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What Primary Students in the Chinese Mainland, Hong Kong and Taiwan Value in Mathematics Learning: A Comparative Analysis

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Abstract It has become increasingly recognized that what teachers and students value affect teaching and learning in general and in the area of mathematics in particular. Yet, the extent to which this is so varies across cultural regions. In recent years, how the ethnic Chinese teach and learn mathematics has attracted much attention worldwide. It is precisely the purpose of the present study to investigate the value structures of three Chinese regions. Using a recently developed and validated questionnaire, students' values in mathematics learning in the Chinese Mainland, Hong Kong and Taiwan are delineated. In the first place, the results reveal that there are six dimensions in the students' value structure, namely *achievement*, *relevance*, *practice*, *communication*, *information and communications technology* as well as *feedback*. However, in each of the six value components derived from the principal components analysis, statistically significant differences between the regions were found.

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Introduction

The effectiveness of mathematics teaching and learning has long been a focus of attention in mathematics education around the world (Anthony & Walshaw, 2008; Cai, Kaiser, Perry & Wong, 2009). It has been shown that the aspects that are valued by teachers and their students play a subtle yet influential role in teaching and learning mathematics (Seah & Wong, 2012). These values contribute to the shaping of students' *lived space* which consequently generated students' *outcome space* (Wong, Marton, Wong & Lam, 2002). These values are derived from—and learnt through—the individual's experience in his/her socio-cultural environment, the mathematics classroom inclusive, with reference to the intrinsic nature of mathematics (Seah, 2005).

Studies into the values underlying mathematics education in Western cultures have shown that values are culture-dependent. Different cultures (as well as education systems) embrace and emphasise different approaches to the teaching of mathematics (Atweh & Seah, 2007). With the increasing interest in demystifying the 'Chinese learner's phenomenon' (Wong, 2004), there is also a need to look into how the ethnic Chinese value mathematics and mathematics education. Indeed, amongst the many attempts to explain the academic success of ethnic Chinese learners, there has been quite a lot of discussion since the 1980s on the values that prevail amongst the ethnic Chinese[1] (Bond, 1996, 2010) and how these values influence the way they teach and learn mathematics (Fan, Wong, Cai & Li, 2004, 2015; Stevenson & Stigler, 1992; Watkins & Biggs, 1996, 2001). The recent work of Wong, Wong & Wong (2012)offers a comprehensive exposition on how different Chinese schools of thought view education and how these in turn influence mathematics education. However, on the one hand, there are only a handful of empirical studies to date on how the Chinese value mathematics and, on the other hand, there is an over-simplified view that the ethnic Chinese community possesses a unified set of values (Wong et al., 2012) when this community represents a vast region with high diversity. The subtle cultural differences amongst the three Chinese regions of the Chinese Mainland, Hong Kong and Taiwan, for example, can be significant.

What makes the issue of differentiating the Chinese Mainland, Hong Kong and Taiwan of particular interest is that these regions had undergone different historical developments in the past century and were thus influenced by different cultural values, resulting in different educational systems in each of these regions.

In the Chinese Mainland, after the Communist party takeover in 1949, the educational system was very much influenced by the Soviet Union. This means that the region was untouched by the modern mathematics movement, while basic skills and traditional topics like Euclidean geometry were emphasised. Furthermore, it was not until the early 2000s that education became available to the general mass of the population. In addition, the open-door economic policy first implemented in the mid-

[1] In this paper, 'ethnic Chinese students/community' refers to those ethnic Chinese residing in the Chinese Mainland, Hong Kong and Taiwan.

1980s has allowed the region to take in educational ideas from elsewhere and from Western countries in particular.

As for Taiwan, after the Nationalist government moved there in 1949, it has maintained its contacts with the Western world. Many educational ideas from all around the world were imported, particularly from the USA and Japan. Universal education was implemented in 1968. The modern mathematics movement did influence Taiwan and was introduced into the mathematics curriculum around that time.

In Hong Kong, the early days saw Western missionaries arriving there and setting up schools. They had wanted to travel to China with the main aim of spreading the gospel, but were refused entry at the 'bamboo curtain'. Although some schools were also run under the influence of either the Nationalist or Communist parties, as a British colony, inevitably, most of the education system was basically British. Various teaching initiatives, such as Nuffield mathematics and modern mathematics, were introduced. Universal education was implemented in the late 1970s.

