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This paper reports the findings of a study investigating junior secondary school students' perceptions of mathematics classroom learning environments in China. An adapted 'What Is Happening In this Classroom?' questionnaire was administered to a sample of 2324 junior secondary school students from 72 classrooms in six provinces. Data were analyzed using factor analysis, descriptive statistics, two-way ANOVA, and cluster analysis. It was found that Chinese junior secondary students generally did not perceive their mathematics classroom environments very favorably. Grade 9 students were found to perceive their mathematics classroom learning environments less favorably than Grade 7 and Grade 8 students did. Moreover, boys were found to perceive their mathematics classes as more inquiry-oriented and perceive themselves as relatively more mathematically involved, while girls perceived more opportunities for cooperation and knew what was needed to compete in mathematics classes. Three types of mathematics classroom learning environments, namely highly favorable, intermediately favorable, and lowly favorable as perceived by participants were further identified in this study.

Keywords: mathematics classroom learning environments, junior secondary school student, mathematics education in China

INTRODUCTION

Since the 1980s, Chinese students have consistently outperformed their Western counterparts in international studies of mathematics achievement, both in small scale studies (e.g., Stevenson et al., 1990), and in large scale international comparative studies, such as the International Mathematical Olympiad and Programme for International Student Assessment (PISA) 2009 (OECD, 2010). While Chinese students' mathematics achievements are impressive, however, researchers argue, particularly from a Western perspective (Biggs, 1998; Watkins & Biggs, 2001), that China's teaching and learning environment is not conductive to effective mathematics teaching and learning. On the contrary, it has been described as "restrictive" (Biggs 1998, p. 724), such as the wide use of expository teaching methods, highly authoritarian classrooms, and focus on preparing students for external examinations (Biggs, 1998; Watkins and Biggs, 2001).

The paradoxical situation between Chinese students' outstanding performance in mathematics and the unfavourable teaching and learning environment has been described as "Chinese Learner Paradox" (Watkins & Biggs, 1996) and has drawn the attention of many researchers, especially Western researchers who found students' mathematics achievements in their own countries disappointing (Stevenson & Stigler, 1992). East-West differences cultural contexts (e.g., parental expectations and beliefs in ability), school organizations, and mathematics curricula have all been hypothesized as contributing to Chinese students' achievement (Lee, 1998; Leung, 2001; Stevenson et al., 1990). In addition, there has recently been increased research interest in

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State of the literature

- In international comparative studies in mathematics teaching, Chinese mathematics classroom teaching – including lesson structure, class organization, tasks employed by teachers, and discourse interaction – has been found to differ from that in Western countries.
- Classroom environment is a major determinant of students' cognitive and affective outcomes.

Contribution of this paper to the literature

- The study extends the 'What Is Happening In this Class' questionnaire, which has been widely used in classroom learning environment research, to a Chinese mathematics education context, and validates it.
- Although many studies have investigated how mathematics is taught in China, few have examined how Chinese secondary students perceive their mathematics classroom learning environments. The current study's findings contribute to an understanding of Chinese junior secondary school students' learning experiences in mathematics classes.
- Findings in the study enhance the understanding of Chinese mathematics teaching practice.

investigating Chinese mathematics classroom teaching practices (e.g., the Learner's Perspective Study), with the underlying assumption that the quality of classroom instruction should be an important influence on students' mathematics achievement since students acquire most of their mathematics knowledge in the classroom. These studies found the lesson structure, class organization, tasks employed by teachers and discourse interaction in Chinese mathematics classrooms to be quite different from those in Western countries (Clarke, 2013; Huang & Leung, 2004; Leung, 1995, 2001; Mok & Lopez-Real, 2006).

These differences in classroom practice may form a particular Chinese mathematics classroom culture, which may in turn cause Chinese students to perceive their classroom learning environment differently since "culture shapes mind" (Bruner, 1996 p. x). However, most of these conclusions about the characteristics of Chinese mathematics classroom practice have been drawn by researchers from outside the Chinese classroom and mainly through comparing Chinese mathematics teaching practice to that in other countries. There is a lack of research into how insiders, such as Chinese students who actually experience and act as a main part to build the classroom culture, perceive their mathematics classroom learning environments; as many previous studies have found, classroom environment is a major determinant of students' cognitive and affective outcomes (Fraser, 2007, 2012). In view of this research gap and the importance of classroom environment in affecting mathematical learning, this study, with the involvement of a large number of students, investigates how junior secondary students in China perceive their mathematics classroom environments.

