EXPLORATION OF ELEMENTARY AND SECONDARY MATH EDUCATION IN CHINA

A CAPSTONE PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF EDUCATION

IN

SECONDARY EDUCATION

COLLEGE OF PROFESSIONAL STUDIES

HAWAI`I PACIFIC UNIVERSITY

SPRING 2020

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Abstract

This study investigated the factors that have been driving excellent performance of Chinese students in elementary and secondary math education. Factors extracted from the literature review included a systematic math curriculum implemented in early grade levels, a well-trained teacher workforce, determined parental support, and linguistic advantages. These factors represented the point of views of educators and professional researchers, but the students' perceptions of their learning experience were rarely included. The purpose of this study was to explore students' opinions regarding their elementary and secondary math learning experience in China. Using a mixed method research design, an electronic survey was conducted, to confirm the factors discovered in the literature review and to uncover any other relevant factors perceived by adults who had completed their elementary and/or secondary math education in China. Convenience sampling and snowball sampling strategies were applied in the survey to collect qualitative data, including two open-ended questions that allowed participants to express additional thoughts. Highlighted findings from the survey were: a significant preference for the importance of a well-designed math curriculum and students' self-determination in math learning. In addition, the survey data presented the participants' expectations for possible improvements in the current Chinese math education curriculum.

Keywords: elementary and secondary math education, China, math curriculum, teacher workforce, parental support, linguistic advantages, self-determination and effort

Exploration of Elementary and Secondary Math Education in China

The World Bank complimented Shanghai education for being topped in two consecutive rounds of the Programme for International Student Assessment (PISA) tests in all assessed subjects (Mena Report, 2016). The performance of Shanghai education would be considered as the top representation of the current education in China because Shanghai is the largest city of China by its population and it has been the economic and foreign affairs center of China for decades. In addition, the most recent PISA reports showed the Chinese students from several cities and provinces had been ranked at the top consecutively since they participated the PISA assessments in 2000s (PISA 2015 Results in Focus, 2018; PISA 2018 Insights and Interpretations, 2019). Meanwhile, on the score board of the well-known international mathematical competition, International Mathematical Olympiad (IMO), the Chinese students has accumulated the most gold awards among their peers since 1985 (Cumulative Results by Country, 2019). Although most of the IMO participants were high school students, and the PISA assessed the fifteen-year-olds, mathematical learning is always a cumulative journey, which necessitates long-term educational contributions. The IMO and PISA results not only demonstrated the mathematical performance of a specific age group, but it also provided evidence of the students' achievement of foundational elementary and secondary math education outcomes. Moreover, the IMO teams were assembled by selected students who represented the highest standards of each country, while the PISA assessed relatively large proportion of the student population of each country, indicating that both high achieving Chinese students and average achieving Chinese students performed well in math. Thus, an interesting research topic would be to explore the major aspects of Chinese elementary and secondary math education that nurtured students' strong mathematical fundamentals.

Statement of the Problem

Since Chinese students have been outperforming in math, inquiring into the factors that contribute to the general Chinese students' math learning is crucial that may benefit students, teachers, and schools worldwide. Math learning is a sequential journey immersed day-to-day learning activity in elementary and secondary education. Isolating either elementary or secondary math education would not provide the complete picture of the math learning journey. Therefore, this study explored both elementary and secondary math education in China.

Review of the Literature

With plenty of curiosity and tons of personal experience, I devoted my attention to the relevant literatures on the subject with an emphasis on excavating the alignment of elementary and secondary math education in China as well as the globalized comparisons of elementary and secondary math performance. Furthermore, the extended objectives of the literature review were to find the outperformance's roots of math education in China. Just as expected, there were already many valuable research studies that had elaborated the explorations on similar topics with international comparisons. For instance, Yuen and Fong (2012) believed that "the achievement of excellent performance is not only the result of individual abilities and efforts but also the collective support from interactive components within the system" (p. 119). The book, *How Chinese Learn Mathematics*, laid out facts and insights about Chinese math education that drove the students' excellent performance over decades in large-scale and in most of the international comparisons (Fan, et al., 2004). In addition, Wang and Lin (2005) did an in-depth literature review about factors that contributed to mathematic learning, including formal schooling, teacher related factors, family values in education, and language-related factors, etc. In total, the abundant literatures could be categorized into four domains: a systematic math curriculum implemented in early grade levels, a well-trained teacher workforce, determined parental support, and linguistic advantages.

Systematic Math Curriculum Implementing in Early Grade Levels

Wong et al. (2012) developed research about the traditional Chinese values, e.g. Confucianism, Daoism, and Buddhism, in math education. The study indicated that "mathematics was not held in high regard" in Chinese traditional values and the mathematics education was only emphasized in arithmetic (p.16). However, Chinese education system reformed after the WWII and completely converted into a western style curriculum. As Cai & Nie (2007), pointed out, "during the period of 1949-1957, the Chinese mathematics education was adopting the Soviet mathematics curriculum" (p. 459). They also observe that not only was the curriculum changed, but also "the three critical properties of mathematics in Soviet school mathematics, rigorousness, abstractness and application, influenced greatly the development of Chinese school mathematics curriculum" (p. 459). Finally, they noted that the pedagogy of "the tradition of integrating mathematical problems into the school curriculum extends to the present" (p. 459). This would be the initiation of the modern China math education.

Being different from the current western style curriculum, Chinese elementary and secondary schools consist of the rigorousness and systematic curriculum since early grade levels. Sun and Zhang (2001) found that Chinese schools do not wait, and Chinese teachers introduced mathematical strategies "as early as first grade" because they believed that "if the foundation is laid early, students can apply their knowledge of the basic facts and these strategies to other mathematical content that they will study later" (p. 24). Even more than that, Li et al. (2018) did quantitative study and found the recent Chinese students started math education as early as preschool with relatively high-quality curriculum. "According to the UK's Institute of Fiscal

Studies, children with high maths scores at age ten earn seven per cent more aged 30 than those with lower scores" ("Teach in maths exchange visit to China," 2014, p.32). Chinese teachers also mentioned that teachers should guide students more in lower grade than in higher grade (Correa, et al., 2008). Another reason of the systematic math curriculum starts in the early grade levels was that schools and teachers believed that the early age mathematical development would predict the higher grades math achievement and development (Anders, et al., 2012). All of these values and beliefs have been insisted in the current math curriculum in China.

Well-trained Teacher Workforce

As Meng et al. (2016) noted, "teachers matter the most when it comes to student learning" (p. 461). Both Chinese and western researchers have been attracted by the teacher effectiveness in recent years (Meng, et al., 2016). Researchers commonly agreed that a well-trained teacher workforce had been an important factor that contributed to Chinese math education. As Correa et al. (2008) pointed out, "teachers are a product of their culture and experiences" (p. 152) and "teachers develop culturally shared ideas about what good teaching and learning look like even before they begin their teaching careers" (p. 141). An et al. (2004) found that, "the Chinese teachers emphasized developing procedural and conceptual knowledge through reliance on traditional, more rigid practices, which have proven their value for teaching mathematics content" (p. 145). Correa et al. (2008) added that Chinese teachers "value the strategy of using mathematics examples from real life" (p. 146). Finally, Wong & Lin (2005) observed that "Chinese students' mathematics performances are assumed to be related directly to their teachers' deep mathematics understanding and ability to represent concepts flexibly in their classrooms, which, in turn, are thought to be influenced by Chinese mathematics curriculum and policies" (p. 3). Thus, starting from elementary schools, "most of Chinese first-grade mathematics teachers in this study mentioned the importance of developing student interest and believed they were responsible for developing their students' interest in mathematics" (Correa, et al., 2008, p. 145).

In the research of math teachers' pedagogical content knowledge, An et al. (2004) mentioned, "Chinese teachers connected concrete models and stories related to a student's life more frequently" (p. 163). Meanwhile, the PISA report indicated that "one of the most impressive aspects of Shanghai's education system is the way it grooms, supports, and manages teachers, who are central to any effort to raise the education quality in schools" (Mena report, 2016).

Since teachers are important assets of the education system, how teachers have been trained and prepared matters the most. Chinese teacher training programs have been dedicated developed and upgraded throughout recent decades.

Table 1

Stages of Elementary and Secondary Teacher Preparation Programs

Stage	Type of institution	Admission	Diploma	Program Durance	Active years
1	Normal schools	Middle school graduates	Intermediate-level diploma	3 years	Late 1970s - late 1990s
2	Junior normal colleges	Middle school graduates & high school graduates	Advanced-level diploma	Middle school graduates: 5 years; High school graduates: 3 years	Mid 1980s
3	Normal or comprehensive universities	High school graduates	B.A. or B.Sc.	4 years	Since 1998

Note. This table was summarized from the research of Mathematical preparation of elementary teachers in China: changes and issues (Li, et al., 2008). It displays the stages of the teacher preparation programs in China. As the above research found, elementary math teacher preparation programs in China have been rigorous and simultaneously upgraded with the demand in education. The sustainability of excellent math teaching in China has been ensured by the well-trained teacher workforce.

