of research has addressed differences in learning approaches across different cultures including in relation to differences between learners from Confucian Heritage Cultures (CHC) and Western cultures. Interest in the learning processes of CHC students has grown since the 1980s when some comparative studies in science and mathematics achievement suggested that students from CHC backgrounds, especially at the higher levels of secondary schooling in the case of Hong Kong, outperformed their Western counterparts (e.g., Postlethwaite & Wiley, 1992; Stevenson & Stigler, 1992). As previously mentioned, a consequence of such findings is that some educators in Western countries have looked to the education systems of CHC-oriented countries for means of improving science teaching and learning. Much research on the learning approaches and metacognition of CHC learners has emanated from Hong Kong. Hong Kong teaching and learning processes are considered generally to reflect the CHC traditions and therefore may serve as examples of such an orientation 'in action.'

In Confucian Heritage Culture Classrooms academic success is often equated with effort and repeated practice (Hau & Salili, 1991; Watkins & Biggs, 1996). The proposition that Hong Kong secondary school students attending local schools perceive their classrooms to be teacher controlled, competitive and encouraging rote learning is a common theme in the literature on CHC education (e.g., Chan & Watkins, 1994; Holbrook, 1990). Chan (1996, p. 96) notes that the "long standing tradition stressing memorisation and the regurgitation of factual knowledge at examinations has been criticised by many psychologists and educators for stultifying the proper and healthy development of a critical mind charged to analyse and solve problems."

However, while the emphasis on memorisation is a consistent theme in the CHC literature, Marton, Dall'Alba, and Tse (1996) and Watkins (1996) have cautioned against assuming that the purported rote learning practices of CHC learners are always counterproductive to their development of deep understanding of concepts. Marton et al. suggested that, for CHC learners, memorisation and repetition can be associated with the higher order processes of deepening and developing understanding as well with processes such as mechanical rote learning. Watkins proposed a tentative developmental model for CHC learners. In this model he suggested that as the demands of schooling and the volume and complexity of material to be learned increased, successful CHC students became more aware that relying solely on rote learning was not sufficient for academic success. These students became more self-reliant and metacognitive and began combining strategies for memorising and deep understanding. Such a proposition is consistent with my own findings (Thomas, 1999a) in a non-CHC context that the development of metacognition and the processes for developing understanding and deep learning in individuals may be

associated with variations in the level of students' awareness to the changing demands of schooling and their responses to such individual realisations rather than as a consequence of the use of any explicit teaching strategies for promoting metacognitive awareness. Further, Gow, Balla, Kember and Hau (1996) have proposed that the approaches to learning of CHC learners are:

1. "more a function of the learning environment than of inherent characteristics,"
2. "contextually bound and intrinsically elated to achievement motivation," and
3. "a function of socialisation processes and the learning context" (p. 108).

A key feature of the socialisation of CHC learners relates to the concept of filial piety which promotes behaviour in children whereby they are "instructed to be obedient to their elders, irrespective of whether the demands or requests at times seem unreasonable" (Gow et al., 1996, p. 114). A consequence of filial piety is that Chinese students reportedly respect their teachers as second only to their parents in authority (Siu, 1992), are seen as passive participants in their classrooms, and do not challenge their teachers' authority. Teachers emphasise academic performance and set high expectations for academic success which, in CHC societies, is measured by results in highly selective examinations. The local Hong Kong education system reflects this emphasis on examinations (Biggs, 1990; Morris, 1985) with the main aim of schooling being to achieve high marks, gain university entry, and then entry to a well-paying position following graduation. Morris noted that the main focus for teachers was on using didactic transmission to prepare students for public examinations. This focus was the major influence on their teaching styles. This perspective is consistent with the general situation in CHC-oriented education systems. Chan (1996, p. 96) summarises this position well:

> . . . traditionally, Chinese society has valued scholars more highly than it has members of other occupations . . . as a result, the examination-oriented education system has continued up to the present day and has dominated schools and universities both in Mainland China and in Hong Kong, Taiwan and Singapore, highly competitive societies made up largely of Chinese people. Students in Hong Kong tend to study only material which will help them to achieve better results in public examinations, and the acquisition of other life skills tends to be neglected.

Irrespective of the success or otherwise of CHC learners compared to their Western counterparts or the origins of and influences on their approaches to learning, the finding that CHC students in the aforementioned literature made significant use of memorisation and rote-learning strategies does not imply that all students attending local secondary schools in Hong Kong are satisfied with the reported situation. Chan and Watkins (1994) used the Classroom Environment Scale (Moos & Trickett, 1974) in their study and proposed that local Hong Kong secondary school students in general preferred a friendlier classroom environment than they perceived was the situation. Students suggested that such an environment would be one within which students and teachers would negotiate to employ a wider range of activities to promote interest, academic challenge and "a deeper, more achievement-oriented approach to learning" (p. 233). Further, Tang (1991) found that many Hong Kong students attending local schools were unhappy with the rigid nature of the learning environment.

Methodology

This research employed a mixed methods approach involving the use of a quantitative learning environments instrument, the Metacognitive Orientation Learning Environment Scale – Science (MOLES-S) (Thomas, 2003, 2004), and semi-structured interviews with purposively selected students. The MOLES-S is an instrument utilising a 5-point Likert scale for each of 7 sub-scales each containing five items. A summary of the 7 sub-scales of the MOLES-S is provided as Table 1.

Each sub-scale of the MOLES-S provides a gauge of students' perceptions in relation to a psychosocial dimension of the science classroom learning environment reflecting what is known from the literature to be related to the development of metacognition. The items comprising this scale are also consistent with the literature on learning environments and the development of previous learning environments instruments. Further, the instrument is premised on the proposition that in addition to engaging students in activities such as, for example, problem-solving, concept mapping or experimental work, there is a need for students to be explicitly made aware of why and how such activities and their associated cognitive processes contribute to their learning so they can develop knowledge, control and awareness of such activities and processes. In other words, such activities, while valuable for learning science, and used in science classrooms, may not necessarily by themselves lead to the development and enhancement of metacognition that is adaptive for students. Rather, they should form the basis of explication and discussion of the thinking processes associated with them as a reasonable means to develop metacognition. The MOLES-S also incorporates dimensions such as student voice and distributed control, derived from critical theory and reflected in the Constructivist Learning Environment Survey (Taylor, Fraser, & White, 1994), and teacher encouragement and emotional support, which are not prominent in the metacognition literature but are justifiably important for the development and enhancement of students' metacognition (Thomas, 2002b, 2003). In the initial development of the MOLES-S, a series of translations and back translations of the individual items between English and Cantonese languages took place using experienced translators to develop conceptually equivalent English and Cantonese versions of the instrument.

