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The Mathematics Learning Attributes Valued by Students in Eastern China

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Abstract

Purpose: Given that prior research has confirmed that students' mathematics values significantly affect their mathematics learning, understanding how students' values form and change, especially during different learning stages, is an important topic.

Design/Approach/Methods: This study administered a questionnaire to investigate the values of primary, junior high, and senior high school students in Eastern China. A principal component analysis was conducted to investigate the factor structure of the students' learning values. Then, paired sample *t*-tests were used to examine the differences in the two continuous categories ranking of each group, and a one-way analysis of variance with a Brown–Forsythe test was used to test the differences in the ranking of each dimension by the different grade-level groups.

Findings: We found that students' mathematics learning values consist of seven elements: culture, memorization, technology, objectism, practice, understanding, and control. Students placed

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different degrees of importance on these seven elements at different learning stages. Additionally, we found that junior high school is a critical period of change in students' values.

Originality/Value: These findings will be invaluable to teachers and educators as they reflect on their teaching approaches. Moreover, the findings that students' values undergo changes in the course of their schooling are important information for educators seeking to foster students' learning.

Keywords

Eastern Chinese learners, mathematics learning, values

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Introduction

The values that students give to various elements of mathematics learning experiences affect the effectiveness of mathematics teaching and the reform of mathematics education (Seah & Wong, 2012). Penk and Schipolowski (2015) found that students' mathematics values were more accurate than success expectancy in predicting effort, and that value and effort together explained over a quarter of the variance in mathematics scores. That is, students' judgment of "what is important in mathematics learning" played an important role in regulating their learning activities. Mathematics teaching is a cultural interaction activity in which values guide teachers' judgments and decisions, further influencing the learning. Hill et al. (2019) argued that when values were acknowledged in the mathematics classroom, relationships were strengthened, students' cultural identities were affirmed, students became more engaged, and, ultimately, mathematics learning was enhanced.

Mathematics education reform is a kind of cultural practice; therefore, in the process of promoting education reform, it is necessary to pay attention to students' values. This understanding has crucial practical implications for the ongoing reform of the mathematics curriculum in China, which aims at cultivating students' key competencies, including reasoning, modeling, creativity, and spatial sense (Ministry of Education of the People's Republic of China [MOE], 2001, 2012, 2017). Competency-based curriculum reforms have been introduced in other countries (OECD, 2018; Zhang, 2017). There is thus a need to determine how the competencies advocated in the curriculum documents are implemented in mathematics teaching.

This study investigated what Chinese students valued in their mathematics learning. There have been prior studies which investigated the values of students at particular learning stages of their mathematics learning. Students' learning experiences constitute an important influence on their values. Therefore, it is necessary to explore the influence of different learning stages on students' values. The results can inform curriculum design and teaching activities and also enrich the understanding of the role of values in mathematics learning. Data were collected across primary to senior secondary grade levels in

Zhejiang province in Eastern China. Eastern China consists of seven provinces and one municipality, including Shanghai, Zhejiang, and Jiangsu, and has an industrialized economy and society.

Values in mathematics education

Research into the role of values and valuing in mathematics learning and teaching began with Bishop's (1988a) proposal of a set of three complementary pairs of values in the mathematics discipline, namely *rationalism* and *objectism*, *control* and *progress*, and *mystery* and *openness*. Later, Bishop (1996) conceptualized the values in mathematics classrooms as falling into three overlapping categories: mathematical values, general educational values (such as equity and diversity), and mathematics educational values (such as flexibility, persistence, creativity, and enjoyment).

Values are culturally relevant. Our sociocultural environment shapes our values and is in turn shaped by our collective values (Seah, 2019). In the context of mathematics classrooms, this means that although members of many different cultures might value the same attributes of mathematics learning and teaching, there are differences in the importance they attach to each of these values. For example, a recent study showed that Swedish students value activities such as knowing the times tables, teachers' explanations, and correctness (Andersson & Oüsterling, 2019), whereas Ghanaian students valued attributes such as achievement, relevance, fluency, authority, the use of information and communication technologies (ICT), versatility, and strategies (Davis et al., 2019). In a Chinese context, Zhang et al.'s (2016) survey of primary school students in Chinese mainland, Taiwan region, and Hong Kong SAR found that they all valued the same six attributes in mathematics learning, but the students in the three regions accorded different degrees of importance to the six attributes. However, most of the studies of students' values using the WIFI have focused on primary or junior high school students. Few studies have examined senior high school students, and very few have compared students in different learning periods. In particular, we know very little about how these valuations might evolve over time within any one culture. Carr (2019) drew attention to this research gap in her extensive review of the research on values and valuing in mathematics education.

Mathematics education in Chinese mainland

Like many other regions, Chinese mainland launched a new mathematics curriculum around 2000 (Wong et al., 2004) that advocated the use of constructivism. High-order thinking skills, generic skills, ICT, and other issues were emphasized in the new curriculum to help the young generation meet the requirements and challenges of the 21st century. Chinese students have consistently achieved outstanding results in all kinds of mathematics competitions and international comparative studies, such as the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study. The "myth" of Chinese learners and teachers has drawn the attention of many scholars, both outsiders (Watkins & Biggs, 1996, 2001) and insiders

(Fan et al., 2004, 2015). Although various research papers have provided some explanation for the success of Chinese mathematics teaching and learning, there is still more to discover. In particular, most researchers have emphasized the cognitive features of Chinese teachers and students. With the social turn in mathematics education research (Lerman, 2006), it is important to know how sociocultural factors influence teaching in Chinese contexts.

Seah (2019) also argued that values should be considered as conative variables, given that it is a predictor of decisions and actions. In his model, conative variables such as values and motivation act as a bridge between cognition and affect on the one hand and behavior on the other. Values are powerful motivating forces that guide how we reason, feel, and learn or teach mathematics. In a comparative study, Leung (2006) pointed out that culture provides a possible explanation for the differences between Eastern and Western mathematics education. It was suggested that the East Asian cultural values of effort, perseverance, modesty, and practicability possibly influence mathematics education in East Asia. However, whether the values particularly associated with the discipline of mathematics education are the same as the general educational values of these Confucian cultural traditions is unknown. Zhang et al. (2016) researched primary school students' learning mathematics values in Chinese mainland, Taiwan region, and Hong Kong SAR. They found six values—achievement, relevance, ICT, practice, communication, and feedback—that were shared by all three groups. However, students in the three regions ranked these six values differently (Zhang et al., 2016). Thus, although they attached different degrees of importance to different values, all of the students within this similar cultural tradition shared the same fundamental values. This unity is reasonable under the educational context of Chinese mainland. The education system of Chinese mainland was deeply influenced by the Soviet Union after the People's Republic of China was founded in 1949, and the unity of education was one of its most significant features. Before 2000, there was just one syllabus with one set of textbooks for each discipline.