Determined Parental Support

The traditional Chinese values, Confucianism, Daoism, and Buddhism, had great influence in parental support in education (Wong, et al., 2012). "In general, the studies relevant to family values and processes suggest that Chinese parents set higher expectations for their children's mathematics achievement, engage their children in working more on mathematics at home, and use formal and systematic instructional approaches at home. Exposure to these family values and processes appears to produce children's synergism with parental expectations and may lead to higher general mathematics achievement. Similar family values and processes were also found in Chinese American families" (Wang & Lin, 2005, p. 9). Therefore, "teacher, and parent attitudes toward mathematics revealed significant differences in what it meant to be a successful student in mathematics" (Correa, et al., 2008, p. 142).

The parental role in mathematical education is crucial. Pan et al. (2018) observed, "parental beliefs on the importance of early math learning had suppressing effects on the relationship between family SES and home math activities" (p. 60). In the Chinese education system, parents value math learning as the top priority among all of the academic subjects. Even after they immigrate to other countries, they still strongly support their children in math learning. For example, 5 out of 6 the U.S. IMO team members were Chinese background students indicating by their Chinese family names (USA at IMO 2019, 2019).

Linguistic Advantages

Fourthly, many internationally comparative evaluations indicated that the Chinese language offers linguistic advantages in mathematical teaching and learning. Linguistic advantages in math learning were not obvious from the students' perspectives, but professional researchers found that children's linguistic development, especially the spoken language had great impacts on children's cognitive development (Miura, et al., 1994). Han and Ginsburg (2001) observed that, "language is used to define mathematical concepts and to express mathematical ideas, and it can facilitate connections among different representations of mathematical ideas" (p. 202). Han and Ginsburg (2001) also gave us many mathematical terminologies that demonstrated the linguistic advantages of Chinese in math learning, e.g. quadrilateral refers "four-sided figure" in Chinese, which clearly illustrates the characteristics of the shape. They further noted:

> Native Chinese speakers generally agree in their judgements that most Chinese mathematical words state their meaning clearly. Native English speakers find it hard to agree on whether English (often really Greek or Latin) mathematical words are clear or not clear and, in general, rate the words as less clear than Chinese judges rate Chinese words (p. 210).

Mark and Dowker (2015) indicated another "linguistic characteristic that could influence children's mathematics learning is the way in which numbers and arithmetical relationships are expressed in the counting system" (p. 1). The Chinese counting system was created on base ten, which "directly mapped onto Arabic numbers," and has great advantages in learning math compared to English numbers, which contained "three forms of ten (*ten, -teen, and -ty*)" that did not "align with the Arabic numbers" (p. 2). Mark and Dowker (2015) "demonstrated that young children who were learning mathematics in Chinese were better at manipulating the number line than those learning mathematics in English" (p. 8). Lim and Presmeg reported the dilemma in Malaysian math education that teachers found very challenging to teach math in English, especially to the low performance students (2011). For the elementary and secondary level math, teaching and learning in Chinese showed tremendous advantages.

Statement of Hypothesis

Drawing from the literature review, in China, a systematic math curriculum implementing from early grade levels, a well-trained teacher workforce, determined parental support, and linguistic advantages had contributed to the effective and efficient elementary and secondary math education. It was an interesting fact that most of the exiting research proceeded from the educators or professional researchers' point of views. The students' perceptions about the education, especially about the math education, were rarely included. A survey to validate the factors extracted from the literature reviews from the students' point of view appeared to be relevant and meaningful. Furthermore, a survey might provide the participants an opportunity to share their personal experience regarding elementary and secondary math education in China.

Method

Participants

Forty participants were planned in this study (N=40). Since China has implemented nationwide unified compulsory education for decades, the 40 participants were capable to representing the majority population of Chinese adults who had earned their elementary and/or secondary math education in China. Even though some characteristics may have had impact on the personal experience of education, e.g. current geographic location, sex, socioeconomic status, or racial group, this study only collected the age group and years of education earned in China as the most relevant demographic data for this analysis.

Sampling Procedures

Convenience sampling and snowball sampling strategies were applied in the survey to collect qualitative data. Due to the free version of electronic survey platform (see details about the selection of survey platform in the Research Design section) only offered a 40-respons allowance, the sampling procedures were designed to proceed with convenience sampling for the first around, and then snowball sampling to fulfill the rest of the forty responses allowance as the second round.

Convenience sampling

Technology has reformed people's communication globally. Chinese people's communication has been influenced by the technology development. Instead of phone calls or emails, Chinese people rely on social media to keep in touch with each other in recent years. WeChat has been the dominant social media platform of Chinese society since 2012. This study's survey was initiated from the contact list on WeChat to reach the qualified participants. The participants received the survey link via the WeChat message function. About 20 to 30 possible participants were planned to be reached for the first around sampling. As it turned out, 29 participants were reached and all of them participated and completed the survey within two days.

Snowball sampling

After the convenience sampling procedure, the participants were asked to share the survey link to additional participants via WeChat message function from their contact list. An additional 11 responses were received within another two days during the snowball sampling procedure for the second-round survey distribution.

In summary, the survey was concluded in 4 days with 40 completed responses. The respond rate of the first around of sampling was 100%, but it was impossible to calculate the snowball sampling response rate from the researcher's side. The possible sampling biases were: the majority of the participants' age group was similar to the researcher's age group because of the nature of convenience sampling; most of the participants grew up and were educated on the east coast of China which provided sufficient, updated, and diverse educational resources to children, and all of the participants were connected via WeChat, which indicated the participants were capable of accessing the internet and social media platforms.

As approved by the internal review board (IRB) of Hawaii Pacific University (HPU), the survey participants granted their consent at the first page of the electronic survey (Appendix A). The consented participants continued and completed the survey while having the freedom to withdraw from this survey at any time without any consequence. Participants provided their unidentifiable profile information in order to give the researcher demographic data to run the analysis. Nevertheless, the majority of the survey was focus on the participants' math education experience and outcomes. The survey was confidential. The data was stored and analyzed at the Survey Monkey platform (see details about the selection of survey platform in the Research Design section) protected by researcher's login credentials. The data generated from this study would not be used for future studies or secondary analyses. All of the data was planned to be erased permanently to protect participants' privacy and confidentiality by the end of July, 2020. There were no known risks, state, or foreseeable risks to participate in this survey. There was no personal benefit for participating in this study. However, it was hoped that in the future, society could benefit from the findings of this study. There were not any costs to the subject for participating in this research project. Subjects were not be compensated for their time and inconvenience for participating in this research project. Results were reported in a summarized manner in such a way that subjects could not be identified. All participation was voluntary.

There was no penalty to anyone who decided not to participate. Nor was anyone be penalized if he or she decided to stop participation at any time during the research project.

Measures

The electronic ten-question survey was created by the researcher, including two open-ended questions that allowed participants to express additional thoughts. The ten-question design was the maximum allowance for the free version on the electronic survey platform. The survey was conducted under the ethic code of confidentiality in order to offer the best way to elicit honest and candid responses from the participants.

Question #1: What's your age group?

This question was designed to analyze the participants' age grouping. The options were: 18-22, 23-25, 26-30, 31-40, 41-50, 51 and above. The 18-22 was the undergraduate student age group, the 23-25 was the graduate student or newly employed age group, the 26-30 was the young adult age group, the 31-40 was the mature adult age group, the 41-50 was the middle aged group, and the 51 and above was the Chinese baby boomer age group (1950s-1960s). Additional analyses of this question's responses with the other questions' responses will be discussed in the result section to see if there is any relationship between the age grouping and the respondent's personal experience.

Question #2: How many years of elementary and/or secondary education have you earned in China?

This question was designed to determine the participants' degree of influence by the Chinese elementary and/or secondary education system. The options were: 6 years and more, 4-5 years, 1-3 years, and under 1 year. Participants who chose the 6 years and more option were the people who were strongly influenced by the Chinese education system and had the most experience throughout the Chinese education system. Participants who chose 4-5 years option were the people who had been moderately influenced by the Chinese education system. Participants who chose 1-3 yeas were the people who had been mildly influenced by the Chinese education system. Participants who chose under 1 year were the people had been slightly influenced by the Chinese education system. Additional analyses of this question's responses with the other questions' responses also will be discussed in the results section to see if there is any relationship between the degree of influence by the Chinese education system and the personal opinions expressed by the respondents.

Question #3: If math was not a required subject, would you be willing to choose math to learn?

Since math has been a required subject in Chinese elementary and secondary education, students have no choice but have to take math as a main subject with intensive learning and testing. This question was designed to let participants re-think whether they wanted to take math as a subject to learn. The options were: Yes, No, and Not sure.

Question #4: Did you ever try your best to learn math well?

This question was designed to examine the participants' effort level in learning math. The options were: I tried very hard, I put the similar effort in math as other subjects, and I did not try hard.

Question #5: What's your most important motivation to learn math well?

This question was designed to collect information regarding students' motivation for learning math well. The options were: school curriculum requirement, parents' expectation, self-motivated, and other (please specify).

Question #6: What do you think is the most important factor for learning math well?

This is the core question that was designed to confirm the factors that had been extracted from the literature review and to give the participants the option to express their own thoughts. The options were: well-designed curriculum, well-prepared teachers, supportive parents, self-determination and effort, Chinese culture, value, and faith in education, and other (please specify).

Question #7: Do you want your next generation to learn math the same way as how you learnt math? And why?