The MOLES-S was administered to 1223 students across 43 classes of Forms 1 to 6 (12–17 years of age) students in order to investigate the perceptions of students from each system. Sixteen classes came from local Hong Kong schools ($n = 578$) and 27 classes came from international schools ($n = 645$). The local Hong Kong school students came from Bands 1 and 2 schools. Hong Kong's local secondary schools are stratified in three bands with the most academically successful students attending generally Band 1 schools and the least academically successful students attending Band 3 schools. This sampling was an attempt to ensure that, as much as practicable, responses from across comparable student populations with respect to socio-economic factors and levels of students' academic achievement were obtained. A one-way analysis of variance (ANOVA) using class membership as the main effect was used to assess the capacity of the MOLES-S to discriminate between

Table 1
Description of Scales and a Sample Item for Each Scale on the Initial Version of the MOLES-S.

Scale name	Description (Extent to which:)	Sample item (In this science classroom:)
Metacognitive demands	. . . students are asked to be aware of how they learn and how they can improve their science learning.	Students are asked by their teacher to think about how they learn science.
Student–student discourse	. . . students discuss their science learning processes with each other.	Students discuss with each other about different ways of learning science.
Student–teacher discourse	. . . students discuss their science learning processes with their teacher.	Students discuss with their teacher about how they can improve their learning of science.
Student Voice	. . . students feel it is legitimate to question the teacher's pedagogical plans and methods.	It is OK for students to ask the teacher why they have to do a certain activity.
Distributed Control	. . . students collaborate with the teacher to plan their learning as they develop as autonomous learners.	Students help the teacher decide which activities are best for them.
Encouragement & Support	. . . students are encouraged by the teacher to improve their science learning processes.	The teacher supports students who try to improve their science learning.
Emotional Support	. . . students are cared for emotionally in relation to their science learning.	Students' ideas are respected.

the students' perceptions. Effect sizes and t-tests were used to investigate potential variations between the perceptions of the students in each system. Further, to assess the degree to which the students in this study and those sampled in the MOLES-S

validation study (Thomas, 2003) might be considered members of a homogeneous local student population, Levine's test for equality of variances was conducted using the data from the 578 students with that of the 1026 students from the validation study. This was seen as necessary to ensure that the sample drawn from local schools for this study, which was less than the sample drawn from the international schools in both number of students and number of classes, could be considered representative of the local student population as much as possible and to allay any concerns in relation to this matter.

The MOLES-S data influenced, but did not exclusively determine, the selection of students for interviews. Students were selected predominantly on the basis of their class membership so that as much as possible a range of student and class responses on each of the dimensions of the MOLES-S were represented. This approach to sampling was an attempt to ensure that a cross-section of student opinion from each system might be accessed via the interviews. In the interviews students were asked to explain the reasons for their responses to the items on the MOLES-S. A three tiered approach similar to that used by McRobbie and Tobin (1997) and McRobbie and Tobin (2000) was employed. Interviews began with general questions about the learning environment, followed by questions related to the individual scales of the MOLES-S, and finally questions related to specific items on the instrument. Thirty-five students in total, consisting of up to six students from six classes, three local and three international, were selected for interviews. The teachers of the students in the international schools were expatriates educated in Australia and Great Britain while those in the local schools were ethnic Chinese who were raised and educated in Hong Kong. Interviews were transcribed and analysed in relation to the conceptualised dimensions of metacognitively oriented science classroom learning environments and what was already known from the literature about cultural influences on the teaching and learning practices in these systems, while at the same time attending to the issue of potential cultural bias as discussed below.

Acknowledging the Issue of Cultural Bias

An issue that needs to be considered and acknowledged in this study is that of potential cultural bias. The potential for cultural bias exists at a number of levels. Firstly, on the surface it might be considered that this research is premised around the notion that there are universal and cross-culturally acceptable views of what can be considered adaptive and acceptable cognitive and metacognitive processes. This claim may be contestable. The MOLES-S reflects my understanding, based on predominantly Western literature, of what might be considered to be important in relation to the classroom factors that influence the development and enhancement of students' metacognition. Such an assumption, if not made explicit, may result in some readers considering that scores on the MOLES-S reflect some quantitative reality that transcends temporally bound cultural identities and practices. Lee (2003) warns against this possibility by suggesting that culture is not static and the practices

and beliefs associated with cultural groups are under constant negotiation, located in history and "carried forward through institutional practices" (p. 3). Further, Erickson (1998) notes that human opinion is "locally distinct and situationally contingent" (p. 1155). Gutierrez and Rogoff (2003) argue for any variations to be considered as differences between groups rather than as reflecting deficits. They argue for the need to use past tense to locate temporally the research, and also to avoid overgeneralisation. In this study I attempt to act on these suggestions in considering assertions arising from data analysis. On a second level there is the potential bias in analysing data and reporting findings and data. To minimise such possibilities the research process engaged peer debriefing and the monitoring of my progressive subjectivity (Guba & Lincoln, 1989). Through these processes I sought to minimise the influence of my own predispositions and potential cultural biases on the research process and on the analysis and reporting of data and findings.

Results and Analysis

The results and analysis are reported in two sections. The first section consists of the analysis of MOLES-S data. In the second section the perceptions of students regarding their learning environments are described. Because the dimensions of the MOLES-S influenced the structure of the interviews, for ease of reporting the students' perceptions and claims are categorised according to their relation to each of the dimensions. The aim of such reporting is to highlight commonalities and variations between the local and international school contexts in relation to the metacognitive orientations of their learning environments.