Furthermore, China established a systematic and well-organized structure for ensuring teaching quality and teacher professional development, consisting of a pedagogy research system that includes teaching laboratories in every city and teaching and research staff (TRS) for each educational level at the provincial, district, and city levels. These TRS are all excellent primary and secondary school teachers who oversee teaching quality insurance and teacher professional development in the corresponding area (Zhao, 2018). This TRS system further promotes educational unity. Taking Zhejiang province as an example, there are provincial-level, 11 district-level, and 89 city-level math TRSs for each learning level (namely, primary, junior high, and senior high school) to oversee professional issues related to the mathematics education of about 5,601 schools. Specifically, under the guidance of its TRS, schools and teachers in the whole region cooperate to promote teaching reform, so that mathematics teaching in the region is relatively consistent. For example, with the cooperation of the TRS from all regions in Zhejiang, the provincial mathematics TRS for junior high school promoted

the “learning-centered” classroom teaching reform over the last decade, explored a learning-centered mathematics classroom teaching model and constructed a rich case database (Xu, 2014).

In another study, Zhang (2019) used Part B of the WIFI questionnaire to identify differences in the values of primary, junior high, and senior high school students in Chinese mainland. Differences might be due to the reshaping of the values by the students’ own learning experiences and changes in the learning environment and teaching methods. In Part B of the WIFI, students were asked to choose one of a pair of items that express opposing values, such as “Leaving it to *ability* when doing math” and “Putting in *effort* when doing math.” The results identified theoretical presuppositions. In Part A, students were asked to rank the importance of 64 value events (see Table 1 for examples), and the shared dimensions were extracted using exploratory factor analysis. Finally, the shared features of all items in each dimension were named and explained theoretically. Part A can extract values that are not present in Part B but are indeed endowed by students.

In this study, we focused on the following two research questions.

1. What values do students in primary, junior high, and senior high schools embrace in mathematics learning in Eastern China?
2. What are the differences in the values of primary, junior high, and senior high students?

Research design

Research participants

This study identified the values that Eastern Chinese students attach importance to in mathematics learning and then analyzed the similarities and differences in the students’ values at different learning levels. We selected students from Zhejiang province for our research samples for two reasons. First, Zhejiang province, located in Eastern China, has a developed economy. The gross domestic product of this provincial-level administrative region has been fourth in China for 22 consecutive years. The economic development of urban and rural areas is well-balanced: The per capita disposable income gap between urban and rural residents is the smallest among all of the provinces in Chinese mainland (Ma et al., 2018). Second, the quality of basic education in Zhejiang is high. Data from the China pilot test of PISA 2012 (Feng, 2014) showed that students from Zhejiang scored an average of 623 points in mathematics, second only to Shanghai. According to the PISA grading standard, 61% of the students attained a high level (Level 5 or 6), and only 4% of the students were at a low level (Level 2 or below). In addition, the average score for students with low economic, social and cultural status (ESCS) was 564, which was above the OECD average of 452. Thus, Zhejiang’s students could be the representatives of Eastern Chinese Learners.

We used stratified sampling and random sampling to select six primary schools, six junior high schools, and six senior high schools in two regions of Zhejiang province. These two regions can be

Table 1. Rotated component matrix.

	Component						
	1	2	3	4	5	6	7
Q18 Stories about recent developments in mathematics	.789						
Q17 Stories about mathematics	.733						
Q61 Stories about mathematicians	.684						
Q39 Looking out for math in real life	.660						
Q34 Outdoor mathematics activities	.609						
Q52 Hands-on activities	.577						
Q12 Connecting math to real life	.544						
Q29 Making up my own math questions	.509						
Q40 Explaining where the rules/formulae came from	.469						
Q19 Explaining my solutions to the class	.445						
Q63 Understanding why my solution is incorrect or correct	.615						
Q59 Knowing the theoretical aspects of mathematics	.615						
Q58 Knowing which formula to use	.612						
Q64 Remembering the work we have done	.576						
Q62 Completing mathematics work	.571				.356		
Q60 Mystery of math	.307	.520					
Q56 Knowing the steps of the solution	.518						
Q55 Shortcuts to solving a problem	.447						
Q23 Learning math with the computer			.838				
Q24 Learning math with the Internet			.808				
Q22 Using the calculator to check the answer			.753				
Q4 Using the calculator to calculate			.554				
Q25 Mathematics games			.540				
Q48 Using concrete materials to understand mathematics				.799			
Q47 Using diagrams to understand math				.787			
Q49 Examples to help me understand				.747			
Q51 Learning through mistakes				.511			
Q36 Practicing with lots of questions					.851		
Q37 Doing a lot of mathematics work					.847		
Q57 Mathematics homework		.260			.556		
Q43 Mathematics tests/examinations		.272			.484		
Q41 Teacher helping me individually					.481		
Q30 Alternative solutions						.659	
Q16 Looking for different possible answers						.631	
Q31 Verifying theorems/hypotheses						.598	

(continued)

Table 1. (continued)

	Component
Q1 Investigations	.473
Q32 Using mathematical words	.404
Q6 Working step-by-step	.639
Q14 Memorizing facts	.633
Q5 Explaining by the teacher	.566
Q13 Practicing how to use math formulae	.565

Note. Extraction method: PCA; rotation method: varimax with Kaiser normalization, minimum factor loadings .40; KMO, MSA, eigenvalues >1. PCA = principal component analysis; KMO = Kaiser–Meyer–Olkin; MSA = measure of sampling adequacy.

Table 2. Participants.

Class name	N	Percentage (%)
Primary school students	426	34.0
Junior high school students	407	32.5
Senior high school students	420	33.5
Total	1,253	100.0

considered to represent average education levels in Zhejiang. The selected schools are also average-performing in the local context. Then, two classes of students were selected from each school to participate in the survey. A total of 456 questionnaires were received from primary school students, 514 from junior high school students, and 503 from senior high school students. These two regions had an average education level for Zhejiang province, and the six schools participating in the survey had average achievements at each education level. We excluded questionnaires that were not completed. As shown in Table 2, the final sample included three groups: 426 primary school students (PS) in Grades 4–6, 407 junior high school students (JS) in Grades 7–9, and 420 senior high school students (SS) in Grades 10–12.

Data collection and instrument

The data source for this study is the WIFI questionnaire, which has been translated from the original English version to the Chinese version through multiple rounds of mutual translation and third-party review. Specifically, one researcher first translated the English version of the questionnaire into Chinese, and then another researcher translated the Chinese version into English and compared it with the original English version. The two researchers together developed a second version of the Chinese version after discussion. Then, six math teachers from primary, junior high,

and senior high schools were invited to review the questionnaire, and the clarity of the questions was tested through the teachers' understanding. Finally, the Chinese version of the student questionnaire was finalized.

The questionnaire consisted of four sections: a 5-point Likert-type 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), and students' demographic and personal information (Section D). The original English-language version of the questionnaire may be viewed at the following link: https://melbourneuni.au1.qualtrics.com/jfe/form/SV_6YDuI41EnRFvozz.

Only the findings from Section A are reported in this article. In Section A, students were asked to evaluate the importance of each statement, using a 5-point Likert-type scale with 1 = *absolutely important* and 5 = *absolutely unimportant*.