Further details relating to the development of educational scenarios in these three regions may be found in Lam, Wong, Ding, Li & Ma (2015). Yet, from the brief overview above, it is evident how the development of mathematics education in each of these three regions has been influenced by different educational systems (and hence cultural values), even though the people in the regions can all be regarded as ethnic Chinese.

The different values that prevailed in the three regions were challenged at the turn of the millennium, when the three regions embarked on (mathematics) curriculum reforms. Higher order thinking abilities such as collaboration, communication and creativity are given greater emphasis (Wong, Han & Lee, 2004) in these reforms. So, it is of great academic interest to examine to what extent the students in these three regions value mathematics in the same way and also to investigate what differences there may be amongst them.

Three (overlapping) categories of values that might be present in mathematics classrooms had been conceptualised, namely the general educational values, the mathematical values and the mathematics education values (Bishop, 1996). Based on this framework, the '*W*hat *I* *F*ind *I*mportant (in mathematics learning)' [WIFI] study was conceptualised and conducted using a validated questionnaire (Seah, 2013) by 21 research teams in 17 education systems around the world. The study was conducted to identify on a large scale what the students from differing cultures valued most. The study reported here was administered in the three Chinese regions as part of the WIFI study, with a view to addressing the following research questions.

(i) What do primary students in the Chinese Mainland, Hong Kong and Taiwan value with regard to mathematics learning?
(ii) How do primary students in the Chinese Mainland, Hong Kong and Taiwan value these aspects of mathematics learning differently?

Research Design

Research Participants and Approach

The aims of this study reported here were to identify and compare what students across different education systems value in mathematics and mathematics learning, and specifically, what they consider important in their learning of mathematics. A total of 1386 students participated, drawn from the Chinese Mainland (N = 298), Hong Kong (N = 367) and Taiwan (N = 718). They were studying at grades 5 or 6 (11 – 12 years old). Students were recruited from government or government-funded primary schools, which are the mainstream schools in each region. Students were mainly from mid-low socio-economic status families. Table 1 provides the details of the participants.

Data Collection and Instrument

Given that the WIFI study aims to map the students' valuations on a large scale in ways which reflect the characteristics of the participating education systems in the different countries and regions, a quantitative approach was adopted. Data for this study were collected using the WIFI questionnaire, which was developed earlier based on ethnographic research (Seah, 2013). The questionnaire consists of four sections, namely, a 5-point Likert scale consisting of 64 items (section A), 10 continuum dimensions items (section B), an open-ended, scenario-stimulated responses section with 4 items (section C), together with students' demographic and personal information (section D). Only the findings from section A are reported in this article.

In section A of the survey, students were asked to evaluate the importance of each statement presented, using a 5-point Likert scale with 1 = absolutely important and 5 = absolutely unimportant with lower score indicating greater importance. A sample of section A is provided in Appendix 1.

Data Analysis

In this study, a principal component analysis (PCA) was conducted to interrogate the factor structure of the students' value dimensions with respect to mathematics and mathematics education (questions 1–64) of the questionnaire for the three regions (the Chinese Mainland, Hong Kong and Taiwan). In order to explore possible cultural differences for each value dimension by region, we conducted a number of multivariate

Table 1 Participants by region and age

Region	Age	Gender		N	Percent
		Female	Male		
Chinese Mainland	11	75	93	168	56.4
	12	55	75	130	43.6
	Total	130	168	298	100.0
Hong Kong	11	145	97	242	65.9
	12	79	46	125	34.1
	Total	224	143	367	100.0
Taiwan	11	181	194	375	52.2
	12	174	169	343	47.8
	Total	355	363	718	100.0

analyses of variance (MANOVA) with Tukey's honest significant difference (HSD) post hoc multiple comparisons tests.

Results

Principal Component Analysis of the WIFI Questionnaire

The questionnaire items were initially subjected to a PCA to shed light on how the research question (i) would be answered. A total of 1383 complete student responses were received. A principal component analysis (PCA) with a varimax rotation and Kaiser normalization was used to examine items 1 – 64 of the questionnaire. The significance level was set at 0.05, while a cut-off criterion for component loadings of 0.45 was used in interpreting the solutions. Items that did not meet the criteria were eliminated. The Kaiser-Meyer-Olkin (KMO) (Kaiser, 1970) measure of sampling adequacy was 0.96 and Bartlett's test of sphericity (BTS) (Bartlett, 1950) was significant at the 0.001 level and so, factorability of the correlation matrix was assumed, which demonstrated that the identity matrix instrument was reliable and confirmed the usefulness of the PCA. According to the cut-off criterion, 17 items were removed and 47 items were retained from the original 64. The analysis yielded six components (see Table 2) with eigenvalues greater than one, which accounted for 45.65 % of the total variance. We identified the six components of the primary students' set of values for mathematics learning as follows.