This question was designed to collect information about the participants' satisfaction with the Chinese elementary and secondary math education from a mature adult's point of view. The options were: Yes, no, and why as the optional field.

Question #8: What's the strength(s) of Chinese elementary and secondary math teaching?

This was one of the open-ended questions to let the participants express their ideas.

Question #9: What's the weakness(es) of Chinese elementary and secondary math teaching?

This was the other open-ended question to let the participants express their ideas.

Question #10: Do you agree that learning math well is important? Yes or No, please explain why.

This question was designed to check the importance of math learning in the participants' personal opinion. The options were: Yes, no, and why as the optional field.

Research Design

In general, this study investigated the factors that have been driving the excellent performance of Chinese students in elementary and secondary math with a mixed method. Exploratory research was the mixed method executed in this study, which included both qualitative and quantitative frameworks. Factors extracted from the literature review included a systematic math curriculum implemented in early grade levels, a well-trained teacher workforce, determined parental support, and linguistic advantages. These factors represented the point of views of educators and professional researchers, but the students' perceptions of their learning experience had been rarely included. Thus, the purpose of this study was to explore students' opinions regarding their elementary and secondary math learning experience in China.

An electronic survey was conducted to confirm the factors discovered in the literature review and to uncover any other relevant factors perceived by adults who had completed their elementary and/or secondary math education in China. As listed in the Measures section, all of the ten questions were designed for specific measurement purposes. The first two questions were designed to collect demographic data; questions #3, 4, 5, 7, and 10 were designed to testify the respondents' attitudes regarding to math learning; question#6 was the core question to verify the factors extracted from literature reviews; questions #8 and 9 were the open-ended questions for collecting the respondents' free thoughts about math learning. The survey sorted the questions in no particular sequential order to prevent biased responses. However, the method for distributing the survey became challenging and contributed to the potential for research failures.

This study was established without any grant or sponsorship. Therefore, the survey had to be conducted at no cost to the research. No costs meant neither traveling nor physical distribution of the survey would be possible. Thus, only the virtual survey distribution options were doable. Although plenty of virtual survey platforms were available, not all of them were accessible by the participants who were residing in China. After searching and several trials, the free version of Survey Monkey platform was decided upon the final solution for this study's survey distribution.

Procedures

This study's procedures took place in two semesters, Fall-2019 and Spring-2020, including drafting thesis proposals, initial literature reviews, research ethics training, IRB application approval, further literature reviews, survey distribution, the written report, and the final presentation in a sequential order.

Drafting the thesis proposal and establishing the initial literature review progressed during the first semester, Fall-2019. In this phase, browsing different research techniques, narrowing down the research fields, briefly reviewing the literature for potential proposals, and drafting the thesis proposals for approval were completed under the close supervision of the thesis course advisor.

Starting from the second semester, Spring-2020, the approved thesis proposal was carried on with further literature review. At the same time, research ethics training started at the beginning of the second semester in January 2020 in order to fulfill one of the requirements of the IRB application. Then this study's IRB application was approved in February 2020.

To avoid imposing additional stress on participants, the survey conducted in late March 2020, which was originally planned in February 2020 but postponed because of the pandemic of COVID-19. The survey was initiated on March 17th. 2020 Hawaii Standard Time (HST) and concluded within 4 days with completed 40 responses by March 20th. 2020 (HST).

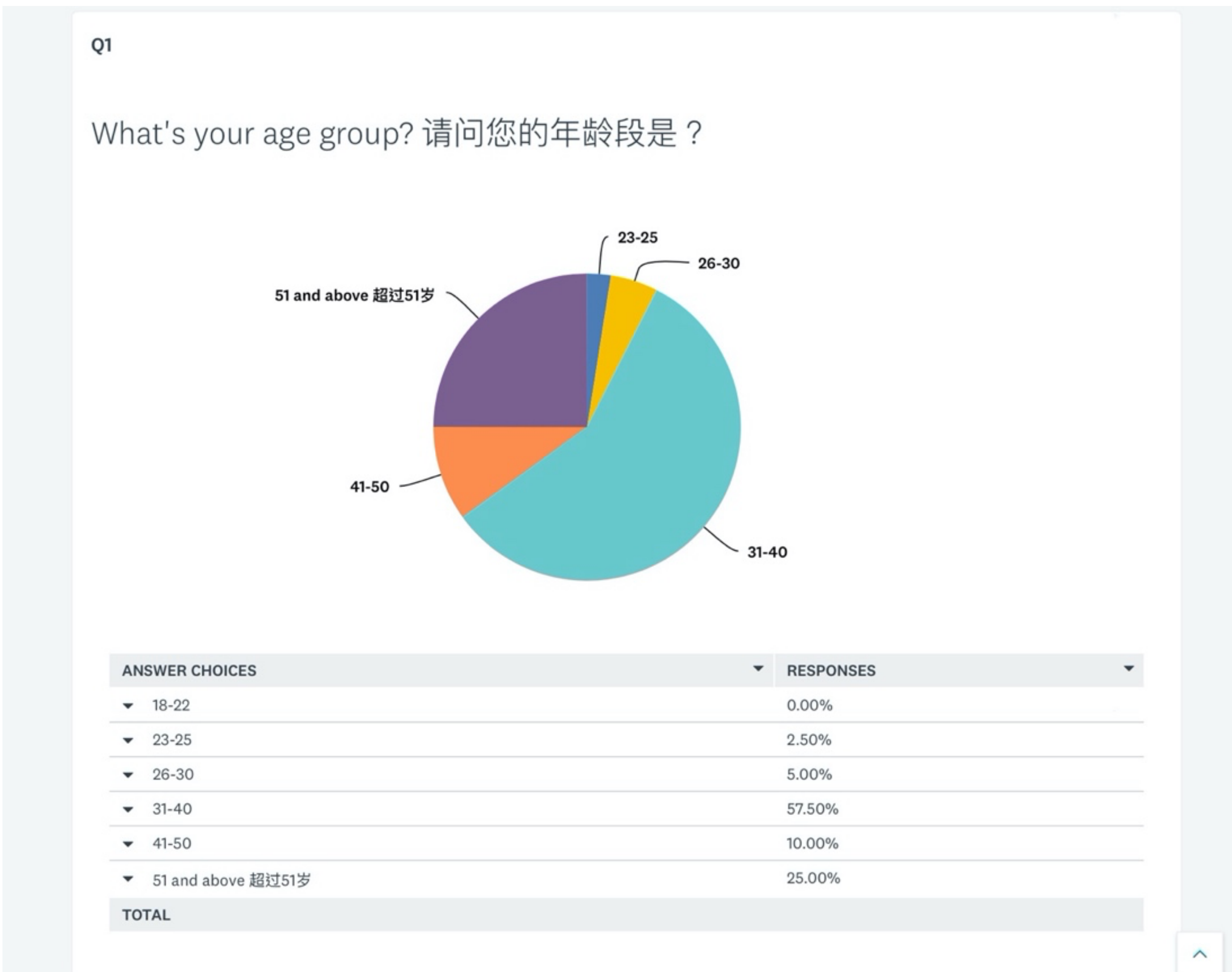
Analyzing data, writing the report, and preparing the final presentation were the emphases in April 2020. The final presentation was approved for the school capstone symposium scheduled on April 23rd. 2020.

Results

The Survey Monkey platform generated brief charts based on the responses as the following graphs. Some of the responses to the open-ended questions were originally completed in Chinese and then translated into English by the researcher, using the literal translation.