LITERATURE REVIEW

Students' perceptions of mathematics learning environment

In recent decades, the field of classroom learning environment research has undergone remarkable growth, particularly in Western countries and in regards to science education. Classroom learning environment includes not only the physical space, but also the social, psychological and pedagogical contexts in which learning and teaching occur, and which in turn affect students' affective and cognitive outcomes (Fraser, 1998, 2007, 2012). Numerous studies have suggested that classroom learning environment is a major factor in determining students' learning (e.g., Fraser, 2007, 2012; Goh & Fraser, 1998), and that, generally speaking, students learn better when they perceive their classroom environment more positively. Questionnaires measuring students' or teachers' perceptions have been the most commonly-used method of assessing classroom learning environments (Fraser, 2012).

Due to the importance of classroom learning environment, mathematics education researchers also have recently begun to investigate students' perceptions of their classroom learning environments using adaptations of instruments widely used in science education. Previous research has pointed to a strong relationship between students' perceptions of their mathematics classroom learning environments and their mathematics achievement at different grade levels. Goh and Fraser (1998), for example, found a consistent and strong relationship between students' perception of their mathematics classroom environment and their mathematics achievement in Singapore primary schools. Specifically, greater student cohesion and less classroom friction imply a more conducive classroom environment and enhance student achievement. Similarly, Chionh and Fraser (2009) found that Singapore senior secondary school classrooms with higher student cohesiveness produced better mathematics examination scores. Fraser and Kahle (2007) also found a consistent and statistically significant association between American middle school students' perceptions of their classroom learning environments and their mathematics achievement. Wong and Watkins (1996) further found that secondary school students tend to achieve better in learning environments that are close to their preferred environments. Recently, Ding and Wong (2012) found that classroom learning environments influence Chinese elementary students' ability to solve problem.

Other studies, conducted in countries from Brunei to Australia, have identified associations between students' affective outcomes and their perceptions of their mathematics classroom learning environments, especially in terms of student motivation (Opolot-Okurut, 2010), student satisfaction with mathematics learning (Majeed, Fraser, and Aldridge, 2002) and mathematics academic efficacy (Dorman, 2001). Other studies (e.g., Fraser & Kahle 2007; Goh & Fraser, 1998), have found that mathematics classroom learning environments strongly influence students' attitudes towards mathematics and mathematics learning.

In addition to investigating the associations between students' cognitive and affective outcomes in mathematics and their perceptions of their classroom learning environments, previous research (e.g., Ben-chaim, Fresko, & Carmeli, 1990) also found that teachers and students perceive the same mathematics classroom learning environments differently. Gender differences were also identified; for example, Goh and Fraser (1998) found that girls in their study generally perceived their classroom learning environments more favorably than boys did. Moreover, students at different grade levels also perceived their classroom learning environments differently. According to Khalil and Saar (2009), Grade 6 students perceived their classroom learning environments less favorably than did Grade 5 students, as the former needed to prepare themselves for junior secondary school learning.

Characteristics of Chinese mathematics teaching practice

In recent years, researchers in China and other countries have started to investigate how Chinese mathematics teachers teach mathematics, and to compare their teaching practices with those found in other countries. Some characteristics of Chinese mathematics teaching were identified in these studies, including its tendency to be teacher-centered or –dominated, with the teacher being the authority for delivering knowledge (Biggs, 1998). Because the average Chinese classroom contains more than 40 students, it is quite common for Chinese mathematics teachers to employ a whole-class instruction approach (Paine, 1990) in which teachers organize the lesson, control the transaction of classroom activities, and dominate classroom interactions (e.g., Biggs, 1996, 1998; Watkins & Biggs, 2001). However, some researchers have recently argued that, even though mathematics teachers in China tend to control the teaching process, this does not necessarily result in students learning mathematics passively (Huang & Leung, 2004), and that inquiry activities are a significant feature in Chinese mathematics classrooms as well. While Chinese mathematics teachers may not use large, open-ended exploratory mathematics activities, they still employ mini-exploration tasks (Lopez-Real et al., 2004), and devote twenty to thirty percent of their lesson time to exploratory teaching methods, such as group activities or peer discussions (Mok & Lopez-Real, 2006).