Data analysis

A principal component analysis (PCA) was conducted to interrogate the factor structure of the students' value dimensions (Questions 1–64) across the three groups. In the next stage of the analysis, the different groups' ranking of the different dimensions was examined to provide a basis for cross-group comparison. We conducted a paired sample *t*-test on the rankings of each group to determine whether there were significant differences between groups. Second, an analysis of variance (ANOVA) with a Brown–Forsythe test was used to test whether there were significant differences in the groups' ranking of each dimension.

Results

PCA of the WIFI questionnaire

A PCA of the questionnaire items was used to shed light on the first research question. The final sample consisted of 1,253 complete responses. A PCA with varimax rotation and Kaiser normalization was used to examine Items 1–64. The significance level was set at .05, and a cutoff criterion for component loadings of .40 was used to interpret the results. Items that did not meet the criteria were eliminated. The Kaiser–Meyer–Olkin (KMO) (Kaiser, 1970) measure of sampling adequacy was .92, and the results of a Bartlett's (1950) test of sphericity (BTS) was significant at the .001 level; thus, the factorability of the correlation matrix was assumed, demonstrating that the identity matrix instrument was reliable. This confirmed the PCA's usefulness. Based on the cutoff criterion, 23 items were removed and 41 items were retained from the original 64. The analysis yielded seven components with eigenvalues greater than one, which accounted for 53.28% of the total variance, and a Cronbach's alpha (α) coefficient of .92 was obtained, indicating high internal consistency. The seven components of the participants' set of values for mathematics learning are discussed separately below.

Component 1: Culture

The first component (C1) consisted of 10 items with a reliability coefficient α of .87; it accounted for 11.59% of the total variance. After reexamining mathematics from an anthropological perspective, Bishop (1988b) argued that mathematics is a pan-human phenomenon and must be understood as a kind of cultural knowledge that all cultures generate, but it does not necessarily “look” the same from one cultural group to another. Furthermore, the generative nature of mathematics has a crucial role; otherwise, one could not explain the incredible and unforeseeable usefulness of mathematics (Emmer, 2005). The mathematics curriculum standard in Chinese mainland also emphasizes the cultural understanding of mathematics from two perspectives. The first presents mathematics as a cultural product that was created by humans, just like other cultural products such as architecture and dance; the second presents mathematics as an important cultural force in the development of human civilization. The content of mathematics history and the content of mathematical activities both use the first perspective to examine the cultural nature of mathematics. The content of mathematics history includes the story of mathematics and mathematicians and recent developments in mathematics. The content of mathematical activities includes math questions, operation activities, mathematical outdoor activities, and their solutions. The second perspective is used when making the connection between mathematics and real life, as this emphasizes the cultural nature of mathematics. Since the reform of the mathematics curriculum in China at the beginning of the 21st century, the connection between mathematics and real life has been emphasized to demonstrate the practical applications of mathematics (see Figure 1). Therefore, this dimension was defined as *culture* in this study.

Component 2: Memorization

The second component (C2) consisted of 8 items with a reliability coefficient α of .79; it accounted for 8.68% of the total variance. The mathematics facts that students memorize form the basis of their mathematical understanding and thinking. As Quirk (2013) argued, knowledge must first be loaded into the brain before it can be connected to other knowledge and “understood,” and explicit memorization is sometimes the most efficient way to achieve this. Many of the items in this component emphasize that mathematics is mysterious, and that during mathematics learning, it is important to know the theoretical aspects of mathematics, such as mathematical definitions and theorems, before one can know which formula to use, the steps to solve the problem, and then to complete mathematics homework and remember what has been done. In these processes, students must understand whether a solution is incorrect or correct and know how to simplify a solution to the problem. Thus, the above items were associated with remembering facts, formulae, solutions, and even previous questions and were focused on achievement (see Figure 2). This component was labeled *memorization*.

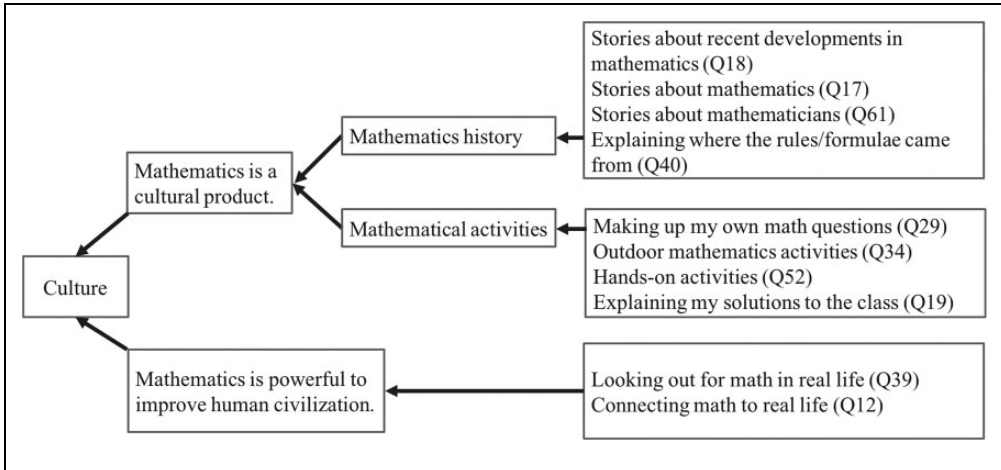


Figure 1. Component 1: culture.

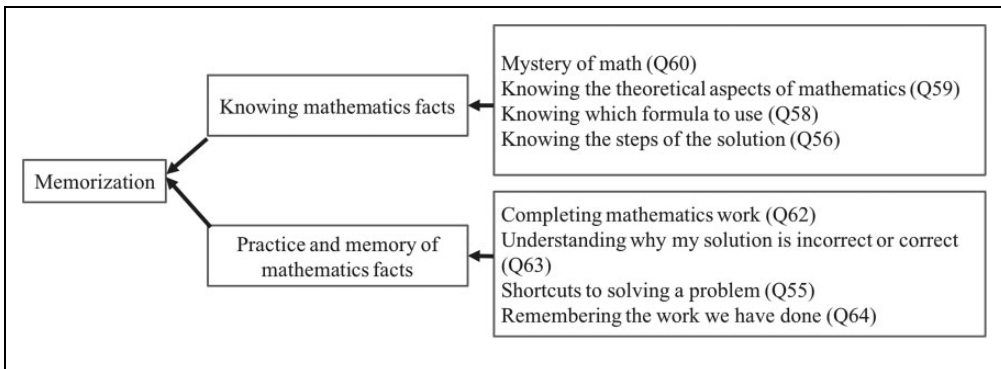


Figure 2. Component 2: memorization.

Component 3: Technology

The third component (C3) consisted of 5 items with a reliability coefficient α of .79; it accounted for 7.11% of the total variance. Items in this component showed that it is important to use different technologies, such as computers, the Internet, or calculators. It also included a mathematics game item that might be related to methods of applying technology to mathematics learning, such as treating mathematics problems as challenging games. Thus, this component was labelled *technology*.