Figure 1

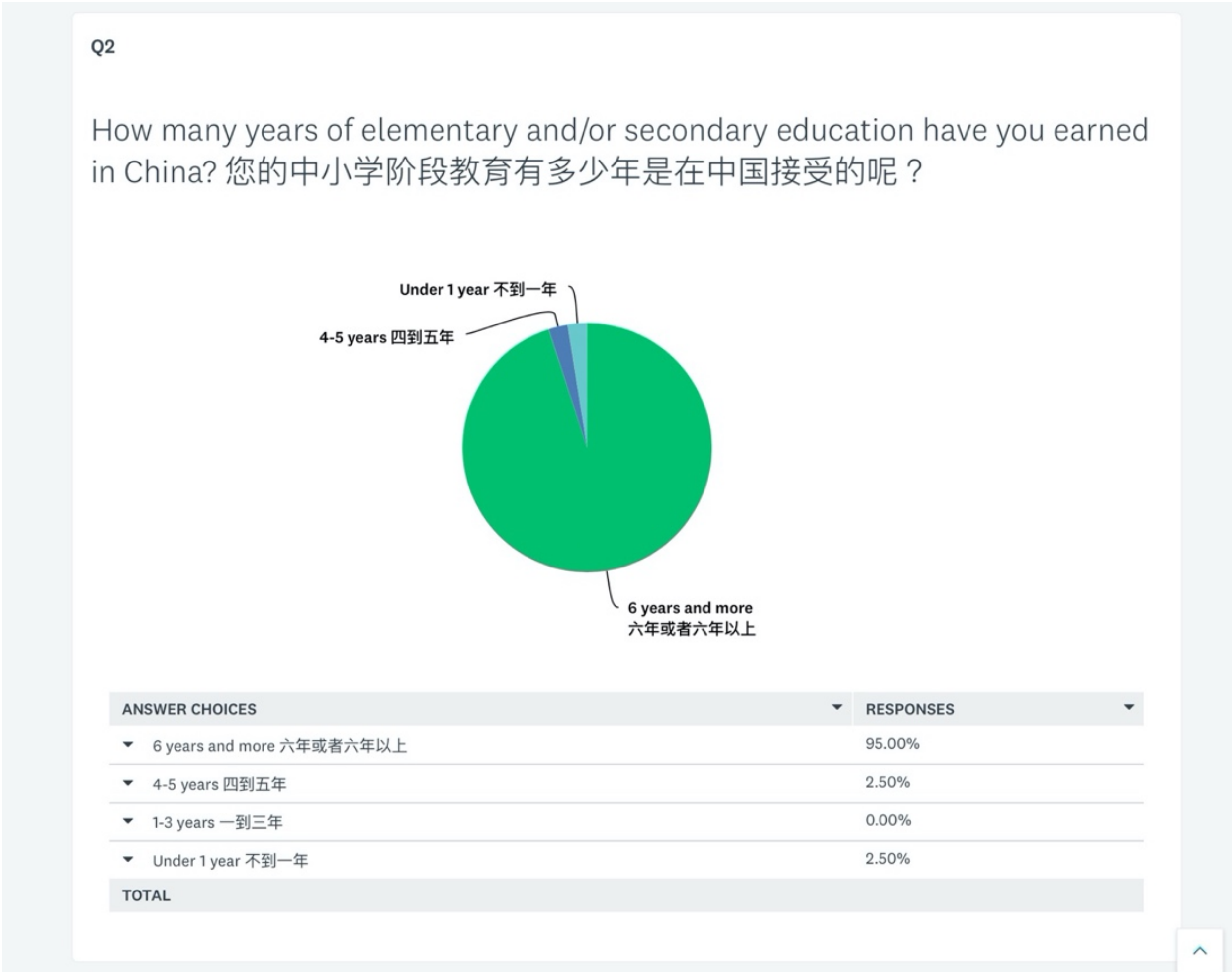
Participant Age Grouping



Note. The responses to question #1 indicate that the majority of the participants were in the 31-40 as well as 51 and above age groups, which reflected the biases of convenience sampling. However, almost all of the age categories were represented by some respondents, indicating a variety of age groups that were reached by this study.

Figure 2

Years of Elementary and Secondary Math Education Experience

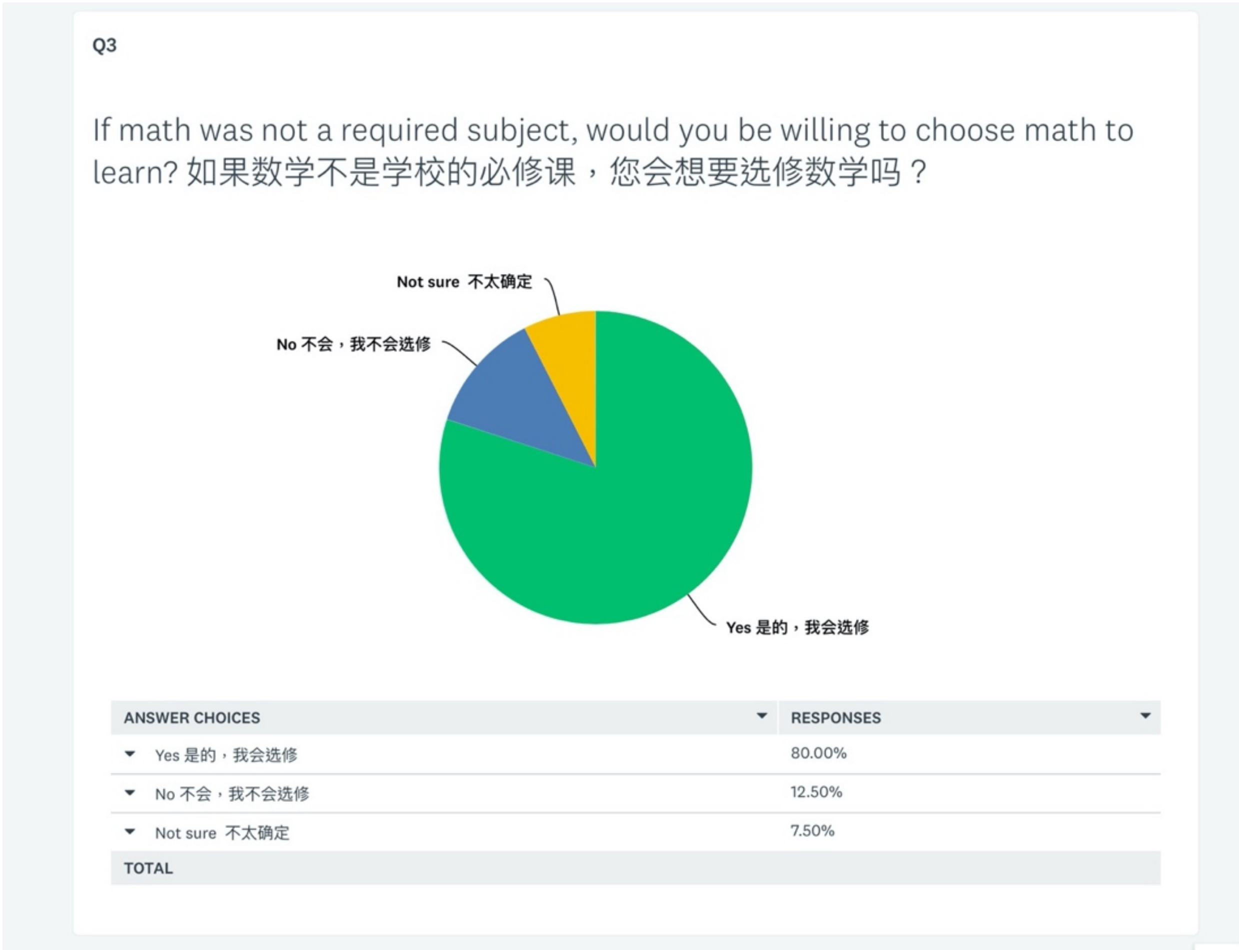


ANSWER CHOICES	RESPONSES
6 years and more 六年或者六年以上	95.00%
4-5 years 四到五年	2.50%
1-3 years 一到三年	0.00%
Under 1 year 不到一年	2.50%
TOTAL	

Note. The significance of the question #2 responses was that 95% of the participants had at least 6 years of elementary and/or secondary education in China, which indicates that 95% of the participants were strongly influenced by the Chinese education system. The participants' enriched Chinese education experience contributed to the validity and reliability of this study.

Figure 3

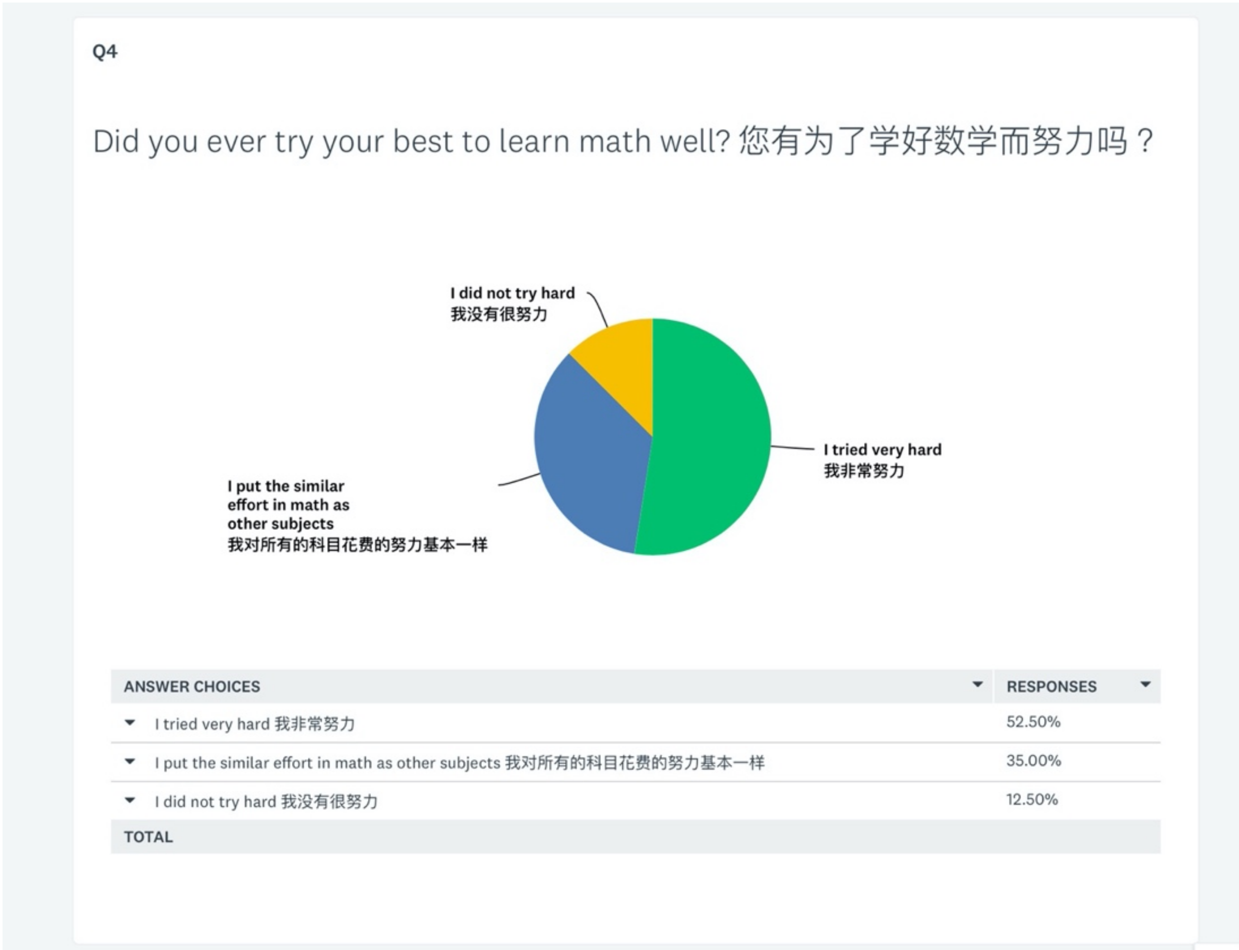
Willingness to Learn Math



Note. Even though math was the required main subject in Chinese elementary and secondary education, 80% of participants were willing to take math throughout their education without compulsoriness as the question #3 response summary chart showed.