Another characteristic of Chinese mathematics teaching is well- or highly-structured lessons. Leung (1995) found junior secondary mathematics lessons in Beijing to be well-structured, particularly when compared to mathematics lessons in London. A typical Beijing mathematics lesson involved revising previous lessons, introducing a new topic, practicing and discuss that new topic through examples, summarization and assigning homework (Leung, 1995). This lesson structure was found to be strictly followed by teachers in other areas of the country as well (Shao et al., 2012; Huang & Leung, 2004).

Another characteristic of Chinese mathematics teaching is the stress on knowledge and problem solving skills. Chinese mathematics teaching has been widely described as being heavily dominated by the basics in two areas: mastering basic knowledge and mastering basic skills (Zheng, 2006). Chinese mathematics teachers popularly believe that practice and exercise facilitate the formation of mathematics concepts and enhance students' conceptual understanding (Li, 2006). As such, they tend to employ extensive exercises, even before students really understand the relevant underlying concepts, to facilitate their mastery of the knowledge and develop their problem-solving skills (Shao et al., 2012); thus, Chinese mathematics students spend relatively more time on exercises and practice than on other activities (Mok & Lopez-Real, 2006).

The above review indicates that Chinese classroom instruction differs from that found in other (especially Western) countries, and that its highly structured lessons, teacher-centeredness and knowledge-centeredness may cause students to experience and interpret their classroom activities differently (Clarke, 2013). As such, students' opinions would be valuable and necessary information for the understanding and interpreting Chinese mathematics classroom practice. However, there have thus far been few attempts to investigate how students, who experience mathematics classroom as both insiders and builders, perceive their mathematics classroom environments. Although some researchers have started to investigate elementary school mathematics classroom learning environments in China (e.g., Ding & Wong, 2012), few have explored how Chinese secondary school students perceive their mathematics learning environments. In view of this, the present study explores how junior secondary school students in China perceive their mathematics classroom learning environments.

Table 1. Background characteristics of the participants

Grade	No. of students		
	Female	Male	Total
Grade 7	450	509	967
Grade 8	458	432	911
Grade 9	210	231	446
Total	1151	1139	2324

Note: 34 surveyed students did not indicate their gender.

Table 2. Description and sample item for each scale in the modified WIHIC

Scale	Description	Sample item
Student Cohesiveness	Extent to which students know, and be friendly to each other	I am friendly to members in my mathematics class.
Teacher Support	Extent to which the teacher helps, befriends, trusts and is interested in students	My mathematics teacher goes out of his her way to help me in class.
Involvement	Extent to which students have attentive interest, participate in discussions, and explain their solutions	I am asked to explain how I solve a problem.
Investigation	Extent to which skills and processes of inquiry and their use in class	I find out answers to questions by carrying out some inquiries in class.
Task Orientation	Extent to which it is important to complete activities planned and to stay on the subject matter	I know what I am trying to accomplish in the mathematics class.
Cooperation	Extent to which students cooperate rather than compete with one another on learning tasks	I cooperate with other students on mathematics class activities.

METHODS

Participants

This study surveyed 2324 junior secondary students from 12 coeducational schools and 72 classrooms in six provinces (Xinjiang, Yunnan, Guizhou, Chongqing, Jiangsu, Hunan) in China, taking into consideration such factors as school academic background, school reputation and teachers' teaching experience. Table 1 describes the background information of sample in the study.

This study adapted six scales and six items of each scale from the widely-used 'What Is Happening In this Class?' (WIHIC) questionnaire that suited the Chinese teaching and learning context: Student Cohesiveness; Teacher Support; Involvement; Investigation; Task Orientation; and Cooperation. The WIHIC questionnaire has been cross-validated in various cultural contexts, including Australia, the United Kingdom and Canada (Dorman, 2003), and Taiwan (Huang et al., 1998). The chosen items were first translated into Chinese by the author, with reference to a Mandarin version of the WIHIC developed by Huang, Aldridge, and Fraser (1998). Some items were further modified to suit the mathematics education situation in China. As the WIHIC has been predominantly used in the science education field, items in the Investigation scale were redesigned by the author, a university mathematics education researcher and a highly experienced secondary school mathematics teacher. The modified version was further checked by five highly experienced secondary school mathematics teachers and two experienced mathematics education researchers; further modifications were made based on their suggestions.