Component 1

The first component (C1) consists of 17 items, which account for 14.15 % of the total variance. A high internal consistency reliability coefficient (Cronbach's α) of 0.91 was obtained. Many of the items emphasised the students' desire to master certain skills or learning strategies, and to do well. For example, "knowing the steps of the solution" (Q56), "knowing which formula to use" (Q58), and "memorizing facts" (Q14) were amongst those skills or strategies. Thus, this component was labelled *achievement*.

Component 2

The second component (C2) consists of 16 items with a reliability coefficient, α of 0.91, which explains 12.09 % of the total variance. This component focuses on certain learning activities or materials relevant to mathematics learning, such as mathematical stories (Q17, Q61), games (Q25), puzzles (Q20), outdoor mathematics activities (Q34) and mathematics in real life (Q12). We labelled this component *relevance*.

Component 3

The third component (C3) consists of five items, which account for 6.15 % of the total variance. The reliability coefficient is 0.77, suggesting satisfactory reliability. All of the

Table 2 Rotated component matrix

	Component					
	1	2	3	4	5	6
Q58KnowingWhichFormulaToUse	0.706					
Q56KnowingTheStepsOfTheSolution	0.678					
Q54UnderstandingConceptsProcesses	0.637					
Q13PractisingHowToUseMathsFormulae	0.623					
Q14MemorisingFacts	0.615					
Q63UnderstandingWhyMySolutionIsIncorrectOrCorrect	0.606					
Q59KnowingTheTheoreticalAspectsOfMathematics	0.577					
Q32UsingMathematicalWords	0.568					
Q49ExamplesToHelpMeUnderstand	0.536					
Q38GivenAFormulaToUse	0.531					
Q15LookingForDifferentWaysToFindTheAnswer	0.522					
Q30AlternativeSolutions	0.514					
Q33WritingTheSolutionsStepbystep	0.513					
Q55ShortcutsToSolvingAProblem	0.504					
Q28KnowingTheTimesTables	0.475					
Q5ExplainingByTheTeacher	0.473					
Q2Problemsolving	0.473					
Q61StoriesAboutMathematicians		0.649				
Q18StoriesAboutRecentDevelopmentsInMathematics		0.640				
Q17StoriesAboutMathematics		0.630				
Q21StudentsPosingMathsProblems		0.613				
Q11AppreciatingTheBeautyOfMathematics		0.590				
Q60MysteryOfMaths		0.586				
Q39LookingOutForMathsInRealLife		0.566				
Q20MathematicsPuzzles		0.552				
Q52HandsonActivities		0.545				
Q29MakingUpMyOwnMathsQuestions		0.524				
Q34OutdoorMathematicsActivities		0.522				
Q40ExplainingWhereTheRulesFormulaeCameFrom		0.506				
Q12ConnectingMathsToRealLife		0.491				
Q47UsingDiagramsToUnderstandMaths		0.480				
Q25MathematicsGames		0.473				
Q19ExplainingMySolutionsToTheClass		0.451				
Q36PractisingWithLotsOfQuestions			0.791			
Q37DoingALotOfMathematicsWork			0.751			
Q57MathematicsHomework			0.699			
Q62CompletingMathematicsWork			0.600			
Q43MathematicsTestsExaminations			0.597			
Q7WholeclassDiscussions				0.702		
Q3SmallgroupDiscussions				0.581		

Table 2 (continued)

	Component					
	1	2	3	4	5	6
Q10RelatingMathematicsToOtherSubjectsInSchool				0.454		
Q23LearningMathsWithTheComputer					0.789	
Q24LearningMathsWithTheInternet					0.777	
Q22UsingTheCalculatorToCheckTheAnswer					0.760	
Q4UsingTheCalculatorToCalculate					0.673	
Q44FeedbackFromMyTeacher						0.726
Q45FeedbackFromMyFriends						0.725

Extraction method: PCA; Rotation method: varimax with Kaiser normalization, minimum factor loadings 0.45; KMO, MSA, eigenvalues >1

five items reflect the importance of practice in mathematics learning, which includes doing lots of mathematics work (Q37), homework (Q57) and tests (Q43). This component was accordingly labelled *practice*.