Figure 4

Effort Level in Learning Math



ANSWER CHOICES	RESPONSES
I tried very hard 我非常努力	52.50%
I put the similar effort in math as other subjects 我对所有的科目花费的努力基本一样	35.00%
I did not try hard 我没有很努力	12.50%
TOTAL	

Note. As shown in Figure 4, more than half of the participants confirmed that they worked very hard to learn math well.

Figure 5

Motivations for Learning Math Well

ANSWER CHOICES	RESPONSES
School curriculum requirement 学校的要求	42.50%
Parents' expectation 家长的期待	0.00%
Self-motivated 自动自发	52.50%
Other (please specify) 其它（请简要解释）	5.00%
TOTAL	

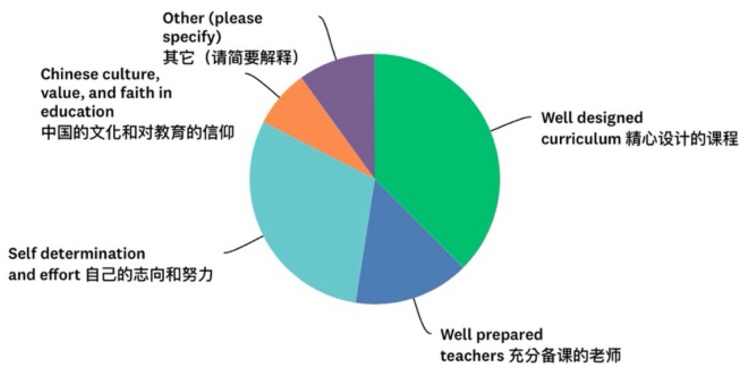
Note. Question #5 attempted to categorize the motivation for learning math well. About half of the responses fell into the self-motivated category, while a little less than half of the responses fell into the school curriculum requirement category. Surprisingly, none of the participants chose the parents' expectation option. Two other responses suggested self-motivation: training in logical thinking and necessary and basic knowledge in daily life.

Figure 6

Important Factors in Learning Math Well

Q6

What do you think is the most important factor for learning math well? 您觉得学好数学的最重要因素是什么？



ANSWER CHOICES		RESPONSES
Well designed curriculum 精心设计的课程		37.50%
Well prepared teachers 充分备课的老师		15.00%
Supportive parents 大力支持的父母		0.00%
Self determination and effort 自己的志向和努力		30.00%
Chinese culture, value, and faith in education 中国的文化和对教育的信仰		7.50%
Other (please specify) 其它（请简要解释）	Responses	10.00%
TOTAL		

Note. Question #6 was the core question to verify the factors extracted from the literature reviews. One more surprise about the supportive parents option was that none of the participants thought parental' support was the most important factor for learning math well. Both a well-designed curriculum and self-determination were the top-rated options. Two respondents suggested that talent was a factor in learning math well, one respondent suggested that old teaching methods were out of date, and one respondent disagreed by saying that the Chinese math curriculum is very systematic and well-designed.

Figure 7

Whether or not support to continue the current math curriculum

Q7

Do you want your next generation to learn math the same way as how you learnt math? And why? 您希望您的下一代沿用您学习数学的模式吗？请简要解释

ANSWER CHOICES	RESPONSES
Yes 是的，希望我的下一代可以沿用我学习数学的教学模式	47.50%
No 不，不希望我的下一代沿用我学习数学的教学模式	52.50%
TOTAL	

Comments (13)

Note. In addition to answering whether or not support to continue the current math curriculum, 13 respondents entered additional comments. Two participants who responded in the affirmative added comments saying the current math curriculum was very practical, systematic, and well-designed. The other 11 participants who responded in the negative added comments, saying the current math curriculum could not motivate students' interests or meet individual needs, not being improved consistently, the teaching methods were out of date, the elementary levels should focus on mathematical thinking development, or teachers were not strict enough, etc.

Question #8: What's the strength(s) of Chinese elementary and secondary math teaching?

All of the 40 participants affirmed the strengths of Chinese elementary and secondary math teaching. The responses were categorized into curriculum, pedagogy, parental support, teacher workforce, personal effort, combining international experience, Chinese history and values, and the Chinese social system, etc. The following table is the list of the counts of the categories and some entries covered more than one category.

Table 2

Categories of Strengths

Category	Number of Entries
Curriculum	31
Pedagogy	28
Personal Effort	5
Parental Support	2
Teacher Workforce	2
Combining International Experience	1
Chinese History and Value	1
Social System	1

Note. The curriculum was the most frequent response to question #8. This reflect the responses of the core question #5. A systematic and well-designed curriculum was considered as the most important aspect of elementary and secondary math education.

Question #9: What's the weakness(es) of Chinese elementary and secondary math teaching?

Forty entries were offered by the respondent to question #9. The responses to question #9 were categorized into categories similar to question #8.

Table 3

Categories of Weaknesses

Category	Number of Entries
Pedagogy	36
Curriculum	21
Educational resource	3
Teacher Workforce	1
Test-oriented	1

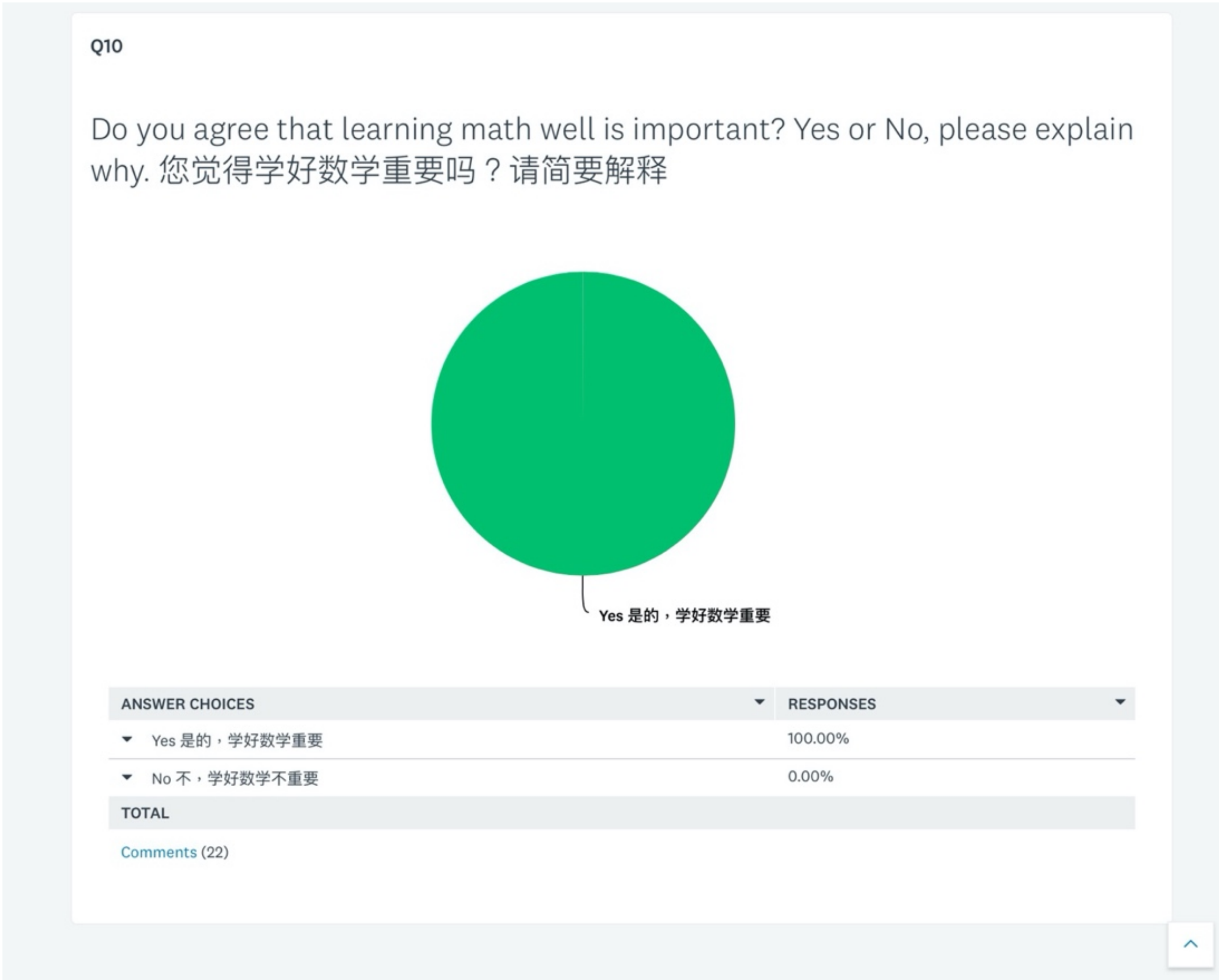
Note. An interesting finding was that, even though the responses to question #8 indicate that the curriculum was the most satisfactory component of math education, many respondents thought the curriculum could be better in the future. The pedagogy category was the most frequently identified weakness of the current math education. This indicated that potential improvements should be implemented to fulfill the students' expectations.