The finial modified version of the questionnaire was constructed using a five-point Likert-type response scale to indicate the degree to which students agreed with each statement made: (1) Never; (2) Seldom; (3) Sometimes; (4) Often; (5) Always. A detailed description of what each WIHIC scale measures and sample items are presented in Table 2. The internal consistency of each modified WIHIC scale (after factor analysis) was estimated using the Cronbach alpha reliability coefficient, with results ranging from 0.755 to 0.859; the questionnaire's overall Cronbach alpha reliability coefficient was 0.944.

Data analysis

Data were analyzed using factor analysis, descriptive statistics, multivariate analysis, and cluster analysis. To validate the instrument, factor analysis was undertaken on the whole data. Then, to obtain a sample description of the mathematics classroom environment in China as perceived by junior secondary students, mean item scores and standard deviations were computed for each scale. Two-way MANOVA were employed to explore grade and gender differences, and follow-up univariate tests were performed to explore differences within gender and grade. Lastly, K-means cluster analysis was performed to identify relatively homogenous groups of students with similar perceptions of their classroom learning environments. Three distinct types of classroom environments were identified, and chi-square tests were used to explore participants' gender differences and grade differences among them.

FINDINGS

Validation of the modified WIHIC questionnaire

Factor analysis was undertaken to explore the structural validity of the modified WIHIC in Chinese school settings. Principal components factor analysis, followed by varimax rotation, was performed to confirm the structure of the modified WIHIC, using individual students' mean score as the unit of analysis. For any item to be retained, its factor loading must be at least 0.40 within its own scale and less than 0.40 with each of the other five scales; these criteria led to the removal five inappropriate items, leaving the final version of the modified WIHIC for the present study with 31 items.

The results of the final factor analysis are presented in the appexdix table. Every item in the refined version of the WIHIC has a factor loading larger than 0.40 in its own scale, and less than 0.40 in each of the other five scales. Approximately 60% of the variance in the final factor structure can be accounted for by the six interpretable factors, with the percentage of variance for different WIHIC scales ranging from 7.92% to 10.95%. The eigen values for the different WIHIC scales ranges from 2.488 to 3.394.

The remaining 31 items were further validated by confirmatory factor analysis (CFA), using AMOS 18.0. No further items were deleted during the CFA, the results of which indicated a good fit with GFI, IFI, TLI, and CFI, all of which were above 0.90 (GFI = .0.933, IFI =0.936, TLI = 0.928, CFI = .935), and RMSEA was below 0.05 (RMSEA =0.046). Only the chi square statistic was not satisfactory in the CFA (X2 = 2435.981, X2/df =5.81, p<0.001). However, as noted by Anderson and Gerbing (1988), the value of the chi-square statistic is dependent on sample size; data from a large sample size will likely have a significant chi-square statistic even if there are only minor discrepancies between the model and the data. As this study involved a large number of participants and the other indices all indicate a good fit, it is safe to say that the CFA results strongly support the six-factor structure of the modified WIHIC.

The modified WIHIC was further validated in terms of internal consistency. As shown in the appendix table, the Cronbach α coefficient for each WIHIC scale was relatively high, ranging from 0.755 to 0.859. This confirms the sound reliability of the modified WIHIC in the Chinese mathematics education context.

Junior secondary students' general perception of mathematics classroom environment

Item mean scores were used to describe how surveyed participants perceived their mathematics classroom environments in this study; these means were obtained by dividing the scale mean score by the number of items in each scale. The average item mean

Table 3. Item means and standard deviations for the six scales of WIHIC

Scale	No. of items	Item Mean ± SD
Student Cohesiveness	6	3.63±0.79
Teacher Support	4	3.52±0.84
Involvement	4	2.90±0.80
Investigation	5	3.10±0.83
Task Orientation	6	3.61±0.71
Cooperation	6	3.31±0.82

Table 4. Mean, standard deviation, and t-test value for gender differences for each WIHIC scale

Scale	Boys	Girls	t
	Item Mean ± SD	Item Mean ± SD	
Student Cohesiveness	3.61±0.79	3.66±0.78	-1.482
Teacher Support	3.51±0.85	3.53±0.84	-0.555
Involvement	2.98±0.82	2.83±0.77	4.345***
Investigation	3.19±0.85	3.05±0.80	4.122***
Task Orientation	3.58±0.72	3.67±0.69	-2.971**
Cooperation	3.27±0.83	3.36±0.80	-2.816**

***<0.01. ***<0.001*

provides a meaningful basis for comparing scales that contain different numbers of items.