Component 4

There are three items in the fourth component (C4), which account for 5.87 % of the total variance. The Cronbach's α is 0.65. Though the coefficient is relatively lower than those of components C1, C2 and C3, it is still considered as satisfactory. These items reflect the importance of discussions during mathematics learning. We labelled this component *communication*. The types of communication include small group and whole class discussion (Q3, Q7). The relationship between mathematics and other subjects (Q10) is also regarded as a kind of communication.

Component 5

The fifth component (C5) consists of four items with the reliability coefficient equal to 0.80, accounting for 4.91 % of the total variance. All of the four items focus on different kinds of technology, such as the Internet (Q24), the computer (Q23) and the calculator (Q22) or using these technologies for learning mathematics (Q4). This component was labelled *information and communications technology* (*ICT*).

Component 6

There are two items in the sixth component (C6), which explain 4.13 % of the total variance. The reliability coefficient for this component is 0.85. The component emphasises feedback from teachers or friends (Q44, Q45) when students are learning mathematics; this component was labelled *feedback*.

Regional Differences in the Six Value Components

In this section, regional differences in the six value components derived from the PCA are analysed. Initially, to answer research question (ii), a comparison was made of the mean responses for each component for each of the three regions. According to the questionnaire design, a higher mean score means that the items making up the component were considered unimportant by the students. This showed that the overall structure of the values' dimensions has some similarities across the regions (see Table 3 and Fig. 1).

In general, the mean scores of achievement (C1) in the Chinese Mainland, Hong Kong and Taiwan (1.44, 1.51 and 1.64, respectively) were the lowest compared to the other five components. That is to say, within six components, students in all regions tend to view achievement as the most important factor for their mathematics learning. The component ICT (C5), on the other hand, was valued least by students in all three regions, compared to the other five components. Comparatively, students in Hong Kong tended to value the importance of ICT for their mathematics learning more than other two regions. However, upon closer examination of the results for each region, specifically by examining the sequencing of the mean scores, we observed the following cross-regional differences (see Table 3). For the Chinese Mainland, Hong Kong and Taiwan, the descending order of the mean scores were C1-C3-C2-C6-C4-C5, C1-C6-C3-C2-C4-C5 and C1-C4-C6-C3-C2-C5, respectively. A comparison of the mean scores of each component for the three regions is shown in Fig. 1.

A multivariate analysis of variance (MANOVA) with Tukey's HSD post hoc multiple comparisons tests was conducted in order to explore cultural differences for each value dimension by region. We had significant univariate main effects for each of

Table 3 Mean comparison amongst three regions for the six components

Component	Region			*F* test	Effect size
	CHN M (SD)	HKG M (SD)	TWN M (SD)		
Achievement (C1)	1.44 (0.37)	1.51 (0.52)	1.64 (0.51)	8.045 $p<0.001$	$\eta^2=0.012$; TWN > CHN
Relevance (C2)	1.79 (0.51)	2.04 (0.62)	2.23 (0.74)	78.078 $p<0.001$	$\eta^2=0.102$; TWN > HKG, CHN; HKG > CHN
Practice (C3)	1.72 (0.62)	1.98 (0.83)	2.07 (0.78)	8.412 $p<0.001$	$\eta^2=0.012$; HKG, TWN > CHN
Communication (C4)	1.95 (0.75)	2.25 (0.75)	1.94 (0.72)	49.140 $p<0.001$	$\eta^2=0.067$; HKG > TWN, CHN
ICT (C5)	3.09 (0.77)	2.69 (0.93)	3.14 (0.88)	18.082 $p<0.001$	$\eta^2=0.026$; TWN, CHN > HKG
Feedback (C6)	1.93 (0.95)	1.92 (0.82)	2.06 (1.0)	13.877 $p<0.001$	$\eta^2=0.020$; TWN > HKG