Component 4: Objectism

The fourth component (C4) consisted of 4 items with a reliability coefficient α of .79; it accounted for 6.87% of the total variance. Items in this component showed that it is important to concretize things such as concrete materials, diagrams, and examples, as well as mistakes during the learning

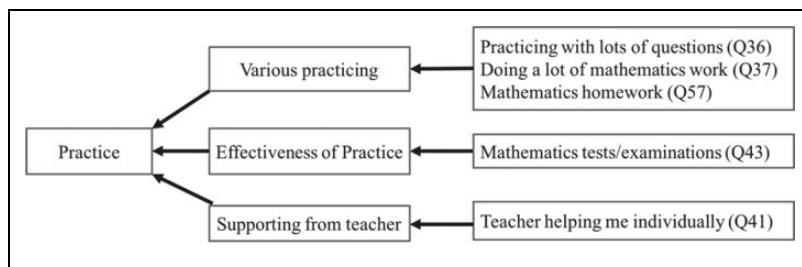


Figure 3. Component 5: practice.

process, which were emphasized by the value of objectism proposed by Bishop (1988a, pp. 65–69). Thus, this component was labeled *objectism*.

Component 5: Practice

The fifth component (C5) consisted of 5 items with a reliability coefficient α of .78; it accounted for 6.73% of the total variance. The items in this component indicated that it is important to do mathematics exercises and homework, take mathematics tests and exams, and receive individualized help from teachers. Thus, this component was labeled *practice* (see Figure 3).

Component 6: Understanding

The sixth component (C6) consisted of 5 items with a reliability coefficient α of .70; it accounted for 6.66% of the total variance. The items showed that verifying theorems or hypotheses, using mathematical language, conducting investigations, and looking for different solutions or possible answers were important for mathematics learning, and all required students' deep understanding of mathematics. Thus, this component was labeled *understanding*.

Learning with understanding is different than mechanical and rote learning. It aims to enable students to develop a deep conceptual understanding of mathematics and to properly apply the knowledge (Chen, 2013). It highlights a positive, more involved and thoughtful learning process (Guo, 2016). The project *American Project Zero* reviewed in *Learning and Teaching for Understanding* (Perkins & Unger, 1999) argued that understanding means that learning can be flexibly implemented through interpretation, confirmation, inference, connection, and application in a way beyond what is possible with knowledge and conventional skills; in other words, “learning with understanding can be expected to yield higher engagement, more active use and transfer of knowledge than learning with a rote emphasis” (p. 95). As Figure 4 shows, the items in this component reflected the behaviors advocated by this project, such as learning that demands thinking, understanding methods used in the domain/discipline, engaging in multiple forms of expression and publicly demonstrating understanding, and teaching students to use knowledge flexibly.

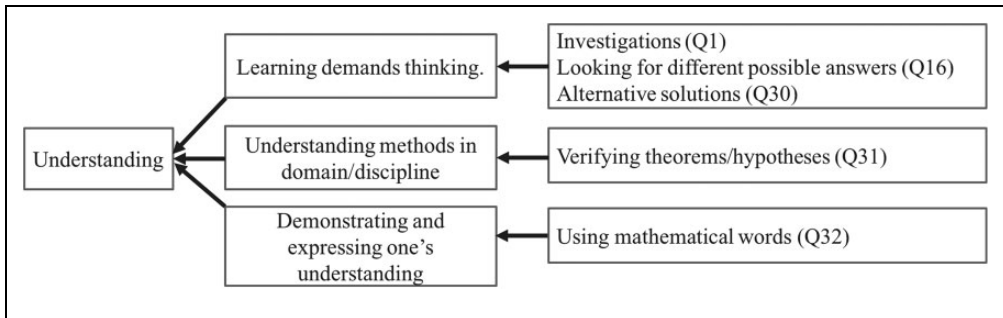


Figure 4. Component 6: understanding.

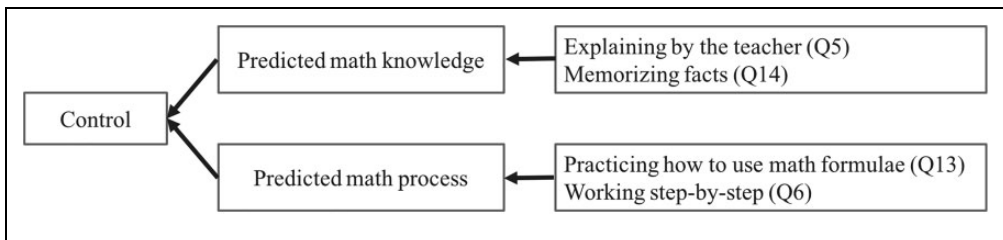


Figure 5. Component 7: control.

Component 7: Control

The seventh component (C7) consisted of 4 items with a reliability coefficient α of .66; it accounted for 5.65% of the total variance. These four items highlighted three related aspects of mathematics learning: memorizing facts, teachers' step-by-step explanations, and practicing how to use mathematics formulae. Such items show a sense of achieving certainty and mastery, which relates to the valuing of *control* (Andersson & Oüsterling, 2019). A similar association was established by Davis et al. (2019), when their study related the mastery of rules, facts, procedures, and established criteria to the valuing of *control* as well. Thus, this component was labeled *control* (see Figure 5).

Differences in the seven components

This section presents the results of the analysis of the differences in respondents' rankings of the seven value components. First, the mean scores of each component for each group are shown. Second, the ranking of the seven components derived from the PCA for each group is shown, and the differences between the groups are tested using paired samples *t*-tests. Third, the differences of each component between the groups are tested using an ANOVA.

Mean scores of each component across school levels

Some descriptive data for each component (value) across primary, junior high, and senior high schools are shown in Table 3 and Figure 6. A higher mean score means that the items making up the component were considered to be less important by the participants.

Table 3. Descriptive data of different groups in seven components.

Component	Primary school student			Junior high school student			Senior high school student		
	M (SD)	95% CI		M (SD)	95% CI		M (SD)	95% CI	
		L	U		L	U		L	U
C1	1.99 (.58)	1.93	2.04	2.10 (.68)	2.03	2.16	2.53 (.77)	2.45	2.60
C2	1.58 (.55)	1.53	1.64	1.69 (.58)	1.63	1.74	1.87 (.56)	1.82	1.92
C3	2.69 (.86)	2.61	2.77	2.86 (.86)	2.77	2.94	2.96 (.84)	2.88	3.04
C4	1.70 (.69)	1.64	1.77	1.63 (.67)	1.57	1.70	1.63 (.63)	1.57	1.69
C5	2.48 (.84)	2.40	2.56	2.12 (.72)	2.05	2.20	2.43 (.79)	2.35	2.51
C6	1.79 (.57)	1.73	1.84	1.58 (.53)	1.53	1.63	1.84 (.57)	1.78	1.89
C7	1.49 (.49)	1.44	1.54	1.63 (.53)	1.58	1.68	1.97 (.64)	1.91	2.03