Table 3 summarizes the mean scores for each scale. These range from 2.90 to 3.63, indicating that, for all scales, the junior secondary students surveyed perceived that, in their mathematics classes, they experienced the phenomenon asked about between sometimes and often. In other words, they generally did not perceive their mathematics classroom learning environments very favorably. The item mean score for Involvement was the lowest among the six scales at 2.90, indicating that students perceived that they "seldom" or at best "sometimes" mathematically participated in their mathematics learning, such as explaining their solutions or taking part in class discussions. The item mean scores for Investigation and Cooperation were also quite close to 3, suggesting that participants believed that they would only "sometimes" experience peer cooperation or carry out mathematics inquiry activities in their classes. The item mean scores for Student Cohesiveness, Teacher Support and Task Orientation, all of which were around 3.5, were the highest in the study. This suggests that participants perceived that they less than "often" but more than "sometimes" received help from their mathematics teacher, were friendly to each other in the classroom, and knew what they were supposed to do.

Gender and grade differences in mathematics classroom environment

The two-way MANOVA, using the six scales of WIHIC as the dependent variables and gender and grade as the independent variables, indicated a significant main effect for gender (Wilks lambda=0.949, F [6, 2279] =20.46, p<0.001) and a significant main effect for grade (Wilks lambda=0.938, F [12, 4558] =12.27, p<0.001). There was no significant interaction between grade and gender (Wilks lambda=0.991, F [12, 4558] =1.73, p=0.056).

Since the interaction between grade and gender was not significant, a t-test was performed to examine gender differences (see Table 4) and one-way MANOVA was conducted to examine grade differences (see Table 5). As shown in Table 4, there exist statistically significant differences between boys' and girls' perceptions on the scales of Involvement, Investigation, Task orientation and Cooperation. No significant differences were found for Student Cohesiveness and Teacher Support, implying that the boys and girls surveyed reported having relatively the same level of support from their mathematics teachers and were friendly to each other in class. In terms of Involvement and Investigation, boys perceived themselves as relatively more mathematically involved in their mathematics classes and as having more opportunities to carry out mathematics inquiry activities. Regarding Task Orientation and Cooperation, girls indicated that they had relatively more opportunities for cooperation and knew what they were expected to complete in the mathematics classes.

As illustrated in Table 5, generally speaking, statistically significant differences were found among Grade 7, Grade 8 and Grade 9 students for all six scales, with relatively larger differences in the scales of Involvement, Investigation, Task Orientation and Cooperation. A Scheffe post hoc test used to examine the differences between grades showed significant differences between Grade 7 and Grade 9 students, and between Grade 8 and Grade 9 students for the scales of Involvement, Investigation, Task Orientation and Cooperation. This suggests that Grade 9 students perceived themselves as having less experience in carrying out mathematics inquiry activities, cooperating with their peers, and being mathematically involved in class discussions than their Grade 7 and Grade 8 counterparts. For the Student Cohesiveness and Teacher Support scales, significant differences were found only between Grade 7 and Grade 8 students, suggesting that the latter felt they enjoyed relatively more support from their teachers and were friendlier to their classmates than Grade 7 students. Overall, as shown in Table 5, Grade 7 and Grade 8 students perceived their mathematics classroom environment more favorably than did Grade 9 students.

Types of mathematics classroom environments

It is reasonable to conjecture that individual students in the same classroom might have different perceptions due to individual differences in personality, interests and mathematics ability; as such, to explore the possible types of mathematics classroom environment that existed among the participants, a Quick Cluster (K-means Cluster) analysis was performed on all cases. Three different types of mathematics classroom environments were clustered in the present study. Item mean scores, standard deviations for each type and one-way ANOVA analysis results are presented in Table 6. Table 6 shows significant differences among the three types of classroom learning environments in terms of the six modified WIHIC scales. Scheffe post hoc test results further show significant differences between any two of the three types of classroom learning environments on each scale, indicating their distinctness from each other. Names were given to each type based on their item mean scores for each of the six scales.