Responses to question #8 and 9 gave us the voice of the students about their personal opinions regarding the current math education system.

Finally, the responses of question #10 revealed significant agreement about the importance of learning math well. 100% of the participants agreed that learning math well was important, and 22 of the participants shared their thoughts about why learning math well was important.

Figure 8

Importance of Learning Math Well



Note. In addition to answering this question as a yes or no, 22 respondents entered comments to explain their rationale for their opinions about the importance of learning math well. These comments were categorized into useful in life and work, fundamental subject, develops logical thinking, and contributes to the community, etc. Some entries covered more than one category.

Table 4

Categories of Rationale about the Importance of Learning Math Well

Category	Number of Entry
Useful in life and work	10
Fundamental subject	9

Develops logical thinking	8
Contributes to the community	1

Note. The majority of the rationales categorized into useful in life and work and most participants agreed on math was fundamental subject. This reflects the responses to question #3 that 80% of participants would like to choose math to learn even if math was not a required subject.

Data Analysis

The free version of the Survey Monkey platform only allowed users to visualize the responses on the website without any download functions. Therefore, the responses were manually entered into the Microsoft Excel spreadsheet for further analysis. Chi-square was used as the statistical method to analyze the data with inferential analysis and correlational analysis. Based on the pie chart result of the core question, the well-designed curriculum and self-determination factors were emphasized in the data analysis.

Inferential Analysis

First of all, the responses to the core question #6, were analyzed with Chi-square test for homogeneity that tested whether or not preferences existing among the options.

Figure 9

Chi-square test for homogeneity of Question #6

Chi-square test				
Q6	Index	Expected	Actural	Chi^
Well-designed curriculum	1	6.67	15	10.4166667
Well-prepared teachers	2	6.67	6	0.06666667
Supportive parents	3	6.67	0	6.66666667
Self determination and effort	4	6.67	12	4.26666667
Chinese culture et al.	5	6.67	3	2.01666667
Other (please specify)	6	6.67	4	1.06666667
X^	24.5			
p-value	0.0001740	smaller than 0.05		
Rejected	H_0:	all factors are equally important, no difference		
✓	H_1:	there is preference among the factors		

Note. The result of the above chi-square test showed there were preferences among the factors for learning math.

Figure 10

Response counts of Question #6

What do you think is the **most important factor** for learning math well?	Responses	Percentage
Well designed curriculum	15	38%
Well prepared teachers	6	15%
Supportive parents	0	0%
Self determination and effort	12	30%
Chinese culture, value, and faith in education	3	8%
Other (please specify)	4	10%

Note. The frequency of response for each factor is listed in Figure 10; the two most frequent responses are highlighted. A well-designed curriculum and self-determination and effort were the significant factors identified by the participants. A well-designed curriculum was one of the factors extracted from the literature review, but self-determination and effort was not a factor from the literature review. Self-determination and effort was a student perspective factor uncovered by the survey. Therefore, the survey did confirm factors from the literature review and discovered additional factors from the students' point of views.

In addition, the responses to questions #1-5 were analyzed with Chi-square test for homogeneity; the results are shown in Figures 11-15 (Appendix B). The chi-square tests showed that questions #1-6 had inhomogeneous responses, while question #7 was homogeneous. Responses to question #7 showed almost evenly divided in the pie chart, so we could assume that there was no statistically significant difference between whether or not support to continue the current curriculum in China. Question #10 showed 100% participants agreed about the importance of learning math well. Thus, question #10 was the single question with unanimous response.

Correlational analysis

As mentioned in the method section, question #1 and 2 were designed to collect demographic data. A chi-square test for association was used to analyze the correlation between the core question responses and the demographic data.

Figure 16

Chi-square test for association between Question #1 and #6

Chi-square for independence

Fail to reject	H_0:	Q6 and Q1 are not associated, they are independent
	H_1:	Q6 and Q1 are associated and correlated
X^	6.6566	
df	8	
p-value	0.574098442	larger than 0.05

Contingency Table

	Survey Options	Index	Well designed curriculum Q6=1	Well prepared teachers Q6=2	Self determination and effort Q6=4	Chinese culture et al. Q6=5	Other (please specify) Q6=6	Total	
18-30	1,2,3	1	1	0	1	1	0	3	8%
		Expected	1.125	0.45	0.9	0.225	0.3		
31-40	4	2	9	4	6	0	3	22	55%
		Expected	8.25	3.3	6.6	1.65	2.2		
40 and above	5,6	3	5	2	5	2	1	15	38%
		Expected	5.625	2.25	4.5	1.125	1.5		
		Total	15	6	12	3	4	40	
			38%	15%	30%	8%	10%		

Q1=1,2,3

Q6 Index	Expected	Actual	Chi^
1	1.125	1	0.0138889
2	0.450	0	0.45
4	0.900	1	0.0111111
5	0.225	1	2.6694444
6	0.300	0	0.3
Total	3	3	3.4444444

Q1=4

Q6 Index	Expected	Actual	Chi^
1	8.25	9	0.0681818
2	3.3	4	0.1484848
4	6.6	6	0.0545455
5	1.65	0	1.65
6	2.2	3	0.2909091
Total			2.2121212

Q1=5,6

Q6 Index	Expected	Actual	Chi^
1	5.625	5	0.0694444
2	2.25	2	0.0277778
4	4.5	5	0.0555556
5	1.125	2	0.6805556
6	1.5	1	0.1666667
Total			1

Note. Due to the limited sample size, the responses to question #1 were regrouped in the following analysis between question #1 and #6. The analysis indicated that responses to question #1 and #6 were independent. It meant the age groups were not associated with the learning math well factors.

Then, a chi-square test for association between question #2 and #6 was conducted.

Figure 17

Chi-square test for association between Question #2 and #6

	Chi-square for independence	
Fail to reject	H_0:	Q6 and Q2 are not associated, they are independent
	H_1:	Q6 and Q2 are associated and correlated
X^	3.5088	
df	8	
p-value	0.898507795	larger than 0.05

Contingency Table			Well designed curriculum	Well prepared teachers	Self determination and effort	Chinese culture et al.	Other (please specify)		
	Survey Options	Index	Q6=1	Q6=2	Q6=4	Q6=5	Q6=6	Total	
6 years and more	1	1	13	6	12	3	4	38	95%
		Expected	14.25	5.7	11.4	2.85	3.8		
4-5 years	2	2	1	0	0	0	0	1	3%
		Expected	0.375	0.15	0.3	0.075	0.1		
Under 1 year	4	3	1	0	0	0	0	1	3%
		Expected	0.375	0.15	0.3	0.075	0.1		
		Total	15	6	12	3	4	40	
			38%	15%	30%	8%	10%		

Q2=1			
Q6 Index	Expected	Actual	Chi^
1	14.250	13	0.1096491
2	5.700	6	0.0157895
4	11.400	12	0.0315789
5	2.850	3	0.0078947
6	3.800	4	0.0105263
Total	38	38	0.1754386

Q2=2			
Q6 Index	Expected	Actual	Chi^
1	0.375	1	1.0416667
2	0.15	0	0.15
4	0.3	0	0.3
5	0.075	0	0.075
6	0.1	0	0.1
Total	1	1	1.6666667

Q2=4			
Q6 Index	Expected	Actual	Chi^
1	0.375	1	1.0416667
2	0.15	0	0.15
4	0.3	0	0.3
5	0.075	0	0.075
6	0.1	0	0.1
Total	1	1	1.6666667

Note. The analysis indicated that there was no correlation between the years of education and the learning math well factors.

The chi-square test for association indicated that the core question responses were not associated with the responses to other questions, as shown in the Figure 18-21 (Appendix C). Although there was no correlation between the core question responses with the other questions' responses, the core question responses indicated that self-determination and effort was a new factor identified from students' perspectives. It would be meaningful to run correlational analysis on the questions and responses related to self-determination and effort.

Referring to the method section and the pie charts of the results, question #3-5 were investigated for the students' willingness, effort level, and motivation in learning math. Then, correlational analyses were run for these questions.