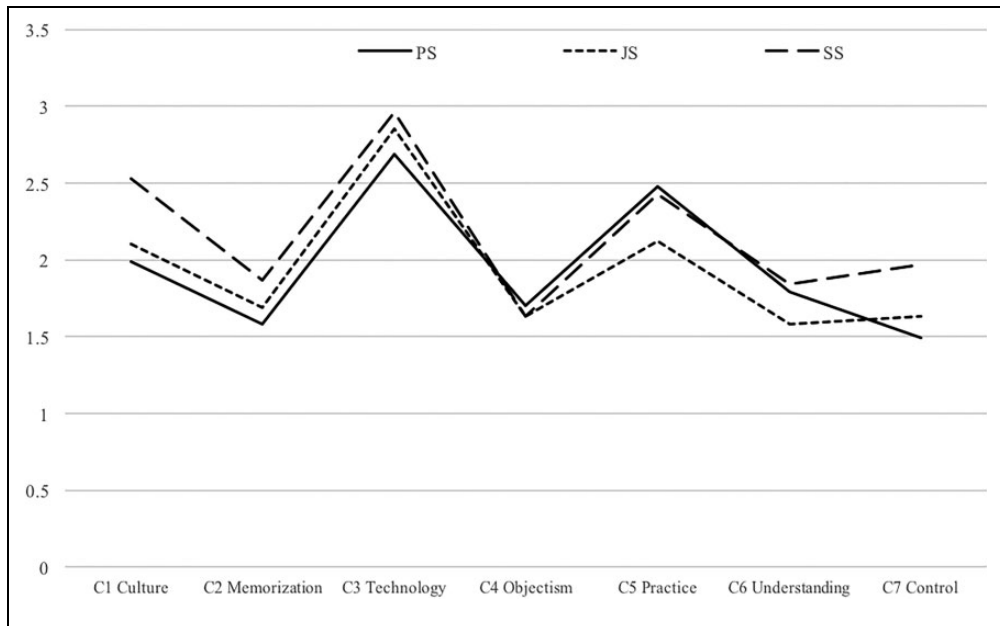


Figure 6. Mean scores of each component by group.

Figure 6 shows that although the different groups ranked the importance of the seven components slightly differently, in general, the participants valued objectism (C4) and understanding (C6), and then control (C7) and memorization (C2) most, and valued technology (C3), practice (C4), and culture (C1) less.

Descending order of importance degree in each group

The seven values embraced by the primary school students were, in decreasing order of importance, control (C7), memorization (C2), objectism (C4), understanding (C6), culture (C1), practice

Table 4. Paired samples *t*-test of primary school students.

	C2	C6	C5
C7	-3.49**		
C4	3.85**	-2.54*	
C1		8.45**	-12.46**
C3			3.47**

* $p < 0.05$. ** $p < 0.01$.

Table 5. Paired samples *t*-test of junior high school students.

	C7	C2	C5
C6	-1.89		
C4	.13	-1.78	
C1		14.14**	-.78
C3			13.77**

** $p < 0.01$.

(C5), and technology (C3). As shown in Table 4, there were statistical differences in the students' value scores for any two successive values in this chain.

Junior high school students attached high importance to understanding (C6), control (C7), objectism (C4), and memorization (C2), and all four were ranked as significantly more important than the subsequent three categories, as shown in Table 5. Further, culture (C1) and practice (C5) were significantly more important than technology (C3), the least important of the seven categories.

Senior high school students attached the most importance to objectism (C4), which was significantly more important than the next two most important, understanding (C6) and memorization (C2; see Table 6). However, understanding and memorization were significantly more important than all of the other components. In descending order of importance, the other components were control (C7), practice (C5), culture (C1), and technology (C3). There were significant differences between each successive pair. Although the order of importance was similar to that of junior high school students, there were more significant differences in the degrees of importance that senior high school students attached to the values. That is, senior high school students prioritized the first four categories, namely, C6, C7, C4, and C2, and two categories in the second half, namely, C1 and C5.

Table 6. Paired samples *t*-test of senior high school students.

	C6	C7	C1
C4	-6.96**		
C2	1.25	-3.25**	
C5		12.60**	-2.01*
C3			11.80**

* $p < 0.05$. ** $p < 0.01$.

Table 7. ANOVA of components for different groups.

Component		Sum of squares	df	Mean square	F	<i>p</i> Value	Post hoc	ω^2	1 - β
Memorization (C2)	Between groups	17.80	2	8.90	28.12	<.001	PS < JS, SS; JS < SS	.042	1.000
	Within group	395.47	1,250	0.32					
	Total	413.27	1,252						
Technology (C3)	Between groups	16.15	2	8.07	11.02	<.001	PS < JS, SS; JS<SS	.016	0.992
	Within group	915.91	1,250	0.73					
	Total	932.05	1,252						
Objectism (C4)	Between groups	1.53	2	0.76	1.73	.178			
	Within group	552.53	1,250	0.44					
	Total	554.06	1,252						
Understanding (C6)	Between groups	14.99	2	7.49	24.11	<.001	JS < PS, SS	.036	1.000
	Within group	388.59	1,250	0.31					
	Total	403.58	1,252						

Note. ANOVA = analysis of variance.

Differences in the importance of the seven components between the different school levels

An ANOVA with a Brown–Forsythe test was used to compare the importance of the seven dimensions across school levels.

According to the homogeneity of variance test, four components were homogeneous, including memorization (C2) ($p = .31$), technology (C3) ($p = .83$), objectism (C4) ($p = .07$), and understanding (C6) ($p = .95$). The results are presented in Table 7. For the other components, the results of the homogeneity of variance test were all heterogeneous; the p values of culture (C1), practice (C5), and control (C7) were all less than .001. Therefore, the Brown–Forsythe statistical method was used for a robustness test of mean equality (see Table 8).

There was a significant difference for all of components except objectism (C4), which was highly valued by all of the students. Details of the differences in the other six components are given below.

Table 8. Robust test for mean equality of components.

Component	F	df1	df2	p Value	Post hoc	ω^2	1 - β
Culture (C1)	72.72	2	1,186.28	<.001	PS, JS < SS	.103	1.000
Practice (C5)	24.69	2	1,239.30	<.001	JS < SS, PS; SS < PS	.036	1.000
Control (C7)	81.27	2	1,182.50	<.001	PS < JS, SS; JS < SS	.114	1.000

Although culture (C1) was not assigned very high importance in general, primary and junior high school students valued this dimension higher than senior high school students. There was no significant difference between primary school students and junior high school students.

Primary school students attached significantly more importance to memorization (C2) than junior high and senior high school students, and junior high school students attached significantly more importance to it than senior high school students.

The same phenomenon was found for the second set of components; that is, students attached less importance to technology (C3) as the learning level increased, and there was a significant difference between each pair in the three groups.

Although all of the groups assigned generally low importance to practice (C5), junior high school students attached significantly more importance to this component than either primary or senior high school students. In addition, senior high school students valued it significantly more than primary school students.

Although all three groups ranked understanding (C6) as important, junior high school students valued it more than the other two groups.

The perceived importance of control (C7) decreased as learning level increased; that is, primary school students attached significantly more importance to control than junior high school students, who attached significantly more importance to it than senior high school students.