A low score means a high importance

CHN (the) Chinese Mainland, *HKG* Hong Kong, *TWN* Taiwan

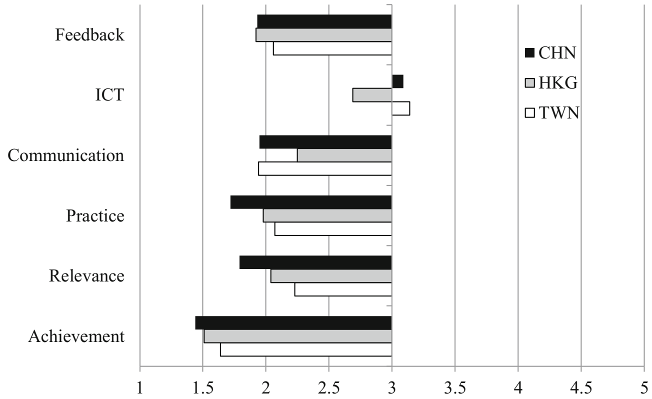

Fig. 1 Comparison of the means of each component for the three regions

the components at the 0.001 level. As shown in Table 3, the results indicated that there were statistically significant differences of each component amongst regions.

Based on the mean scores of each region, though achievement (C1) was valued most by students in all the regions, students in the Chinese Mainland valued achievement more than their counterparts in the other two regions. Significant differences only existed between the Chinese Mainland and Taiwan. Those students from the Chinese Mainland also valued relevance (C2) and practice (C3) more than students in Hong Kong and Taiwan. Statistically significant difference in C2 was also found between Hong Kong and Taiwan while there were no significant differences in C3 between them. As for communication (C4), students in Taiwan and the Chinese Mainland valued it more than those in Hong Kong and no significant difference was found between Taiwan and the Chinese Mainland. Although the valuing of ICT (C5) was not as prominent as the other components by the students across all regions, Hong Kong students valued ICT more than students in the Chinese Mainland and Taiwan did. As for the sixth component, feedback (C6), statistically significant differences were only found between Hong Kong and Taiwan. In the next section, we will give detailed explanations of our findings.

Discussion

From the above data analyses, six value components were extracted from the questionnaire data. The labelling of the six components was guided by the nature of the items associated with each component. According to items loading, the derived components are: Achievement (C1), relevance (C2), practice (C3), communication (C4), ICT (C5) and feedback (C6). We should note however, that although each component is concerned with students' values on their mathematics learning, the above-mentioned sequence does not necessarily indicate the degree of importance of each component. That is to say, C2 does not mean that relevance was the second most important students' value as far as mathematics learning was concerned; it might well be the most or least important amongst the six. In fact, the relative importance of component varies within each region (see Table 3). In the discussions below, firstly, we will provide a more detailed explanation of each component and then discuss the cross-regional differences amongst the three regions.

The Components of Ethnic Chinese Students' Values in Mathematics Learning

The questionnaire items which loaded onto the first component had been considered to be associated with the student valuing of achievement. These reflect the achievement orientation of the ethnic Chinese, a cultural trait which is rather well-documented in the literature (for examples, Bond, 1996, 2010). The items in this component reflect the high value that the ethnic Chinese students place on basic skills or strategies, such as knowing, memorising and using mathematical facts and formulae, emphasising solutions and even looking for different ways to solve problems. In the ethnic Chinese context, particularly in the Chinese Mainland, when a student can solve a problem by using different methods, he/she is generally considered to have mastered the problem solving skills and have in-depth understanding of the problem. This kind of mastery and understanding—together with success—can be regarded as a measure of a student's achievement in his/her learning. However, achievement is not easily attained. A student's valuing of achievement can bring with it tremendous pressure on the student him/herself. The pressure can also be intensified when the students view learning as an obligation, to repay the care given to them by their parents (Wong, 2004). In addition, when the 'basics' progress from computation to other higher order thinking skills, students will interpret 'memorizing facts' as 'memorizing hands-on skills' and 'memorizing problem solving routines' as well (Wong et al., 2004).

As the second component of the values structure, relevance is about students finding mathematics activities or materials (e.g. mathematical stories, games, puzzles and mathematics in real life) that are relevant to mathematics to be important. Although these mathematics-related learning activities might not be directly related to examinations, they are of utmost importance to problem solving (Dienes, 1971; Ginsburg, Lin, Ness & Seo, 2003; Hong, 1996). In addition, these activities could foster a relaxed learning atmosphere in the classroom. Through becoming involved in such activities, students could feel happier (Ding & Wong, 2012; Wu, 2013). This may also reflect the emphasis on hands-on experience in the mathematics curriculum reform which was introduced at the turn of the millennium.