Table 5. Mean, standard deviation, and F value for grade differences for each WIHIC scale

Scale	Grade 7	Grade 8	Grade 9	F	Scheffe post hoc test*
	Item Mean ± SD	Item Mean ± SD	Item Mean ± SD		
Student Cohesiveness	3.56±0.81	3.70±0.77	3.62±0.74	7.394**	B>A
Teacher Support	3.45±0.88	3.59±0.82	3.48±0.81	6.983**	B>A
Involvement	2.95±0.81	2.94±0.81	2.72±0.73	14.024***	A>C, B>C
Investigation	3.19±0.83	3.12±0.83	2.90±0.78	19.908***	A>C, B>C
Task Orientation	3.66±0.71	3.66±0.71	3.44±0.69	17.417***	A>C, B>C
Cooperation	3.27±0.83	3.40±0.81	3.21±0.78	10.564***	A>B, B>C

***<0.01. ***<0.001 * A: Grade 7; B: Grade 8; C: Grade 9*

Table 6. Mean, standard deviation, and one-way ANOVA analysis results for the three types

Scale	Type 1 (n=618)	Type 2 (n=1050)	Type 3 (n=656)	F
	Item Mean ± SD	Item Mean ± SD	Item Mean ± SD	
Student Cohesiveness	4.40±0.41	3.66±0.54	2.86±0.64	1301.756***
Teacher Support	4.30±0.50	3.59±0.58	2.66±0.66	1276.331***
Involvement	3.72±0.60	2.88±0.54	2.17±0.54	1232.042***
Investigation	4.00±0.54	3.10±0.53	2.29±0.53	1656.090***
Task Orientation	4.32±0.44	3.63±0.46	2.94±0.59	1233.207***
Cooperation	4.20±0.47	3.30±0.50	2.48±0.56	1820.980***

****<0.001*

Table 7. Frequencies, percentages of types and chi-square statistics for demographic variables

Variable	Type 1	Type 2	Type 3	X^2	p
Gender				3.372	0.185
Boys	324(52.6%)	501(48.2%)	326(51.3%)		
Girls	292(47.4%)	538(51.8%)	309(48.7%)		
Grade				22.464	0.000
7	258(41.7%)	427(40.7%)	282(43.0%)		
8	272(44.0%)	417(39.7%)	222(33.8%)		
9	88(14.2%)	206(19.6%)	152(23.2%)		

Type 1 Highly favorable mathematics learning environment (n=618, 26.6%). With the exception of Involvement, the item mean scores for all scales in this type of classroom were above 4. This suggests that students clustered to this type perceived that they very often received support from their teacher, cooperated with their peers, carried out mathematics inquiry tasks, and were more deeply involved in their mathematics class.

Type 2 Intermediately favorable mathematics learning environment (n=1050, 45.2%). As shown in Table 6, this type of classroom features item mean scores for each scale that are below 4, with Involvement and Investigation scores close to or lower than 3. This suggests that students in these classrooms “sometimes” cooperated with other students and perceived that they had the experience to carry out mathematics inquiry activities in class.

Type 3 Lowly favorable mathematics learning environment (n=656, 28.2%). The item mean scores for each scale in this type of classroom are below 3, suggesting these students “seldom” or less than “sometimes” experienced the investigated characteristic. In particular, the item mean scores for Involvement and Investigation are very close to 2, indicating that the students “seldom” experienced mathematics inquiry activities and participated in mathematics discussions in class.

As shown in Table 7, after Chi-square testing, significant differences were found among Grade 7, 8 and 9 students for the three types of classroom learning environments identified in this study. Relatively speaking, the differences between Grade 7 and Grade 8 students were small; however, a lower percentage of Grade 9 students were clustered into the most favorable classroom environment, and a relative large percentage were clustered in Type 3 classroom learning environment, the least favorable. In addition, although no significant gender differences were for the three types of classrooms, as shown in Table 7, relatively more boys were clustered in the most favorable class learning environment and more girls were in Type 2 classroom, the intermediate learning environment identified in the study.