Figure 22

Chi-square test for association between Question #3 and #4

Chi-square for independence

Rejected	H_0:	Q3 and Q4 are not associated, they are independent
✓	H_1:	Q3 and Q4 are associated and correlated

X^	19.7393	
df	4	
p-value	0.000562191	smaller than 0.05

Contingency Table

Q3	Survey Options	Index	I tried very hard Q4=1	I put the similar effort in math as other subjects Q4=2	I did not try hard Q4=3	Total	
Yes	1	1	21	9	2	32	80%
		Expected	16.8	11.2	4		
No	2	2	0	2	3	5	13%
		Expected	2.625	1.75	0.625		
Not sure	3	3	0	3	0	3	8%
		Expected	1.575	1.05	0.375		
		Total	21	14	5	40	
			53%	35%	13%		

Q3=1

Q4 Index	Expected	Actual	Chi^
1	16.800	21	1.05
2	11.200	9	0.4321429
3	4.000	2	1
Total	32	32	2.4821429

Q3=2

Q4 Index	Expected	Actual	Chi^
1	2.625	0	2.625
2	1.75	2	0.0357143
3	0.625	3	9.025
Total	5	5	11.685714

Q3=3

Q4 Index	Expected	Actual	Chi^
1	1.575	0	1.575
2	1.05	3	3.6214286
3	0.375	0	0.375
Total	3	3	5.5714286

Note. The analysis indicated that there was a correlation between question #3 and #4. Question #3 was asking the willingness of learning math even if math was not a required subject. Question #4 was asking the effort level engaged in learning math. It showed that the participants who were willing to learn math even if math was not a required subject also put more effort in learning math. This was a positive correlational analysis supporting the self-determination and effort factor.

Figure 23

Chi-square test for association between Question #4 and #5

Chi-square for independence		
Rejected	H_0:	Q4 and Q5 are not associated, they are independent
✓	H_1:	Q4 and Q5 are associated and correlated
X^	12.5789	
df	4	
p-value	0.013527628	smaller than 0.05

Contingency Table

Q5	Survey Options	Index	I tried very hard Q4=1	I put the similar effort in math as other subjects Q4=2	I did not try hard Q4=3	Total	
School curriculum requirement	1	1	5	8	4	17	43%
		Expected	8.925	5.95	2.125		
Self-motivated	3	2	16	4	1	21	53%
		Expected	11.025	7.35	2.625		
Other (please specify)	4	3	0	2	0	2	5%
		Expected	1.05	0.7	0.25		
		Total	21	14	5	40	
			53%	35%	13%		

Q5=1 Q4 Index	Expected	Actual	Chi^
1	8.925	5	1.7261204
2	5.950	8	0.7063025
3	2.125	4	1.6544118
Total	17	17	4.0868347

Q5=3 Q4 Index	Expected	Actual	Chi^
1	11.025	16	2.2449546
2	7.35	4	1.5268707
3	2.625	1	1.0059524
Total	21	21	4.7777778

Q5=4 Q4 Index	Expected	Actual	Chi^
1	1.05	0	1.05
2	0.7	2	2.4142857
3	0.25	0	0.25
Total	2	2	3.7142857

Note. This analysis indicated that there was also a correlation between question #4 and #5. Question #4 asked about the effort level engaged in learning math. Question #5 asked about the motivations of learning math well. It showed that the participants who put more effort in learning math also turned towards self-motivated in learning math well. This was an additional positive correlational analysis supporting the self-determination and effort factor.

Discussion

Throughout this exploratory research, significant findings were harvested both qualitatively and quantitatively.

For qualitative framework, four major factors were defined in the literature review: a systematic math curriculum implementing in early grade levels, a well-trained teacher workforce, determined parental support, and linguistic advantages. In addition, the survey's open-ended questions offered students' evaluations and expectations about the current elementary and secondary math education in China. These evaluations and expectations were categorized into curriculum, pedagogy and educational resources, etc. Some of the evaluations and expectations reflected the literature review as well. For example, Zhou et al. (2006) pointed out, “In China, teacher training programs may need to place greater emphasis on developing teachers’ knowledge of pedagogical and psychological theories and their impact on children’s learning. …Their deficits in this area could possibly lead to difficulties in teaching with regard to motivation, spontaneity, creativity, and so on” (pp. 453-454).

For quantitative framework, pie charts, inferential analysis including chi-square tests for homogeneities and associations expanded the interpretations about the survey data as explained in the data analysis section.

Meanwhile, this study did have limitations and biases. Due to the offering of the free survey platform, only forty responses were collected and analyzed. The sample size was small compared to the population of China. As mentioned in the method section, sampling biases would have occurred, due to the nature of convenience sampling. Last but not the least, the electronic survey format limited the access of possible participants by the internet connection, so this may create another sampling bias. All of these limitations and biases would be important considerations for future studies or replications of this study.

Conclusion

Several major factors that have been driving excellent performance of Chinese students in elementary and secondary math education were identified in this study. From the educators and researchers’ point of view, a systematic math curriculum implemented in early grade levels, a well-trained teacher workforce, determined parental support, and linguistic advantages were crucial in math education. On the other hand, students believed that a well-designed curriculum, self-determination and effort were keys in learning math well. As a result, a systematic and well-designed math curriculum was the most common factor among educators, researchers, and students.

For teaching practice, we could learn from this study that the well-designed curriculum that has made math teaching in China so successful. However, a well-designed curriculum could not be a single teacher's contribution. It usually requires the entire education system integration to develop and improve consistently, which has been supported by the Chinese social system.

Even though Chinese elementary and secondary math curriculum has been working well, students made a voice that they expected the Chinese math curriculum to be adapted into the globalized standards and up-to-date circumstance. The pedagogy was the aspect that criticized a lot by students among all of the factors. It looks like Chinese math education did well in well-designed curriculum, but lack of focus in encouraging students' motivation, self-determination, and effort, which was considered as important as curriculum. If we consider the math curriculum as the nurture aspect of elementary and secondary math education, self-determination and effort would be the nature aspect in learning math well. Both nurture and nature factors supported the excellent math performance of Chinese students.

Although the elementary and secondary math education in China seems well performed, the higher education does not extend the mathematics excellence in China. Jing (2007) pointed out that, Chinese "university mathematics education research had not really started in China. There are very few teachers who can really concentrate on doing mathematics education research at Chinese universities. The existing research is also difficult to connect with the counterparts of other countries in the world. The first-rank study results are really very few" (p.77). If there are not attractive academic paths in universities or research institutions, the desire and interests in learning math will be reduced in elementary and secondary education. This would be a fascinating further research topic.

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Appendix A. Survey

Exploration of Elementary and Secondary Math Teaching in China 中国中小学数学教学的探索

This survey is conducted under the ethic code of confidentiality. 这个问卷调查遵守保密原则。

* 1. What's your age group? 请问您的年龄段是？

◯ 18-22
◯ 23-25
◯ 26-30
◯ 31-40
◯ 41-50
◯ 51 and above 超过51岁

* 2. How many years of elementary and/or secondary education have you earned in China? 您的中小学阶段教育有多少年是在中国接受的呢？

◯ 6 years and more 六年或者六年以上
◯ 4-5 years 四到五年
◯ 1-3 years 一到三年
◯ Under 1 year 不到一年

* 3. If math was not a required subject, would you be willing to choose math to learn? 如果数学不是学校的必修课，您会想要选修数学吗？

◯ Yes 是的，我会选修
◯ No 不会，我不会选修
◯ Not sure 不太确定

* 4. Did you ever try your best to learn math well? 您有为了学好数学而努力吗？

◯ I tried very hard 我非常努力
◯ I put the similar effort in math as other subjects 我对所有的科目花费的努力基本一样
◯ I did not try hard 我没有很努力

* 5. What's your most important motivation to learn math well? 您学好数学的出发点是什么？

◯ School curriculum requirement 学校的要求
◯ Parents' expectation 家长的期待
◯ Self-motivated 自动自发
◯ Other (please specify) 其它 （请简要解释）

* 6. What do you think is the most important factor for learning math well? 您觉得学好数学的最重要因素是什么？

- ◯ Well designed curriculum 精心设计的课程
- ◯ Well prepared teachers 充分备课的老师
- ◯ Supportive parents 大力支持的父母
- ◯ Other (please specify) 其它（请简要解释）
- ◯ Self determination and effort 自己的志向和努力
- ◯ Chinese culture, value, and faith in education 中国的文化和对教育的信仰

* 7. Do you want your next generation to learn math the same way as how you learnt math? And why? 您希望您的下一代沿用您学习数学的模式吗？请简要解释

- ◯ Yes 是的，希望我的下一代可以沿用我学习数学的教学模式
- ◯ No 不，不希望我的下一代沿用我学习数学的教学模式

Why？请简要解释

* 8. What's the strength(s) of Chinese elementary and secondary math teaching? 您认为中国中小学数学教育的优势是什么？

* 9. What's the weakness(es) of Chinese elementary and secondary math teaching? 您认为中国中小学数学教育的不足之处是什么？

* 10. Do you agree that learning math well is important? Yes or No, please explain why. 您觉得学好数学重要吗？请简要解释