Quantitative Data Analysis

Table 2 highlights the main findings from the analysis of the quantitative data from the MOLES-S. Cronbach alphas for the sub-scales ranged from .74 to .89 suggesting an acceptable level of internal consistency among the items for each of the dimensions. The discriminant validity for the seven sub-scales of the MOLES-S, using the mean correlation of a scale with the other scales as a convenient index, ranged from .32 to .48 suggesting that, while there is some overlap between the dimensions, they measure distinct aspects of the psychosocial environment. Such overlap was also evident in the study of the development of the MOLES-S (Thomas, 2003). The ANOVA analysis indicated that the MOLES-S was able to distinguish between the classrooms of the Hong Kong schools and between those from international schools for all dimensions of the instrument.

The effect size for five of the MOLES-S sub-scales ranged between less than one tenth of a standard deviation (.04) to close to six tenths of a standard deviation (.58). According to the criteria of Cohen (1988) these effect sizes suggest small to medium differences between the perceptions of students at local Hong Kong schools and

Table 2
Cronbach alpha, Mean, Standard Deviation, Eta^2, Effect Size and t-test for Independent Samples Results Between Local and International Schools in Hong Kong in Perceptions of the Metacognitive Orientation of the Classroom Learning Environment.

Scale	Cronbach alpha		Scale mean*		Standard deviation		Comparison between local and international		Eta^2	
	Local	Int.	Local	Int.	Local	Int.	Effect size	t	Local	Int.
Metacognitive demands	.79	.76	3.39	2.9	.75	.75	.58	10.69**	.31**	.16**
Student–student discourse	.82	.81	2.89	2.70	.80	.84	.20	3.6**	.16**	.17**
Student–teacher discourse	.84	.84	3.00	2.72	.80	.83	.33	5.98**	.26**	.17**
Student Voice	.79	.74	3.5	3.79	.81	.77	.37	−6.5**	.17**	.16**
Distributed Control	.89	.82	2.24	1.86	.9	.73	.45	8.11**	.26**	.19**
Encouragement & Support	.86	.86	3.4	3.49	.83	.91	.04	−.83	.27**	.13**
Emotional Support	.86	.88	3.83	4.13	.82	.85	.35	−6.26**	.21**	.13**

*Scale mean maximum = 5.
**$p < .001$.

those at international schools on the sub-scales representing the dimensions of the MOLES-S with the exception of the Encouragement and Support sub-scale where the effect size is very small. The quantitative findings in relation to the metacognitive orientation of the local Hong Kong school science classrooms are consistent with those of Thomas (2003). The results of Levine's test for equality of variances suggested that the samples of local students for this study and that of the previous validation study were samples from a homogeneous Hong Kong population of high school students for all dimensions other than Metacognitive Demands ($F(1,1602) = 7.156$, $p < .01$). The sample of students in this study reported a higher level of metacognitive demand in their classroom learning environments than those sampled in the previous validation study. This may be because the classes in this study came from higher banded schools compared to those in the validation study. To explore further

any implications of this variation for generalisations that might arise from this study, the perceptions of the metacognitive demands of the international school students in this study were compared with those of the local students sample from the validation study using an independent samples t-test. Again, the perceptions of the metacognitive demands for students' from the local schools were statistically higher than those of students from the international schools ($t(1669) = 4.2$, $p < .001$). This finding suggests that while there might be differences in the variances of the two local school student samples for the metacognitive demands sub-scale, the contrasts between the perceptions of the local and international students in relation to this sub-scale were reproducible.

On the basis of this data analysis is reasonable to suggest that:

1. the students in Hong Kong's local schools perceived higher levels of metacognitive demands, student–student discourse, student–teacher discourse, and distributed control in their classrooms then students in the international schools perceived was the situation in their classrooms, and
2. the students in international schools perceived higher levels of student voice and emotional support in their classrooms than students in local schools perceived was the case for them.

There was no statistically significant difference between the two groups of students in relation to the encouragement and support dimension. What seems apparent, however, is that students from both systems reported generally low levels of metacognitive orientation in their science classrooms in relation to several of the dimensions. Yet, even so, given the aforementioned impetus for the debate in Hong Kong and what is generally reported in the literature in relation to CHC learning environments, the quantitative findings might be seen by some as surprising, especially in relation to the local students' perceptions of the metacognitive demands and distributed control dimensions of their learning environments compared with those of the international students. However, the quantitative data, while informative, does not provide insights or potential explanations for the commonalities and variations that might be inferred from it. Therefore, in what follows, the metacognitive orientations of the learning environments of the classes from the local and international schools are explored further with reference to the interview data.

Interview Data and Interpretation

In reporting on the students' views of their learning environments, comments that are indicative and that reflect any variations in their intimations are provided. The major findings from the analysis of the interview data are presented in relation to the dimensions of the MOLES-S. However, prior to that, the perceptions of the general characteristics of the science learning environments reported by students from both systems are reported. As previously noted, the development of metacognition is not divorced from other aspects of classroom life including the activities that students engage in. It is valuable therefore to provide a brief overview of students' views of

their general classroom activities to provide a context within which to locate their perceptions related to metacognitive orientation that are of specific interest in this research.

Students' perceptions of general classroom characteristics

It was clear from the intimations of most students from both systems that they perceived that the predominant focus in their classrooms was on teacher transmission of knowledge and experimental work that focused on verifying textbook information. The dominance of teacher talk was a common theme in students' claims. Local students, for example, suggested, "The students sit properly, listen to the teacher, and the teacher tells us what they need to teach," "The students don't ask many questions, they just listen," and "The teacher will ask us to look at the textbook first at home. . . then, in the lesson, the teacher will write something on the board and tell us what the chapter is all about." Students in the international schools suggested, for example, that "The teacher just explains it [information] from the book," "We take notes. . . we always copy the board. . . then we try experiments to test whether they work or not. . . if we can't do it we get told the answers. . . we don't really have to think because we just get told the answers," "I don't answer questions because our teacher doesn't give us questions to answer. The teacher copies off the books. . . sometimes we do practicals and we do worksheets," "We just have to read the textbook and answer some questions (the teacher) asks us," and "The teacher explains most of the stuff. . . you don't have to think because the information's from the teacher." An exception to the views outlined above came from students in one international classroom who suggested that their teacher engaged them in a wider range of activities then those reported by the students in the other sampled classes. These activities included, for example, quick questions, a form of revision test, and the use of the Internet during class time, activities not reported by students in other classes: "If the teacher thinks the textbook is boring for us, the teacher will book the computer and let us go online." The suggestions from students in most classes therefore are commensurate with research in relation to both CHC (e.g., Gao, 2002) and non-CHC (e.g., McRobbie & Tobin, 1995; Tobin & Gallagher, 1987) science education and classrooms. Such accord with the existing literature is important because it enables the reader to understand something of students' views of what constituted the majority of the activities within their classrooms in relation to such literature.