Discussion

Values embraced by students in Eastern China

This study uses a PCA of the WIFI questionnaire responses of 1,253 primary, junior high, and senior high school students across Eastern China to identify seven student values: *culture* (C1), *memorization* (C2), *technology* (C3), *objectism* (C4), *practice* (C5), *understanding* (C6), and *control* (C7). It is worth noting that the identification of these values does not imply that the student participants value all of these attributes of mathematics education. If a set of items is consistently ranked as “least important” on the Likert-type scale, this indicates that the associated value is very much rejected by the questionnaire respondents. In this instance, however, all seven attributes are valued by the student

respondents. The seven values that are evident in the WIFI questionnaire analysis reflect the culture of Chinese mathematics education. In particular, *memorization*, *practice*, *objectism*, *understanding*, and *control* are emphasized in traditional Chinese mathematics education, whereas the other two values (i.e., culture and technology) have only been emphasized since the curriculum reform in 2000.

The cultural nature of mathematics has been highlighted in the various Chinese mathematics curriculum standards produced since 2001. For example, in the “introduction” to the 2001 curriculum (MOE, 2001), mathematics is referred to as one of humankind’s cultures. Also, the key components of mathematics culture are viewed as contentment and the conceptualization, method, and language of mathematics. In the revised edition of curriculum standard (MOE, 2012), mathematics is not only regarded as an important component of modern civilization but also closely related to human development and societal advances, with wide-ranging applications in production, daily life, humanities, and the social sciences. Similar references to the mathematics discipline are found in the new senior secondary syllabus (MOE, 2017).

Technology has also been increasingly emphasized in curriculum revisions, in line with global technological growth. The post-2001 editions of the Chinese mathematics curriculum standards not only emphasize the bridging of technology and mathematics curricula but also promote the application of technology in mathematics teaching.

A characteristic of traditional Chinese mathematics education has been a focus on the two basics (basic knowledge and basic skills). In this regard, memorization is valued for its contribution to “understanding through memorization” (Zhang, 2006, p. 3). Practice is also emphasized for the above reasons. This cultural trait is best illustrated by the phrase “Practice makes perfect” (in Chinese: 熟能生巧) (Li & Huang, 2006).

The valuing of *objectism* (see Bishop, 1988b) in Chinese mathematics education is often demonstrated through the use of specific examples and visualizations, which is in line with the belief that Chinese culture advocates understanding things through “drawing inferences about other cases from one instance” (in Chinese: 举一反三). *Objectism* is also embodied in the belief in “learning from mistakes.” Although teachers may often select “standard” questions for explanation or demonstration, students—especially secondary school students in this study—are commonly seen recording and analyzing their errors in their notebooks which are sometimes named as corrections book, as shown in Figure 7.

Although learners’ deep understanding of mathematics has been a feature of traditional Chinese mathematics education, the facilitation of students’ understanding has developed over time. This has involved the use of justifications and proofs to structure students’ understanding, the use of mathematical language to provide students with opportunities to explore the abstract nature of the discipline, and the use of investigative activities to strengthen students’ rationalizing processes.

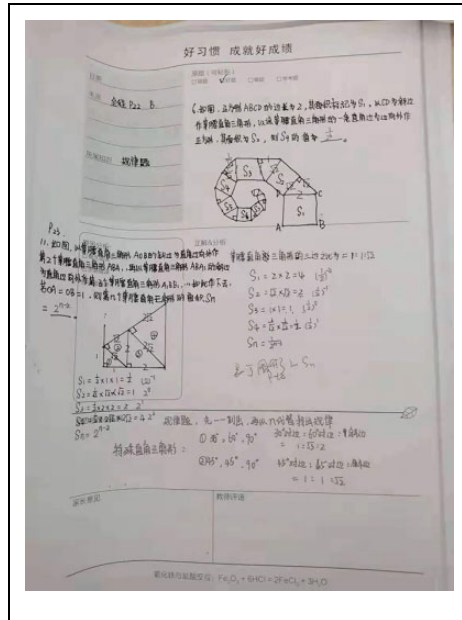


Figure 7. One typical page from a corrections book.

The “authoritative master” role of the teacher has been an important component of Chinese mathematics education, reflecting the valuing of control. In the 1950s, the teaching profession in China embraced a pedagogy represented by the slogan “lecture well, practice lots” that was based on the transmission model. It came to be regarded as a principle for improving mathematics teachers’ professional practice (Wang, 2005). Classrooms that took on board this slogan are characterized by teachers offering accurate and clear explanations, and by students’ extensive practice.

Students’ valuing across grade levels

The above analyses (summarized in Table 3) suggest that students in different school grades do not have the same relative values in mathematics learning. A comparison of the three groups’ ranking of the seven components shows that students in all levels rank C2, C4, C6, and C7 as the most important values and C1, C3, and C5 as the least important values. Accordingly, we can divide the seven values into two categories. The internal order of the values in the two categories varies between different education levels. Junior high school students see no significant difference between the four values in the first category or between the fifth and sixth values in the second category. In other words, at the junior high school level, students’ values are changing, and the perceptions of the relative importance of the components are rather vague. In contrast, both primary and senior high school students clearly distinguish between important and unimportant values. Therefore, it can be seen that the perceived importance of values switches between primary

school and senior high school. Specifically, the emphasis on memorization and control among primary school students shifts to an emphasis on objectism and understanding in high school students. The importance of technology declines as grade level increases, and the value of practice increases slightly. Thus, it seems that the junior high school years (about 11–14 years old) represent a crucial transition period in this development. This insight adds to our understanding of the significance of the middle years of schooling (van den Berg et al., 2014).

Emerging phenomenon of “primary-to-secondary pressure” in the Chinese education system

Although the attributes of *memorization* (C2) and *control* (C7) are valued by all of the student participants, they are especially valued by primary school students, which is consistent with the findings of Zhang (2019). This may be surprising given the well-recognized intense competitiveness and study pressure associated with the pre-tertiary standardized *Gaokao* examinations during senior high school (Wang, 2001). However, our findings reflect a recent phenomenon of increasingly strong pressure on primary school students to achieve admittance to prestigious and “good” high schools. This phenomenon is called “primary-to-secondary pressure” (in Chinese: 小升初压力).

Despite the government’s best efforts to provide standardized high-quality education across regions in Chinese mainland, it will be some time before this is an on-the-ground reality given the size and diversity of the country. Therefore, there is a short-term imbalance in the supply and demand of high-quality education. Furthermore, the implementation of a district enrolment policy for public schools with compulsory education makes parents focus on gaining admittance to a few high-quality private schools, which increases competition between families with children in the final years of primary schooling.

According to Fan and Zhang (2017) and Yu (2011), the “primary-to-secondary pressure” phenomenon has also been fueled by a relative lack of specificity in the standards of the relevant examinations compared to those of the *Zhongkao* and *Gaokao* exams. This inevitably increases the pressure on parents. Out-of-school tuition programs have become increasingly popular, as parents attempt to provide the best opportunities for their children to successfully enroll in the “good” schools. Such anxiety is often felt by the primary school students, with some children claiming that the experience has made them feel they have aged (Yu, 2011).