DISCUSSION

This study focused on investigating how junior secondary students in China perceive their mathematics classroom learning environments, using a modified, short WIHIC Questionnaire to collect information on students' experiences in mathematics classroom. The item mean scores for the questionnaire's six scales were all below 4 and in some cases closer to 3, which were lower than scores reported in previous studies conducted in other contexts (e.g.,Afari, Aldridge, & Fraser, 2012; Opolot-Okurut, 2010). Participants in this study perceived that they only or close to "sometimes" participated in mathematics discussions, carried out mathematics inquiries or cooperated with their other classmates during mathematics class. The findings may suggest that, at least in the participants' opinion, Chinese mathematics teachers do not offer sufficient opportunities for discussion, inquiries or in-class cooperation. This, despite the fact that, from a theoretical perspective, student activities – such as asking questions, explaining and justifying their ideas and having their ideas evaluated – are considered effective strategies for mathematics knowledge construction (Cobb et al., 1991; Inagaki, Hatano, & Morita, 1998). Thus, the findings in this study suggest that, generally speaking, mathematics learning environment as perceived by junior secondary school students are not very favorable for effective mathematics learning.

These findings differ from those in previous similar studies conducted in Chinese contexts. In Ding and Wong's (2012) study, for example, elementary school students indicated having plenty of opportunities for group discussion. Given the grade differences identified in the current study, however, the differences between it and Ding and Wong's study might be attributable to the grade differences of the respective participants. Indeed, Huang et al. (1998) found that secondary school classes in Taiwan were also perceived to be teacher-centered, with few opportunities for students to discuss during teaching, much as was found in the current study. Findings like this suggest that, given its tradition of highly structured, teacher-centered lessons focusing on mastering knowledge and training of problem solving skills, Chinese mathematics teaching at the junior secondary school level may still be dominated by teachers' talk to a certain extent. This further suggests that, although the newest mathematics curriculum standard, which has been implemented in China since 2001, promotes student-centered teaching and cooperative learning, teachers have yet to implement these in their practice at the junior secondary school level.

Another key finding of this study is that, similar to previous studies (e.g., Khalil & Saar, 2009), differences were also found among students at different grade levels, with Grade 9 students generally viewing their mathematics classroom learning environments less favorably than did their Grade 7 and Grade 8 counterparts; this can be seen in the relatively lower item mean scores at the Grade 9 level and the smaller percentage of Grade 9 students found in highly favorable mathematics learning environments. This might be due to the fact that Grade 9 students in China are required to take the Senior Secondary School Entrance Examination, which determines the academic quality and nature of the senior secondary schools to which they will be admitted on graduation; as not every junior secondary school graduate is admitted to senior secondary school, this examination is highly competitive in nature. As such, teachers' practices tend to be relatively more knowledge-centered and emphasize the skills needed to solve mathematics problems similar to those found in the examination (Shao et al., 2012; Zheng, 2006). These sorts of classroom practices may lead to Grade 9 students to perceive their mathematics classroom learning environments as offering fewer opportunities for cooperation and mathematics inquiry than they were afforded in earlier grades.

Although gender differences were identified in this study, it is hard to conclude that either girls or boys generally perceived their classroom learning environments to be more favorable, as was found in previous studies (e.g., Goh & Fraser, 1998). In general, boys in the study more often reported having opportunities to carry out mathematics inquiry activities and to participate in in-class discussions; on the other hand, girls in the study perceived that they often cooperated with classmates and felt they knew what they are supposed to do in mathematics classes. At the same time, while no significant gender differences were found in the distribution of students among the three types of mathematics classroom learning environments identified in the study, a relative higher percentage of boys were clustered in highly favorable environment, while a relatively higher percentage of girls were found in intermediately favorable environment.

Three distinct types of mathematics classroom learning environments as perceived by students were identified in this study. Unlike previous studies (e.g., Ding & Wong, 2012), in which mean class scores were used as the unit of comparison for cluster analysis, this study employed mean individual student scores, based on the conjecture that even within a single class, there might exist differences in students' individual perception. As shown in Table 7, more than 26% of students indicated that they often had opportunities for mathematics inquiry activities and in-class cooperation. This indicates that not all students perceive their mathematics classroom learning environments as one in which recitation, memorization, and teacher-centered instruction are stressed, as has been concluded in previous studies (e.g., Biggs, 1998). Of course, as described in Table 7, roughly half of all participants were clustered in intermediately favorable learning environment, and around 28% indicated that they seldom discussed and cooperated with their classmates in mathematics class and received less support from teachers and peers. This again suggests that, for most students in China, mathematics teaching is still largely knowledge-centered or directive, as described by previous researchers (Mok & Lopez-Real, 2006). That is, for most of Chinese students, directive teaching, rather than exploratory, is still the dominant teaching style in China.