Metacognitive demands

The quantitative data suggested that students in local Hong Kong schools perceived that more metacognitive demands were made of them than students in international schools perceived to be the case for them. The students in the local schools reported that the teachers continually reminded them to memorise the information that was presented to them. This was encapsulated in comments such as "The teacher says this is important for the examination so we should remember it," "The teacher

always asks us to remember the conclusion and why it is the conclusion and how you make it." The students reported little else in terms of the teachers' metacognitive demands.

Rather than focus on any particular cognitive processes, the international schools' students typically related information regarding teacher demands on them to extend the range of activities that they performed, rather than any particular cognitive processes such as memorisation, "The teacher told us to go through websites on the Internet and then read more books about science," and "The teacher says you can go look for some reference books. . . mostly tells you how to find information." The international school students also reported that their teachers predominantly used general phrases such as "Think about it," and "Think!" In the one international classroom in which students reported a wider range of activities they also reported how they considered such activities assisted them to develop as science learners. For example, in relation to quick questions a typical comment was that these were "tests of what we learnt in the past few weeks and days to help us remember what we did. . . it keeps our brain functioning so we don't forget what we learnt in other lessons," and in relation to their online learning activities, "The teacher tells us you can become a better learner if you go to the websites on the list."

Students in both systems suggested that their teachers could do more to help them learn how to learn science. This is exemplified by statements from local students such as "I think the teachers should tell us how to learn science," and "The teacher just asks us to find the ways to learn science. . . but seldom explains how to do that," and from international students such as "The teacher doesn't actually teach us how to learn science," and "We don't get asked to think about how we could become better learners."

Student–student discourse

While the mean values for this dimension were not too different between the two populations, the students in the local Hong Kong schools perceived that they engaged in more discussion with their peers about the processes of learning the consequences of those processes that the students in the internationals schools perceived they did. Both groups of students reported that this happened less than sometimes and that most classroom discussion between them centred about the subject matter. Examples of comments related to this dimension students from local schools typically related to test preparation and memorisation and are exemplified by "Sometimes I will ask someone who is good at science. . . I will ask him, 'How do you study science? Why are your marks so high?' I will ask before the test," "Sometimes I will ask them to how to remember something well," and "The students discuss things about the topic and not how they learn." Students from the local schools provided explanations as to why discussing of learning processes was not a common occurrence suggesting, "We don't talk about this much in class because we should listen to the teacher. If we don't the teacher will think we are talking about something that is not related to the lesson," and "In the lesson we don't have enough time to discuss this." Students in the

international school classrooms provided fewer examples but those examples were similar to those of their local school counterparts such as "Before the test we test each other and revise together," "I ask my friends, 'Do you get that? (sic)', and they say no, and (then) we work it out together," "With close friends, we examine how we are studying. I just said only, 'You should try reading it and writing it out until you memorise it,' 'cos it works for me," and "We ask each other what the teacher actually meant but we don't really talk about how we learn it." In explaining why there was little student–student discussion of learning processes they suggested, "The teacher doesn't like us to talk. . . I think we should be allowed to talk, but not too loudly," and "We don't really discuss new ways (to learn), we just get on with the work." From the responses of students in both systems it seems that discussions related most often to content and less to learning or cognitive processes.

Student–teacher discourse

The statistical data for this dimension suggests that the students in local Hong Kong schools perceived that they engaged in more discussion with their teachers about the processes of learning then the students in the internationals schools perceived they did. On average, the students from the local schools reported that this happened sometimes, while the students from the international schools reported that it happened less than sometimes. However, the interviews for both local and international schools suggest that the discussion was most often about the consequences of the learning rather than focusing on the processes involved. Indicative comments from local students were "The focus is on what we learn instead of how we learn. . . the teacher doesn't tell us a different way to learn it," and "I think the teacher mostly just takes care of the [exam] mark, so they always talk about the topic." Those of the international school students were, for example:

> The teacher explains the topic, then we do experiments. The teacher doesn't say how we can think about it and how we can learn it better. I don't think that copying off the board is helping us to learn. She just said that it is good for us. . . that we memorise it by copying off the board.

> Students usually go into the classroom and are told what to do. They don't really discuss with the teacher that much (sic) how they can improve and learn. . . it's just left to them to work out.

Even in the class where a reportedly larger variety of activities were engaged in, students made statements such as "The teacher just tells us different things we can do. . . he doesn't teach us how to learn."

Student voice

The international school students perceived a higher level of opportunity to have their say in classroom matters, that is student voice, than their local school counterparts reported was the case for them even if they didn't always make use of this freedom. Comments such as "I think its OK to tell them [the teachers]. . . but I don't

do it," were supportive of this claim. The international students were open about their exchanges with their teachers. "We tell the teacher to do more experiments because it's quite boring if we are just learning the books," and "If I have a good activity, of course the teacher will listen to me."

The local students suggested it may be impolite for students to question the teacher's authority, for example, "The Chinese teacher will think it is impolite for you to do so... you should follow the instructions of the teacher, keep quiet, listen, and take notes, and do revision at home," "In Hong Kong the students must obey the teacher," and "The students always follow the teacher. Sometimes, they don't know what they are doing... and they continue to follow." Some also expressed concern in relation to questioning the teacher's authority, "It is not respectful to the teacher. The teacher may get unhappy and then punish me, I think this will happen," and "Some students are afraid of the teacher. I think that most students are not brave enough to tell the teacher to stop doing something... but if I want to, I might. But I am scared because the teacher is the teacher." However, some local students gave more pragmatic reasons for their reported levels of critical voice, for example, "Time is not enough... the teacher tells us all the things fast and we should not disturb the teacher's plan... the teacher has their own plan to teach us." Such pragmatism was also evident but less reported by international school students, "The teacher knows better and they planned it beforehand to have a smooth lesson... they don't really need us to help them decide what to do."