In these contexts, *memorization* and *control* are highly valued, even in the out-of-school tuition programs. An investigation of the effects of cram schools on children’s mathematics learning (Huang, 2004) found that cram schools have a positive impact on students’ computation skills, homework completion, and self-confidence in mathematics but a negative impact on understanding mathematical concepts. The teacher participants explained this as a result of the different teaching

strategies: “Cram schools place emphasis on ‘shortcut’ and ‘effectiveness,’ and focus solely on producing the correct answers to problems rather than exploring the systematic structure of mathematics concepts” (Huang, 2004, pp. 296–297). It thus appears that future reform plans should consider the roles of values and valuing in mathematics learning and should design pedagogical activities that inculcate the prioritizing of enabling values.

The students’ valuing of *culture* and *technology* seems to erode as grade level increases, which is probably related to the demands of mathematics at the different grade levels. At the primary level, where the content is not very deep, teachers can find more opportunities to harness technology and to incorporate more learning activities that embody the cultural nature of the mathematics discipline. Nevertheless, there is scope for further research on the extent to which attributes such as culture and technology impact the effectiveness of mathematics learning.

The students’ valuing of *practice* is also generally weak. This may be related to how mathematics schoolwork is designed and to students’ affective dispositions toward such schoolwork. Ren’s (2015) study, for example, showed that mathematics homework at primary, junior high, and senior high school levels in Chinese mainland suffered from issues such as excessive length, monotonous designs, “dry” and uninteresting content, overemphasis on teacher bulk marking, and weak student interest. In particular, the phenomenon of teacher bulk marking might explain why student respondents to the questionnaire emphasized “teacher helping me individually” (Q41) as an important component. Thus, there is a need for research into improving the form and content of mathematics homework to increase students’ interest and thereby boost study effectiveness.

This study also shows that the student respondents emphasize *objectism*. From the perspective of students’ mathematics learning, it is easy to understand why *objectism* is valued by students. The abstractness of mathematics makes it difficult for students to learn, while concretization provides a scaffold for students’ understanding of mathematics. Valuing *objectism* is also evident in Chinese traditional culture. In Chinese culture, it is very important to learn through examples, and to “understand by analogy” (in Chinese: 触类旁通) and “draw inferences about other cases from one instance” (in Chinese: 举一反三).

Understanding is another component that is highly valued by all students, especially juniors. The Chinese mathematics curriculum standard in the 21st century encourages students to think actively in mathematics learning, use mathematics thinking, and develop the traditional “Two Basics” (i.e., basic knowledge and basic skills) into the “Four Basics” (the two basics plus basic thinking modes and basic activity experiences), which require students to have a deep understanding of mathematics. In addition, building on Ma’s (1999) research on primary school teachers in Shanghai, it emphasizes the understanding of mathematical concepts. Ma’s study found that Shanghai teachers were more focused on conceptual teaching strategies, which emphasized teaching through explaining mathematical concepts.

Conclusion

The research activities reported in this article were part of a larger study that investigated the differences in the valuing of teachers and students and the potential for conflict of these differences. To achieve this, a PCA was used to identify the seven value components of a sample of students from all grade levels. The PCA was not applied separately to each grade-level sample. This methodology does not allow for a complete picture of what students at different stages of schooling value in their mathematics learning. Our findings therefore need to be understood in context, and future studies may want to use sample of only primary or secondary students, as in Zhang et al. (2016).

Nevertheless, this study's use of the WIFI questionnaire showed that Eastern Chinese students valued *culture*, *memorization*, *technology*, *practice*, *objectism*, *understanding*, and *control* in their mathematics learning. This insight will be invaluable to teachers and educators as they reflect and review their mathematics teaching approaches to promote greater student engagement, understanding, and performance. Not only did students at different levels of schooling value all seven attributes (albeit to different degrees), but students' progress through the grade levels also affected the degree to which each of the seven attributes was valued. In particular, we found that the junior high school years represented an important transition period in students' valuations. This period appeared to witness a transformation of students' valuations from one stable state (in the primary school) to another stable state (in the senior high school). This is also the time when the students are undergoing adolescence and the associated physical, psychological, and emotional changes.

In particular, the emerging "primary-to-secondary pressure" phenomenon in the final primary school year is embodied through students' increasing valuing of attributes such as *memorization* and *control*. This knowledge should contribute to our understanding of students' experience at this stage of their schooling, and of how we might facilitate students' well-being. The findings are also timely, given that this knowledge of what students generally value in their mathematics learning experiences would help us to better plan for any inculcation of 21st century competencies through mathematics education.

China is a large country with widely varying landscapes. While the focus of this article has been on mathematics students studying in Eastern China, we believe that students from schools elsewhere in China, and elsewhere around the world for that matter, would value different attributes of mathematics education. By developing a portrait of what students in Eastern China value in their mathematics learning, this article positions us in a great opportunity to plan for and conduct future research which examines the similarities and differences between what students in different cultures (understood broadly) value, and what this knowledge might mean.

Contributorship

Hengjun Tang was responsible for writing the abstract, the bulk of the main body, finalizing the paper and responding to the reviewers' comments. He covered various aspects of the paper including the collection and

analysis of WIFI data, as well as the interpretation of Chinese students' values in math learning from a Chinese cultural perspective. Wee Tiong Seah developed the WIFI questionnaire based on English literature, participated in the translation between English and Chinese versions of the questionnaire, participated in the writing of data analysis and discussion part, and polished the text of the paper. Based on the Chinese and English literatures, Qiaoping Zhang wrote the introduction part of the paper, participated in the revision of the data analysis and discussion part, and polished the text of the paper. Based on the Chinese literature, Weizhong Zhang identified the values of Chinese students in mathematics learning, and participated in the revision of the whole paper.

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References

- Andersson, A., & Oüsterling, L. (2019). Democratic actions in school mathematics and the dilemma of conflicting values. In P. Clarkson, W. T. Seah, & J. S. Pang (Eds.), *Values and valuing in mathematics education* (pp. 25–52). Springer Nature Switzerland.
- Bartlett, M. S. (1950). Tests of significance in factor analysis. *British Journal of Psychology*, 3, 77–85.
- Bishop, A. J. (1988a). *Mathematical enculturation: A cultural perspective on mathematics education*. Kluwer.
- Bishop, A. J. (1988b). Mathematics education in its cultural context. *Educational Studies in Mathematics*, 19(2), 179–191.
- Bishop, A. J. (1996). *How should mathematics teaching in modern societies relate to cultural values—Some preliminary questions* [Paper presentation]. Seventh Southeast Asian Conference on Mathematics Education, Hanoi, Vietnam.
- Carr, M. E. (2019). Student and/or teacher valuing in mathematics classrooms: Where are we now, and where should we go? In P. Clarkson, W. T. Seah, & J. S. Pang (Eds.), *Values and valuing in mathematics education* (pp. 25–52). Springer Nature Switzerland.
- Chen, J. (2013). Curriculum and instruction design principles for promoting learning with understanding. *Global Education*, 42(1), 53–61.
- Davis, E. K., Carr, M. E., & Ampadu, E. (2019). Valuing in mathematics learning amongst Ghanaian students: What does it look like across grade levels? In P. Clarkson, W. T. Seah, & J. S. Pang (Eds.), *Values and valuing in mathematics education* (pp. 89–102). Springer Nature Switzerland.
- Emmer, M. (2005). *Mathematics and culture II*. Springer.