The third value component is practice, and the valuing of this was reflected in the ways in which the student respondents emphasised the importance of doing mathematics in the classroom as well as homework. As mentioned above, studies have indicated that the ethnic Chinese consider that there can be no success without effort. Everybody, regardless of his/her talent, has the opportunity to strive for a better achievement in life. Furthermore, success at school also constitutes a pass to this life achievement. Thus, engaging in and emphasising the value of practice is an expression of effort. However, the strong belief that 'practice makes perfect' exerts a great deal of pressure on the learners.

The students across the three regions also valued communication. This valuing expressed itself in the form of discussions between the teacher and their students, as well as amongst the students. This kind of classroom interaction is what was advocated by social constructivists (e.g. Lampert, 1990). Again, in the mathematics curriculum reform in the early 2000s, communication was one of the various higher order thinking skills that were emphasised in the curriculum (Wong et al., 2004). For instance, in Hong Kong, it was explicitly referred to in the curriculum as one of nine 'generic skills' that should be nurtured (Curriculum Development Council, 2002). The situation is similar in the other two regions (Lam et al. 2015) as well. Such an emphasis at the institutional level might have been successfully passed on to the students, with the result that over time they also began to consider it as a valuable part of their learning.

The fifth value component arising from the data analysis is *ICT*. The use of ICT education has been promoted since the 1990s (Wong, 2003) and was once again a focus of attention in the mathematics curriculum reform at the turn of the millennium (Wong et al., 2004). Many resources, such as the Internet, computers, calculators and a range of software have been invested into the school system, in particular those in the Chinese regions since then, in particular to assist those who are economically disadvantaged to have access. From our observation in the classrooms amongst three regions, though ICT was gradually incorporated into day-to-day teaching, it does not replace the traditional teaching methods immediately. Many students are still unfamiliar with it. That could explain why the mean score of the component ICT is around 3.0 which means neither important nor unimportant.

The sixth value component is feedback with the mean scores of near 2.0 (see Table 3). That means primary students in these regions also value the importance of feedback from teachers and friends. Studies of the impact of feedback on student achievement indicate that feedback has a potentially significant effect on student learning (Hattie & Timperley, 2007). An earlier study in Hong Kong revealed that students looked for timely feedback from the teachers so that they could understand how well they were doing individually (Wong, 1993). In a recent study in Hong Kong (Law, Wong & Lee, 2012), both the teachers and junior secondary students considered teachers' feedback to be an important factor for the effectiveness of the students' learning. The Hong Kong students wanted their teachers to point out when their work went wrong and the teachers thought it was important to identify students' common mistakes in class and give them remedial lessons after class. Similar findings were found in Taiwan. For example, Wu (2013) revealed that most Taiwanese primary students thought that it would be effective if the teacher could check their homework and help them to modify any mistake committed in the classroom. The reason that feedback is highly regarded by the students can basically coincide with earlier studies on students' preferred learning environment for mathematics (Ding & Wong, 2012; Wong, 1993).

Cross-Regional Differences

As mentioned at the start of this article, although these three regions share basically the same Chinese culture, there are subtle differences due to their respective developments in the course of history. Indeed, statistically significant differences between and amongst the three regions were found for each of the six value components.

According to the mean scores, achievement was valued most by students in all the regions and difference only existed in the Chinese Mainland and Taiwan students. This is possibly explained by the position on the universal-elite spectrum at which each of the three regions is situated. As mentioned above, universal education was implemented in Taiwan and Hong Kong in the late 1960s and the mid-1970s, respectively, whereas in the Chinese Mainland, it was not until the early 2000s that basically every child had a chance to receive basic education. The competition to strive to reach the apex of the educational pyramid has been, and remains, intense. The huge population in the Chinese Mainland might also contribute to a greater sense of the need to achieve in one's (mathematics) education, thereby imposing a great deal of examination pressure on the students there. They feel they must achieve in school in order to climb up the societal ladder. Obviously that would affect the students' valuing of practice, which in turn possibly explains why the Chinese Mainland students valued practice more than their counterparts in Hong Kong and Taiwan. This is also relevant to our next cross-regional difference relating to relevance.