Distributed control

Despite the quantitative variation across populations in relation to the distributed control dimension, both groups of students reported in interviews that they had almost no say in what happened in the classroom. Evans and Fisher (2000) found previously that students' perceptions of student–teacher interactions were influenced by the cultural backgrounds of students. Of relevance to this study, Evans and Fisher speculated that students from an Asian background might expect that their teachers would keep them on task. Students' comments in this study such as "Since we were three and began studying in the kindergarten in Hong Kong since we have followed this type of plan. It is established so I don't have any feelings about it," supported such a proposal. Such compliance, however, did not mean that the students did not have opinions regarding alternatives to what was prescribed by their teachers. Students comments such as "Maybe we could do more experiments," "I want more time to watch the TV program about science," and "In the science lesson they could give the students more time to do discussions, because I think that discussing is quite a good way to improve," are indicative of their proposals. Some students were particularly vocal about their lack of control, for example:

I want to have some freedom in the lesson because the teacher has their ideas and we have our ideas. Why must we obey their idea? I want to choose what I want to learn and I want to choose some of the activities. Some [we do now] are boring and some are interesting. So I would choose interesting but we can't... we just get given something and we just do it.

The comments from the international students were similar to their local counterparts. They too confirmed, with infrequent exceptions, their perception of little or no control over classroom activities in comments such as "The students ask, "Why do we have to do it?" and the teacher says, "Hey, you are going to do it," "The teacher plans it... decides it; of course the teacher decides it... doesn't encourage us to decide what we are going to do," and "Students usually go into the classroom and are told what to do. They don't really discuss with the teacher that much how they can improve and learn... it's just left to them to work out." Students' comments supporting such a lack of distributed control were of the kind, "If we were to control the classroom then it would not be a classroom... it would be total chaos." Interestingly, some students in the classroom where there was reportedly a wider range of activities engaged in by students reported a more flexible arrangement with their teacher.

The students ask the teacher, "Can we go on the computer in the last corridor or in the science lab to find some information?" The teacher sometimes says, "For the last thirty minutes." You have to ask first. We can also suggest to watch videos. Sometimes if the teacher thinks it's appropriate we'll be given the video.

Teacher encouragement and support

Both samples of students reported via the MOLES-S that they received encouragement and support from their teachers to try to improve how they learn science. On average, both groups perceived that this happened more regularly than sometimes. In both populations the main encouragement for students to try different ways of learning related to undertaking certain activities such as to "watch the television... read the newspaper article or books or notes," rather than promoting a knowledge, control and awareness of different thinking processes. Some local students commented, for example, that the teacher "always encourages us to improve how we learn science by just saying, 'OK, you can try to use another method of study but then they do not do anything to help us to do this.' " The lack of a language for teachers to talk with students about their thinking so that the encouragement could be more prescribed was also evident. For example, students commented, "Now we just listen to the teacher and the teacher says she wants us to think to answer her question. If we get the answer wrong she just asks us to think, think... try again," and "The teacher will tell us to think more." These comments suggest that the encouragement is not specifically related to particular strategies but is much more general in its nature. Some local students also commented that the exam result was the main reason for their teacher's encouragement in statements such as:

I think the teacher is just teaching us and wants us to get high marks in the test and exam, but they don't encourage us to study ourselves and to learn other things about science besides what is in the books and the lessons... they just want us to remember things and get high marks. They just teach us and learning is our problem, how to learn and how to study is our problem.

I think the teacher is just for the examination and when we get a lower mark in the test the teacher will not punish us but will get angry and ask why we were so lazy to not study the textbook. The teacher doesn't teach us how to study the textbook... just asks us to try to think about it and asks us some questions.

International students reported predominantly a different type of encouragement, more specifically related to praising students when they were successful and attempting to build their self-confidence, rather than specifically related to levels of academic performance, for example, "The teacher will say you are good, well done, you've done quite well," "The teacher will mention if somebody got really good marks in the test or really high quality homework." One student who had transferred to an international school from a local school exemplified the differences in the perceptions of the two populations.

> I actually came from a local school about a year ago. . . in my old school if we were told [to do] something we couldn't do any other things, or we couldn't make a mistake. . . in this school if you have made a mistake in an experiment the teachers will help you, but in my old school they punish you for not listening to the teacher if you do the wrong thing. That's kind of unreasonable because, with an experiment, that's the first time we do it and we don't know if we would do it right or not.

Emotional support

While the mean scores for students from both systems were the highest for both populations of students for any of the MOLES-S scales, there was a clear indication that international school students perceived a higher level of emotional support in their science classrooms than the students in the local school classrooms perceived they did. Some students in the local schools were quite critical of the level and type of emotional support they received as exemplified by "Time is limited and the teacher just teaches. . . even if we get high marks the teacher will not be especially happy. . . but if we get a low mark they will say we don't listen and we don't study hard." However, some students in the local schools defended their teacher's form and level of provision of emotional support suggesting, for example, "The teacher will not punish us without reason." Further, while some local students proposed that their teacher was not interested in them aside from their formal education, for example, "The teacher is just teaching and doesn't understand us," other students defended the teacher and sought to share the responsibility for the perceived distance between themselves and the teacher. One student summarised this position well, suggesting:

> In the science lesson the students are inactive. . . but I can see that the teacher is very hard working and prepares a lot of notes for us. The main problem is the students. We don't give responses, we don't answer or even agree. I'm too lazy to raise up my hand to ask a question. We prefer to ask other students more than the teacher.

Students from the international schools gave clear evidence of their perceptions that respect and trust was shared with their teacher. For example, "We have good trust because the teacher can leave us in the classroom by ourselves and we still get our work done. . . maybe we talk a bit but by the end of the lesson we are finished," "I know I'm not the best behaved person in the classroom but we are all treated fairly," and:

Students ideas and individual differences are respected... the teacher will consider the ideas we have, maybe just briefly, and then give an answer... even though some people may be quicker 'picking up' stuff, some people a little slower, the teacher will try their best to teach us. The teacher treats us very fairly.