- Fan, L., Wong, N. Y., Cai, J., & Li, S. (Eds.). (2004). *How Chinese learn mathematics: Perspectives from insiders*. World Scientific.
- Fan, L., Wong, N. Y., Cai, J., & Li, S. (Eds.). (2015). *How Chinese teach mathematics: Perspectives from insiders*. World Scientific.
- Fan, L., & Zhang, P. (2017). Reduce the burden must be from “primary-to-secondary schooling” [in Chinese]. *Wenhui Newspaper*, 2–10.
- Feng, C. (2014). An analysis of basic education in Zhejiang from PISA: Based the data of Zhejiang students in PISA 2012 [in Chinese]. *Zhejiang Education Science*, (5), 3–8.
- Guo, X. (2016). Practical strategies for understanding learning: From the perspective of philosophical hermeneutics [in Chinese]. *Global Education*, 45(2), 41–49, 128.
- Hill, J., Hunter, J., & Hunter, R. (2019). What do Pasifika students in New Zealand value most for their mathematics learning. In P. Clarkson, W. T. Seah, & J. S. Pang (Eds.), *Values and valuing in mathematics education* (pp. 103–114). Springer Nature Switzerland.
- Huang, H. M. (2004). Effects of cram schools on children’s mathematics learning. In L. Fan, N.-Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 282–306). World Scientific Publishing.
- Kaiser, H. F. (1970). A second generation little Jiffy. *Psychometrika*, 35, 401–416.
- Lerman, S. (2006). Cultural psychology, anthropology and sociology: The developing ‘strong’ social turn. In J. Maasz & W. Schloeglmann (Eds.). *New mathematics education research and practice* (pp. 171–188). Sense.
- Leung, F. K. S. (2006). Mathematics education in East Asia and the West: Does culture matter? In F. K. S. Leung, K. D. Graf, & F. J. Lopez-Rea (Eds.), *Mathematics education in different cultural tradition* (pp. 21–46). Springer Science+Business Media.
- Li, S., & Huang, X. (2006). Practice makes perfect is one way to a strong two-basics [in Chinese]. In D. Zhang (Ed.), *Two-basic teaching in Chinese mathematics education* (pp. 230–240). Shanghai Educational Publishing House.
- Ma, L. (1999). *Knowing and teaching elementary mathematics*. Lawrence Erlbaum Associates.
- Ma, Z., Li, J., & Wu, D. (2018). Explore the happiness path of balanced development of urban and rural areas in Zhejiang [in Chinese]. *Ifeng.com*. http://news.ifeng.com/a/20180720/59299004_0.shtml
- Ministry of Education of the People’s Republic of China [MOE]. (2001). *Mathematics curriculum standard for compulsory education stage (experimental version)* [in Chinese]. Beijing Normal University Press.
- Ministry of Education of the People’s Republic of China [MOE]. (2012). *Mathematics curriculum standard for compulsory education stage (2011 edition)* [in Chinese]. Beijing Normal University Press.
- Ministry of Education of the People’s Republic of China [MOE]. (2017). *Mathematics curriculum standard for senior secondary education stage (revised edition)* [in Chinese]. Beijing Normal University Press.
- OECD. (2018). *The future of education and skills 2030*. OECD Publishing. [https://www.oecd.org/education/2030/E2030%20Position%20Paper%20\(05.04.2018\).pdf](https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf)
- Penk, C., & Schipolowski, S. (2015). Is it all about value? Bringing back the expectancy component to the assessment of test-taking motivation. *Learning and Individual Differences*, 42, 27–35.

- Perkins, D. N., & Unger, C. (1999). Learning and teaching for understanding. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 91–114). Lawrence Erlbaum Associates.
- Quirk, B. (2013). The “Parrot Math” attack on memorization. *Nonpartisan Education Review*, 9(1), 1–2.
- Ren, B. (2015). A survey on students’ homework in five provinces in China [in Chinese]. *Educational Science Research*, (12), 49–56.
- Seah, W. T. (2019). Values in mathematics education: Its conative nature, and how it can be developed. *Research in Mathematical Education*, 22(2), 99–121.
- Seah, W. T., & Wong, N. Y. (Eds.). (2012). Values in East Asian mathematics education: The third wave. *ZDM*, 44(1).
- van den Berg, G. J., Lundborg, P., Nystedt, P., & Rooth, D. O. (2014). Critical periods during childhood and adolescence. *Journal of the European Economic Association*, 12(6), 15–21.
- Wang, Y. (2001). A study on *Gaokao* pressure of grade 12 students and their personality [in Chinese]. *Journal of Psychological Science*, (1), 104–105.
- Wang, Y. (2005). My understanding on “explain accurately, practice more” [in Chinese]. *Journal of Mathematics (China)*, (3), 19–20.
- Watkins, D. A., & Biggs, J. B. (Eds.) (1996). *The Chinese learner: Cultural, psychological and contextual influences*. Comparative Education Research Centre & Australian Council of Educational Research.
- Watkins, D. A., & Biggs, J. B. (Eds.) (2001). *Teaching the Chinese learner: Psychological and pedagogical perspectives*. Comparative Education Research Centre & Australian Council of Educational Research.
- Wong, N. Y., Han, J. W., & Lee, P. Y. (2004). The mathematics curriculum: Towards globalization or westernization? In L. Fan, N. Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 27–70). World Scientific.
- Xu, F. (2014). Preliminary exploration of learning-centered classroom characteristics and basic teaching styles in junior high school mathematics classes [in Chinese]. *Curriculum, Teaching Material and Method*, 34(5), 53–57.
- Yu, Z. (2011). The child says: For “primary-to-secondary schooling”, feel oneself old [in Chinese]. *Workers’ Daily*, 2–17.
- Zhang, D. (2006). Theory framework of two-basics teaching in Chinese mathematics education [in Chinese]. In D. Zhang (Ed.), *Two-basics teaching in Chinese mathematics education* (p. 3). Shanghai Educational Publishing House.
- Zhang, Q. (2017). Mathematical competencies in western mathematics education: Comparison and prospect [in Chinese]. *Global Education*, (3), 29–44.
- Zhang, Q. (2019). Values in mathematics learning: Perspectives of mainland China primary and secondary students. In P. Clarkson, W. T. Seah, & J. S. Pang (Eds.), *Values and valuing in mathematics education* (pp. 185–196). Springer Nature Switzerland.
- Zhang, Q., Barkatsas, T., Law, H. Y., Leu, Y. C., Seah, W. T., & Wong, N. Y. (2016). What primary students in the Chinese mainland, Hong Kong and Taiwan value in mathematics learning: A comparative analysis. *International Journal of Science and Mathematics Education*, 14(5), 907–924.
- Zhao, H. (2018). Transitions and prospects of the role of teaching and research staff in China [in Chinese]. *Curriculum, Teaching Material and Method*, 38(10), 111–116.