From the questionnaire, relevance refers to mathematical stories, games, puzzles and real life examples. It was valued more by the Chinese Mainland students, which could be related to the focus of the latest mathematics curriculum reform in the Chinese Mainland that began in 2000. In its curriculum syllabus, the original two basics (basic knowledge and basic skills) were formally extended to the four basics (together with basic thoughts and basic experience on activities) in the latest curriculum standards (Lam et al. 2015). Hands-on experience was newly added to the list of basics (the fourth being thinking skill). In the relevance component, there are two items (Q18 and Q61) on the use of the history of mathematics. The use of history has been promoted for a considerable period of time in all three regions. But recent analyses show that the emphasis on the history of mathematics in the textbooks in the three regions run in a descending order from the Chinese Mainland, to Hong Kong and to Taiwan (Hsu & Hsu, 2009; Hsu & Lin, 2009). Furthermore, Hong Kong's textbooks provide more hands-on and realistic examples than those in the other two regions (Hsu & Lin, 2009). This may, at least partially, explain the differences in the valuing of these components across the three regions. Furthermore, the findings showed that students in Taiwan and the Chinese Mainland valued communication more than those in Hong Kong. This may also reflect the learning environment that was induced by the mathematics curriculum reform in the Chinese Mainland in which communication is another focus (Ministry of Education, 2012).

Nowadays, the applications of ICT to facilitate learning have been highly regarded in education all over the world. However, the impact on the mathematics curriculum does vary (Wong, 2003). It is evident that ICT is a resource-consuming endeavour, the promotion of which depends on infrastructure and support. There is no doubt too that the various governments did invest a lot of resources to this end. Compared to the Chinese Mainland and Taiwan, Hong Kong is a small region and it might be easier to provide for ICT in education. A 5-year plan to promote ICT in education was published in 1998 (Education and Manpower Bureau, 1998). A great deal of investment in equipment, facilities and teacher preparation (for example, teachers were benchmarked against IT literacy) was put into the educational system thereafter. Indeed, the latest IEA Second Information Technology in Education Study has revealed that, although Hong Kong and Taiwanese schools may have comparable access to the internet and computers, there were about double the number of mathematics teachers in Hong Kong who utilised ICT in their pedagogical practices (Law, Pelgrum & Plomp 2008). The greater institutional focus on—and practices relating to—the use of ICT in mathematics teaching in Hong Kong might offer an explanation why Hong Kong students value ICT more than their peers in the other two regions, though we have no doubt that ICT is part of the educational agenda in all three regions.

Conclusion

In the present study, the value structure of ethnic Chinese students with regards to mathematics learning has been identified through the administration of a validated questionnaire. Based on the mean scores of the six derived components, achievement was valued most and ICT was valued least by the participants. Relevance, practice, communication and feedback were also highly regarded, although the degree of importance attached to each component varied in each region. The achievement orientation, to some extent, influences the students' learning style. They are more concerned about engaging in practising basic skills and solving problems than about using ICT or playing mathematics games, although the latter are also valued by the students. It is as if the students can see for themselves the fruit of their practice and problem-solving, and these are aligned with their valuing of achievement, communication and feedback are both concerned with teacher-student or student-student interactions. Although students know and appreciate the importance of interactions in learning mathematics, when they face the pressure of examination or competition, these components may be put aside for a while.

These findings contribute to current knowledge with a view to further improving our practices in mathematics teaching. It is often suggested that congruence between the students' preferences and the perceived classroom environment is an influential factor for better learning (Fraser, 1998), and current research relating to values alignment reflect this (Seah & Andersson, 2015). The understanding of what our students value would thus provide useful information to the teachers and curriculum/textbook developers in terms of how teaching and learning can be made more effective.

Subtle value differences were also delineated amongst the three regions. Inevitably, we find more similarities than differences since they are all ethnic Chinese. All three ethnic Chinese regions value achievement most but the subsequent orders of importance were different. Achievement, relevance and practice, which are closely tied to examinations, are more salient in the values of students in the Chinese Mainland. Students in Hong Kong valued relevance, ICT and feedback more than their counterparts whereas those in Taiwan and the Chinese Mainland valued communication more than students in Hong Kong. These differences, no matter how subtle they are, precisely reinforce the common belief that values are culture dependent. And culture may be a result of historical developments, educational ideologies and curriculum settings. However, although there were such statistically significant differences of each component between regions, considering that the effect size is not large (Cohen, 1988) and the sample is also not large, we still need to be cautious to treat these differences. The findings just reflect some aspects of ethnic Chinese students and cannot be casually generalized.