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS

In this study, Chinese junior secondary school students' perceptions of their mathematics classroom learning environments were investigated, using an adaptation of the WIHIC questionnaire, which is widely-used in classroom learning environment research. Generally speaking, the participating students did not perceive their classroom learning environments very favorably. The students indicated that they only "sometimes", of less than "often", experienced the characteristics being investigated in their mathematics class, such as carrying out mathematics inquiry activities, cooperating with peers, and participating in in-class discussions. Gender differences and grade differences were found in the study, and Grade 9 students were found to perceive their mathematics classroom learning environments less favorably than did their Grade 7 and Grade 8 peers. In addition, while the study identified three distinct types of mathematics classroom learning environments, only around 26% of participants were clustered in the most favorable type and around 28% were clustered in the least favorable.

As indicated above, few previous studies have investigated how secondary school students in China perceive their classroom learning environments. The present study is one of the very few studies that extend the widely-used WIHIC questionnaire to, and validate it within, a Chinese mathematics education context. In addition, since students' perceptions of their mathematics classroom learning environments were the main focus of the study, its findings offer a greater understanding of the culture of Chinese mathematics teaching practice from a student perspective. More important, the present study's findings contribute to a more complete picture of Chinese mathematics teaching practices, as the data were obtained from students, who are the main parts of Chinese mathematics teaching practice and the main builders of Chinese mathematics culture. Moreover, as in previous studies (e.g., Ding & Wong, 2012), three types of mathematics classroom learning environments were identified in the study. Its findings show that, even though mathematics teaching practice in China has been widely criticized as overly teacher-centered or knowledge-centered (Biggs, 1998), not all Chinese students perceive their mathematics learning environments in this way. They further indicate that, even though reforms have been introduced in the most recent mathematics curriculum standard, teachers may not yet be implementing these new ideas in their teaching practice.

This present study has certain limitations. First, as only junior secondary school students were involved, it is not clear how senior secondary school students perceive their mathematics classroom learning environments. As senior secondary students must, in Grade 12, take the College Entrance Examination, one of the most competitive examinations in China, it may be possible that they perceive their mathematics classroom learning environments differently. Future studies should investigate these students' perceptions of their mathematics classroom learning environments to facilitate a more comprehensive understanding of Chinese mathematics classroom teaching practice. Second, while all the participants in this study were drawn from urban schools, there are a great many rural school students, and teaching conditions are relatively poorer in rural schools than in urban schools in China (Wang, 2011). Future studies could investigate rural secondary school students' perceptions of their mathematics classroom learning environments and compare them with urban school students' perceptions; such a study could provide meaningful information for the understanding of how particular sub-cultures influence students' perceptions. Finally, no information about class size was collected in the study. Since large class size is quite common in China, it would be meaningful to investigate how class size influences students' perceptions of their mathematics classroom learning environments.

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APPENDIX A. Factor loadings, internal consistency reliability (Cronbach α) for the modified WIHIC

Item No.	Factor loading					
	Student Cohesiveness	Teacher Support	Involvement	Investigation	Task Orientation	Cooperation
1	0.479					
2	0.695					
3	0.674					
4	0.753					
5	0.701					
6	0.451					
7		0.760				
8		0.609				
9		0.732				
10		0.434				
11			0.685			
12			0.497			
13			0.629			
14			0.601			
15				0.707		
16				0.502		
17				0.680		
18				0.669		
19				0.538		
20					0.437	
21					0.654	
22					0.568	
23					0.566	
24					0.591	
25					0.618	
26						0.699
27						0.624
28						0.473
29						0.668
30						0.667
31						0.617
Percentage of variance	10.280	8.027	7.917	10.628	10.169	10.950
Eigenvalue	3.187	2.488	2.454	3.295	3.153	3.394
α reliability	0.830	0.755	0.757	0.824	0.793	0.859