Discussion

This was a cross-cultural study that, while seeking to identify commonalities and variations, has not sought to value or under-value the learning environments of the classrooms within local and international schools in Hong Kong. That classrooms are not often enough oriented toward the development of students' metacognition is a common theme in the education literature. It has previously been suggested that what is required in schools is a meta-curriculum (Perkins, 1992). In such a curriculum there would be a focus on the processes of thinking and learning and the development of metacognition and self-regulation as well as on what subject matter is to be learnt. Students would explore their learning approaches, develop declarative, procedural and conditional metacognitive knowledge, and understand the motives and reasoning behind classroom activities and the consequent value of engaging in them. What becomes clear from this Hong Kong study is that there is limited evidence of the existence of a meta-curriculum in the sampled classrooms of either of these systems. Further, the trend from the quantitative data suggests that the classrooms of both systems were not, on average, particularly metacognitively oriented. The focus is still predominantly on examination assessment and content coverage. Statistically significant differences and qualitative differences in relation to the metacognitive orientation of the classroom learning environments were evident. The interview data provided support for the existence of variations and commonalities and this again highlights the value of mixed methodologies in the studies of learning environments.

From the data interpretation, the commonalities between the science classroom learning environments in relation to their metacognitive orientations could be summarised as, a predominant focus on discourse related to content rather than an overt focus on discourse related to the processes of thinking and learning, a lack of student control over their actions in the classroom, and a moderate level of encouragement and support in both contexts. Given that content is such a powerful influence on science teaching and learning the findings regarding the discourse dimensions are not too surprising. Teachers and students would obviously have to spend much time talking about the science to be learned. However it would be appropriate for teachers to speak more with students about the processes of thinking and learning, to model those processes for students, and to draw students' attention to when and why to use such processes. Students from both systems reported that they would appreciate more of such cognitive and metacognitive leadership from their teachers. The lack of distributed control in both populations suggests that the teacher is still the dominant authoritarian figure in these classrooms. The concept of filial piety can be used to

explain why the local students defer to their teachers and do not challenge their authoritative role and conform to what Gow et al. (1996) describe as "traditional, pro-social, and well-socialised outcomes" (p. 115). This is despite the views of some local students that they would like to be more autonomous. The international students, with the exception of those in one classroom, reported a similar lack of control and often for similar reasons to their local counterparts. It seems clear the notion of the teacher as an authority figure spans Western as well as CHC culture as the teacher is often viewed as *in loco parentis* in both contexts. Ideally, students would be taught how to be in increased control of their classroom actions and there is evidence (Thomas & McRobbie, 2001) that, when this occurs, students can make substantial metacognitive and learning gains, even though some students may resist the notion of taking more control of their actions.

Even though both populations reported statistically indistinguishable levels of encouragement and support, the nature of the encouragement and support varied between contexts. The local students reported that their teachers were more focused on encouraging them in relation to assessment tasks and this finding is supported by summarises of previous research (see, e.g., Gow et al., 1996) that suggest that Chinese teachers are strict in their demands, set high expectations, and seldom praise their students. In contrast international school students reported more encouragement related to praising students for their efforts. These findings suggest that the qualitative variations in encouragement and support might, to some extent, be explained with reference to cultural differences.

The metacognitive demands made on students varied with local students being asked more to engage in the cognitive activity of memorisation and the international students reporting in general that their teachers focused more on the provision of activities. This variation reflects to some extent different cultural heritage in relation to education. In CHC culture the notion of memorisation as a prime mental activity is still a powerful influence on the beliefs of teachers regarding what constitutes appropriate cognitive activity. Despite the curriculum reform documents in Hong Kong mirroring, to a very large extent, Western curriculum documents that emphasise a diverse range of thinking and learning processes, the cultural text in Hong Kong's local schools is still such that teachers, as reported by their students, still subscribe to and enact their traditional CHC values. It would seem that a necessary task for curriculum reformers in Hong Kong would be to acknowledge the influence of CHC culture on classroom practice and adapt curriculum to account for such influence. The students in the international schools spoke more of activities and general requests to think rather than any specific cognitive process and this may to some extent reflect the different perspectives that their teachers bring from overseas. Ever since the 1960s, large scale curriculum reform in the West has emphasised the use of a variety of activities and resources even though there is still much to be done in realising the intent of such reform in science classrooms. Students reported their participation in classroom activities but most often did not report the necessary next step being taken their teachers in developing metacognition in relation to those activities. Further, the issue of teachers having an appropriate vocabulary to explain

thinking and learning processes to students seems to be salient in relation to the international classes selected in this research. The use of generic terms such as 'think' does not necessarily lead to a development of students' metacognition and the use of more specific terminology to describe thinking and learning processes as proposed by Tishman and Perkins (1997) should be a priority for teachers.

Substantial qualitative and quantitative differences, and few similarities, were found in relation to the student voice and emotional support dimensions. The level of Student voice in the local schools seems to also strongly reflect the CHC concept of filial piety which, as previously mentioned, holds that it is improper to question authority figures. This finding coalesces strongly with the existing CHC-related literature. In the sampled international school classrooms students reported being more outspoken and suggested that they would be listened to by their teachers, even if their proposals were not adopted. It may be that the teachers in the international schools support the view that students should be allowed to express their opinion as part of a gradual shift towards independence and autonomy, even if the teacher remains the primary authoritarian figure in the classroom. The variation in emotional support strongly supports the existing contention that CHC teachers focus on students' academic achievement as the primary goal of education while the teachers of the students in the international classrooms sought to promote emotional support that was more related to personality and the development of trust, respect and fairness beyond academic parameters. To some extent the variation in emotional support may be due to the larger class sizes of local schools compared with international schools, approximately 30 to 40 in local schools compared with 20 to 30 in international schools. However, even if the difference in class sizes does exert some influence, the variations reported by students in this study seem to also reflect cultural variations in relation to what teachers in aforementioned past studies have seen as important for the emotional well-being of their students.

This research suggests that the field of learning environments research can make a valuable contribution to understanding differences between different educational systems that operate in the same geographical location and enable a fuller understanding, based on empirical evidence, of issues that might otherwise be confined to hearsay. The findings suggest that commonalities and variations exist between local and International schools representative of non-CHC schools in Hong Kong in relation to the metacognitive orientation of their science classrooms' learning environments. These variations to some extent reflect and relate to variations in broader cultural values and pedagogical orientations that mediate teaching and learning and how education is conceptualised within those schools. It is important for educators to be aware of the cultural context/s within which they operate and to acknowledge that the potential development of students' metacognition will be influenced by the context/s. The adoption of a perspective that excludes the view that cultural factors may not be at play in influencing the development of students metacognition is clearly inappropriate in the case of the classrooms sampled in this study in Hong Kong.