When these ethnic Chinese students are considered as a group, their preferences and/or the conditions under which they learn well can be compared with students elsewhere (such as in Western countries). Indeed, the findings reported in this paper and the research design used provide the mathematics education research community with a perspective on student values and can contribute to a better understanding of mathematics learning in different cultures. Such knowledge can only become increasingly important for societies as they become more and more culturally diverse and as there is also a growing need for more inclusive (mathematics) pedagogical practices.

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Appendix 1: Sample of the Questionnaire (Section A)

For each of the learning activities below, tick a box to tell us how **important** it is to you when you learn mathematics.

	Absolutely Important	Important	Neither Important or unimportant	unimportant	Absolutely unimportant
1. Investigations	□	□	□	□	□
2. Problem-solving	□	□	□	□	□
3. Small-group discussions	□	□	□	□	□
4. Using the calculator to calculate	□	□	□	□	□
5. Explaining by the teacher	□	□	□	□	□
6. Working step-by-step	□	□	□	□	□
7. Whole-class discussions	□	□	□	□	□
8. Learning the proofs	□	□	□	□	□
9. Mathematics debates	□	□	□	□	□
10. Relating mathematics to other subjects in school	□	□	□	□	□
11. Appreciating the beauty of maths	□	□	□	□	□
12. Connecting maths to real life	□	□	□	□	□
13. Practising how to use maths formulae	□	□	□	□	□
14. Memorising facts (e.g. Area of a rectangle= length × breadth)	□	□	□	□	□
15. Looking for different ways to find the answer	□	□	□	□	□
16. Looking for different possible answers	□	□	□	□	□
17. Stories about mathematics	□	□	□	□	□

18. Stories about recent developments in mathematics	□	□	□	□	□
19. Explaining my solutions to the class	□	□	□	□	□
20. Mathematics puzzles	□	□	□	□	□
21. Students posing maths problems	□	□	□	□	□
22. Using the calculator to check the answer	□	□	□	□	□
23. Learning maths with the computer	□	□	□	□	□
24. Learning maths with the internet	□	□	□	□	□
25. Mathematics games	□	□	□	□	□
26. Relationships between maths concepts	□	□	□	□	□
27. Being lucky at getting the correct answer	□	□	□	□	□
28. Knowing the times tables	□	□	□	□	□
29. Making up my own maths questions	□	□	□	□	□
30. Alternative solutions	□	□	□	□	□
31. Verifying theorems / hypotheses	□	□	□	□	□
32. Using mathematical words (e.g. angle)	□	□	□	□	□
33. Writing the solutions step-by-step	□	□	□	□	□
34. Outdoor mathematics activities	□	□	□	□	□
35. Teacher asking us questions	□	□	□	□	□
36. Practising with lots of questions	□	□	□	□	□
37. Doing a lot of mathematics work	□	□	□	□	□
38. Given a formula to use	□	□	□	□	□
39. Looking out for maths in real life	□	□	□	□	□
40. Explaining where rules / formulae came from	□	□	□	□	□
41. Teacher helping me individually	□	□	□	□	□
42. Working out the maths by myself	□	□	□	□	□
43. Mathematics tests / examinations	□	□	□	□	□

44. Feedback from my teacher	□	□	□	□	□
45. Feedback from my friends	□	□	□	□	□
46. Me asking questions	□	□	□	□	□
47. Using diagrams to understand maths	□	□	□	□	□
48. Using concrete materials to understand mathematics	□	□	□	□	□
49. Examples to help me understand	□	□	□	□	□
50. Getting the right answer	□	□	□	□	□
51. Learning through mistakes	□	□	□	□	□
52. Hands-on activities	□	□	□	□	□
53. Teacher use of keywords (e.g. 'share' to signal division; contrasting 'solve' and 'simplify')	□	□	□	□	□
54. Understanding concepts / processes	□	□	□	□	□
55. Shortcuts to solving a problem	□	□	□	□	□
56. Knowing the steps of the solution	□	□	□	□	□
57. Mathematics homework	□	□	□	□	□
58. Knowing which formula to use	□	□	□	□	□
59. Knowing the theoretical aspects of mathematics (e.g. proof, definitions of triangles)	□	□	□	□	□
60. Mystery of maths (example: 111 111 111 × 111 111 111 = 12 345 678 987 654 321)	□	□	□	□	□
61. Stories about mathematicians	□	□	□	□	□
62. Completing mathematics work	□	□	□	□	□
63. Understanding why my solution is incorrect or correct	□	□	□	□	□
64. Remembering the work we have done	□	□	□	□	□

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