Future Directions

In conclusion, it is important to note that this study has not reported on the nature and extent of the metacognition of the students that participated in this research but rather on the metacognitive orientation of the science classroom learning environments of these students. It is inappropriate to infer any correlation between the scale scores on the MOLES-S and the nature of the participating students' metacognition. Studies are still needed that explore potential correlations between measures of students' metacognition and self-regulated learning and the psychosocial dimensions of their learning environments. Based on such studies, it would be possible to undertake comprehensive research, possibly employing case study methodology and metacognitive profiling that would explore changes to students' metacognition as a consequence of changes in the metacognitive orientation of their science classrooms over time. This would be a major study incorporating classroom observations that, despite the difficulties in measuring and profiling students' metacognition (see, e.g., Schraw & Impara, 2000) would shed further light on how to develop and enhance students' metacognition.

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References

Aldridge, J. M., & Fraser, B. J. (2000). A cross cultural study of classroom learning environments in Australia and Taiwan. *Learning Environments Research, 3*(2), 101–134.

Baird, J. R., & Mitchell, I. J. (Eds.). (1987). *Improving the quality of teaching and learning: An Australian case study – The PEEL project*. Melbourne, Victoria: Monash University.

Biggs, J. B. (1990, July). *Asian students' approaches to learning: Implications for teaching overseas students*. Paper presented at the 8th Australian Tertiary Learning Skills and Language Conference, Brisbane, Queensland.

Billett, S. (1996). Situated learning: Bridging sociocultural and cognitive theorizing. *Learning and Instruction, 6*(3), 263–280.

Brown, A. L. (1978). Knowing when, where, and how to remember: A problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology* (Vol. 2, pp. 77–165). Hillsdale, NJ: Erlbaum.

Chan, J. (1996). Chinese intelligence. In M. H. Bond (Ed.), *The handbook of Chinese psychology* (pp. 93–108). Hong Kong, PRC: Oxford University Press.

Chan, G. Y.-Y., & Watkins, D. (1994). Classroom environment and approaches to learning: An investigation of the actual and preferred perceptions of Hong Kong secondary school students. *Instructional Science, 22*, 233–246.

Cobb, P. (1996). Where is the mind? A coordination of sociocultural and cognitive constructivist perspectives. In C. T. Fosnot (Ed.), *Constructivism: Theory, perspectives and practice* (pp. 34–52). New York: Plenum.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Hillsdale, NJ: Academic Press.

Erickson, F. (1998). Qualitative methods for science education. In B. J. Fraser & K. G. Tobin (Eds.), *International handbook of science education* (pp. 1155–1173). Dordrecht, The Netherlands: Kluwer.

Evans, H., & Fisker, D. (2000). Cultural differences in students' perceptions of science teachers' interpersonal behaviour. *Australian Science Teachers Journal, 46*(2), 9–17.

Flavell, J. H. (1979). Metacognition and cognitive monitoring; A new area of cognitive-developmental inquiry. *American Psychologist, 34*, 906–911.

Fraser, B. J. (2003). Learning environments research in Asia: Editor's introduction. *Learning Environments Research, 6*(1), 1–3.

Gao, L. (2002). Conceptions of teaching held by school science teachers in P.R. China: Identification and cross-cultural comparisons. *International Journal of Science Education, 24*(1), 61–79.

Garner, R., & Alexander, P. A. (1989). Metacognition: Answered and unanswered questions. *Educational Psychologist, 24*(2), 143–158.

Gow, L., Balla, J., Kember, D., & Hau, K. T. (1996). The learning approaches of Chinese people: A function of socialization processes and the context of learning. In M. H. Bond (Ed.), *The handbook of Chinese psychology* (pp. 109–123). Hong Kong, PRC: Oxford University Press.

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Beverly Hills, CA: Sage.

Gunstone, R. F. (1992). Constructivism and metacognition: Theoretical issues and classroom studies. In R. Duit, F. Goldberg, & H. Niedderer (Eds.), *Research in physics learning; Theoretical issues and empirical studies* (pp. 129–140). Kiel, Germany: Institut für die Pädagogik der Naturwissenschaften an der Universität Kiel.

Gutierrez, K. D., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher, 32*(5), 19–25.

Hau, K. T., & Salili, F. (1991). Structure and semantic differential placement of specific causes: Academic causal attributions of Chinese students in Hong Kong. *International Journal of Psychology*, 26, 175–193.

Ho, D. Y.-F. (2002). Myths and realities in Confucian Heritage education. In D. W.-K. Chan & W. Y. Wu (Eds.), *Thinking qualities initiative conference proceedings 2000 and 2001* (pp. 3–17). Hong Kong, PRC: Centre for Educational Development, Hong Kong Baptist University & The Hong Kong Society for the Advancement of Learning and Teaching of Thinking.

Ho, D. Y.-F., Peng, S.-Q., & Chan, F. S.-F. (2001). An investigative research in teaching and learning in Chinese societies. In C.-Y. Chiu, F. Salili, & Y.-Y. Hong (Eds.), *Multiple competencies and self-regulated learning: Implications*

for multicultural education (pp. 215–244). Greenwich, CT: Information Age Publishing.

Holbrook, J. B. (1990). *Science education in Hong Kong: Achievements and determinants*. Hong Kong, PRC: The Education Faculty of the University of Hong Kong.

Hong Kong Curriculum Development Council. (2000). *Learning to learn: Science Education*. Hong Kong, PRC: Hong Kong Curriculum Development Council.

Hong Kong Education Commission. (2000). *Review of education system reform proposals: Education blueprint for the 21st century*. Hong Kong, PRC: Education Commission of the Hong Kong S.A.R. Government.

Lave, J., & Wenger, E. (1991). *Situated learning – legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.

Law, N. (1996). *Science and mathematics achievements at the junior secondary level in Hong Kong*. Hong Kong, PRC: The University of Hong Kong.

Lee, C. D. (2003). Why we need to re-think race and ethnicity in educational research. *Educational Researcher, 32*(5), 3–5.

Leung, F. K.-S., Yung, B. H.-W., & Tso, A. S.-F. (2002). *Secondary analysis of the TIMSS-R data for Hong Kong*. Hong Kong, PRC: Hong International Association for the Evaluation of Educational Achievement Centre.

Marton, F., Dall'Alba, G., & Tse, L.-K. (1996). Memorising and understanding: The keys to the paradox. In D. A. Watkins & J. B. Biggs (Eds.), *The Chinese learner: Cultural, psychological and contextual influences* (pp. 69–84). Hong Kong, PRC: Comparative Education Research Centre.

McRobbie, C., & Thomas, G. P. (2000). Changing the learning environment to enhance explaining and understanding in a year 12 chemistry classroom. *Learning Environments Research, 3*(3), 209–227.

McRobbie, C., & Tobin, K. (1995). Restraints to reform: The congruence of teacher and student actions in a chemistry classroom. *Journal of Research in Science Teaching, 32*(4), 373–385.

McRobbie, C., & Tobin, K. (1997). A social constructivist perspective on learning environments. *International Journal of Science Education, 19*(2), 373–385.

Milne, C., & Taylor, P. C. S. (1995). Metaphors as global markers for teachers' beliefs about the nature of science. *Research in Science Education, 25*(1), 29–49.

Moos, R. H. (1991). Connections between school, work and family settings. In B. J. Fraser & H. J. Walberg (Eds.), *Educational environments: Evaluation, antecedents and consequences* (pp. 29–51). Oxford, NY: Pergamon Press.

Moos, R. H., & Trickett, E. J. (1974). *Classroom Environment Scale Manual*. Palo Alto, CA: Consulting Psychologists Press.

Morris, P. (1985). Teachers' perceptions of the barriers to the implementation of a pedagogic innovation: A South-East Asian case study. *International Review of Education, 31*(1), 3–18.

Perkins, D. N. (1992). *Smart schools: From training memories to educating minds*. New York: Macmillan.

Postlethwaite, T. N., & Wiley, D. E. (1992). *The IEA study of science II: Science achievement in twenty-three countries*. New York: Pergamon.

Schraw, G., & Impara, J. C. (Eds.). (2000). *Issues in the measurement of metacognition*. Lincoln, NE: Buros Institute of Mental Measurements.

Schraw, G., & Moshman, D. (1995). Metacognitive theories. *Educational Psychology Review, 7*, 351–371.

She, H.-C., & Fisher, D. (2000). The development of a questionnaire to describe science teacher communication behaviour in Taiwan and Australian. *Science Education, 84*(6), 706–726.

Siu, S. F. (1992). *Toward an understanding of Chinese–American educational achievement: A literature review*. Boston, MA: Center for Families, Communities, Schools, and Children's Learning.

Stevenson, H. W. (1992). Learning from Asian schools. *Scientific American, 267*(6), 70–76.

Stevenson, H. W., & Stigler, J. (1992). *The learning gap: Why our schools are failing and what we can learn from Japanese and Chinese education*. New York: Summit Books.

Tang, T. (1991). Students' perceptions of the learning context and their effects on approaches to learning: A phenomenographic study. Unpublished MEd dissertation, The University of Hong Kong, Hong Kong, PRC.

Taylor, P. C. S., Fraser, B. J., & White, L. R. (1994 April). *CLES: An instrument for monitoring the development of constructivist learning environments*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Thomas, G. P. (1999a). Developing metacognition and cognitive strategies through the use of metaphor in a year 11 chemistry classroom. Unpublished PhD thesis, Queensland University of Technology, Brisbane, Queensland.

Thomas, G. P. (1999b). Student restraints to reform Conceptual change issues in enhancing students' learning processes. *Research in Science Education, 29*(1), 89–109.

Thomas, G. P. (2002). The social mediation of metacognition. In D. McInerny & S. Van Etten (Eds.), *Sociocultural influences on motivation and learning: Vol. 2. Research on sociocultural influences on motivation and learning* (pp. 225–247). Greenwich, CT: Information Age Publishing.

Thomas, G. P. (2002). Conceptualising metacognitively oriented learning environments: Insights from research. In D. W.-K. Chan & W. Y. Wu (Eds.), *Thinking qualities initiative conference proceedings 2000 and 2001* (pp. 311–326). Hong Kong, PRC: Centre for Educational Development, Hong Kong Baptist University & The Hong Kong Society for the Advancement of Learning and Teaching of Thinking.

Thomas, G. P. (2003). Conceptualisation, development and validation of an instrument for evaluating the metacognitive orientation of science classroom learning environments: The Metacognitive Orientation Learning Environment Scale – Science (MOLES-S). *Learning Environments Research, 6*(2), 175–197.

Thomas, G. P. (2004). Dimensionality and construct validity of an instrument designed to measure the metacognitive orientation of science classroom learning environments. *Journal of Applied Measurement, 5*(4), 367–384.

Thomas, G. P., & McRobbie, C. J. (2001). Using a metaphor for learning to improve students' metacognition in the chemistry classroom. *Journal of Research in Science Teaching, 38*(2), 222–259.

Tishman, S., & Perkins, D. N. (1997). The language of thinking. *Phi Delta Kappan, 78*(5), 368–374.

Tobin, K. (1993). Referents for making sense of science teaching. *International Journal of Science Education, 15*(3), 241–254.

Tobin, K., & Gallagher, J. J. (1987). What happens in high school science classrooms? *Journal of Curriculum Studies, 19*(6), 549–560.

Watkins, D. A. (1996). Hong Kong secondary learners: A developmental perspective. In D. A. Watkins & J. B. Biggs (Eds.), *The Chinese learner: Cultural, psychological and contextual influences* (pp. 107–119). Hong Kong, PRC: Comparative Education Research Centre.

Watkins, D. A., & Biggs, J. B. (1996). *The Chinese learner: Cultural, psychological and contextual influences*. Hong Kong, PRC: Comparative Education Research Centre.

Yamoto, Y., & Bray, M. (2002). Education and socio-political change: The continued growth and evolution of the international schools sector in Hong Kong. *Asia Pacific Education Review, 3*(1), 1–21.