- ◯ Yes 是的，学好数学重要
- ◯ No 不，学好数学不重要

Why？ 请简要解释

Appendix B. Additional figures of homogeneity tests

Figure 11

Chi-square test for homogeneity of Question #1

Chi-square test					
Q1	**Index**	**Expected**	**Actural**		**Chi^**
18-22	1	6.67	0		6.66666667
23-25	2	6.67	1		4.81666667
26-30	3	6.67	2		3.26666667
31-40	4	6.67	23		40.0166667
41-50	5	6.67	4		1.06666667
51 and above	6	6.67	10		1.66666667
X^	57.5				
p-value	0.0000000000398850	smaller than 0.05			
Rejected	H_0:	no difference or preference among age groups			
✓	H_1:	there is difference or preference among the age groups			

Figure 12

Chi-square test for homogeneity of Question #2

Chi-square test					
Q2	**Index**	**Expected**	**Actural**		**Chi^**
6 years and more	1	10.00	38		78.4
4-5 years	2	10.00	1		8.1
1-3 years	3	10.00	0		10
Under 1 year	4	10.00	1		8.1
X^	104.6				
p-value	0.0000000000000000	smaller than 0.05			
Rejected	H_0:	no preference among the education experience categories			
✓	H_1:	there is preference among the education experience categories			

Figure 13

Chi-square test for homogeneity of Question #3

Chi-square test					
Q3	Index	Expected	Actural		Chi^
Yes	1	13.33	32		26.1333333
No	2	13.33	5		5.20833333
Not sure	3	13.33	3		8.00833333
X^	39.35				
p-value	0.0000000028526998	smaller than 0.05			
Rejected	H_0:	no preference among the willingness of learning math			
✓	H_1:	there is preference among the willingness of learning math			

Figure 14

Chi-square test for homogeneity of Question #4

Chi-square test					
Q4	Index	Expected	Actural		Chi^
I tried very hard	1	13.33	21		4.40833333
I put the similar effort in math as other subjects	2	13.33	14		0.03333333
I did not try hard	3	13.33	5		5.20833333
X^	9.65				
p-value	0.0080265538703952	smaller than 0.05			
Rejected	H_0:	no differnce among the student effort level in learning math			
✓	H_1:	there is difference among the student effort level in learning math			

Figure 15

Chi-square test for homogeneity of Question #5

Chi-square test					
Q5	Index	Expected	Actural		Chi^
School curriculum requirement	1	10.00	17		4.9
Parents' expectation	2	10.00	0		10
Self-motivated	3	10.00	21		12.1
Other (please specify)	4	10.00	2		6.4
X^	33.4				
p-value	0.0000002651911396	smaller than 0.05			
Rejected	H_0:	no preference among the motivations of learning math			
✓	H_1:	there is preference among the motivations of learning math			

Appendix C. Additional figures of association tests

Figure 18

Chi-square test for association between Question #3 and #6

	Chi-square for independence	
Fail to reject	H_0:	Q6 and Q3 are not associated, they are independent
	H_1:	Q6 and Q3 are associated and correlated
X^	9.5347	
df	8	
p-value	0.29921124	larger than 0.05

Contingency Table

	Survey Options	Index	Well designed curriculum	Well prepared teachers	Self determination and effort	Chinese culture et al.	Other (please specify)		
			Q6=1	Q6=2	Q6=4	Q6=5	Q6=6	Total	
Yes	1	1	14	4	10	1	3	32	80%
		Expected	12	4.8	9.6	2.4	3.2		
No	2	2	0	1	2	1	1	5	13%
		Expected	1.875	0.75	1.5	0.375	0.5		
Not sure	3	3	1	1	0	1	0	3	8%
		Expected	1.125	0.45	0.9	0.225	0.3		
		Total	15	6	12	3	4	40	
			38%	15%	30%	8%	10%		

Q3=1			
Q6 Index	Expected	Actual	Chi^
1	12.000	14	0.3333333
2	4.800	4	0.1333333
4	9.600	10	0.0166667
5	2.400	1	0.8166667
6	3.200	3	0.0125
Total	32	32	1.3125

Q3=2			
Q6 Index	Expected	Actual	Chi^
1	1.875	0	1.875
2	0.75	1	0.0833333
4	1.5	2	0.1666667
5	0.375	1	1.0416667
6	0.5	1	0.5
Total	5	5	3.6666667

Q3=3			
Q6 Index	Expected	Actual	Chi^
1	1.125	1	0.0138889
2	0.45	1	0.6722222
4	0.9	0	0.9
5	0.225	1	2.6694444
6	0.3	0	0.3
Total	3	3	4.5555556

Figure 19

Chi-square test for association between Question #4 and #6

Chi-square for independence		
Fail to reject	H_0:	Q6 and Q4 are not associated, they are independent
	H_1:	Q6 and Q4 are associated and correlated
X^	10.4444	
df	8	
p-value	0.29921	larger than 0.05

Contingency Table

	Survey Options	Index	Q6=1 (Well designed curriculum)	Q6=2 (Well prepared teachers)	Q6=4 (Self determination and effort)	Q6=5 (Chinese culture et al.)	Q6=6 (Other (please specify))	Total	
I tried very hard	1	1	9	2	8	1	1	21	53%
		Expected	7.875	3.15	6.3	1.575	2.1		
I put the similar effort in math as other subjects	2	2	6	3	3	1	1	14	35%
		Expected	5.25	2.1	4.2	1.05	1.4		
I did not try hard	3	3	0	1	1	1	2	5	13%
		Expected	1.875	0.75	1.5	0.375	0.5		
		Total	15	6	12	3	4	40	
			38%	15%	30%	8%	10%		

Q4=1 Q6 Index	Expected	Actual	Chi^
1	7.875	9	0.1607143
2	3.150	2	0.4198413
4	6.300	8	0.4587302
5	1.575	1	0.2099206
6	2.100	1	0.5761905
Total	21	21	1.8253968

Q4=2 Q6 Index	Expected	Actual	Chi^
1	5.25	6	0.1071429
2	2.1	3	0.3857143
4	4.2	3	0.3428571
5	1.05	1	0.002381
6	1.4	1	0.1142857
Total	14	14	0.952381

Q4=3 Q6 Index	Expected	Actual	Chi^
1	1.875	0	1.875
2	0.75	1	0.0833333
4	1.5	1	0.1666667
5	0.375	1	1.0416667
6	0.5	2	4.5
Total	5	5	7.6666667

Figure 20

Chi-square test for association between Question #5 and #6

Chi-square for independence		
Fail to reject	H_0:	Q6 and Q5 are not associated, they are independent
	H_1:	Q6 and Q5 are associated and correlated
X^	8.2316	
df	8	
p-value	0.411183981	larger than 0.05

Contingency Table

	Survey Options	Index	Q6=1 (Well designed curriculum)	Q6=2 (Well prepared teachers)	Q6=4 (Self determination and effort)	Q6=5 (Chinese culture et al.)	Q6=6 (Other (please specify))	Total	
School curriculum requirement	1	1	8	2	4	1	2	17	43%
		Expected	6.375	2.55	5.1	1.275	1.7		
Self-motivated	3	2	6	4	8	1	2	21	53%
		Expected	7.875	3.15	6.3	1.575	2.1		
Other (please specify)	4	3	1	0	0	1	0	2	5%
		Expected	0.75	0.3	0.6	0.15	0.2		
		Total	15	6	12	3	4	40	
			38%	15%	30%	8%	10%		

Q5=1 Q6 Index	Expected	Actual	Chi^
1	6.375	8	0.4142157
2	2.550	2	0.1186275
4	5.100	4	0.2372549
5	1.275	1	0.0593137
6	1.700	2	0.0529412
Total	17	17	0.8823529

Q5=3 Q6 Index	Expected	Actual	Chi^
1	7.875	6	0.4464286
2	3.15	4	0.2293651
4	6.3	8	0.4587302
5	1.575	1	0.2099206
6	2.1	2	0.0047619
Total	21	21	1.3492063

Q5=4 Q6 Index	Expected	Actual	Chi^
1	0.75	1	0.0833333
2	0.3	0	0.3
4	0.6	0	0.6
5	0.15	1	4.8166667
6	0.2	0	0.2
Total	2	2	6

Figure 21

Chi-square test for association between Question #7 and #6

Chi-square for independence

Fail to reject	H_0:	Q6 and Q7 are not associated, they are independent
	H_1:	Q6 and Q7 are associated and correlated

X^	1.6374	
df	4	
p-value	0.802050188	larger than 0.05

Contingency Table

			Well designed curriculum	Well prepared teachers	Self determination and effort	Chinese culture et al.	Other (please specify)		
	Survey Options	Index	Q6=1	Q6=2	Q6=4	Q6=5	Q6=6	Total	
Yes	1	1	7	3	7	1	1	**19**	48%
		Expected	7.125	2.85	5.7	1.425	1.9		
No	2	3	8	3	5	2	3	**21**	53%
		Expected	7.875	3.15	6.3	1.575	2.1		
		Total	**15**	**6**	**12**	**3**	**4**	**40**	
			38%	15%	30%	8%	10%		

Q7=1

Q6 Index	Expected	Actual	Chi^
1	7.125	7	0.002193
2	2.850	3	0.0078947
4	5.700	7	0.2964912
5	1.425	1	0.1267544
6	1.900	1	0.4263158
Total	19	19	0.8596491

Q7=2

Q6 Index	Expected	Actual	Chi^
1	7.875	8	0.00198
2	3.15	3	0.00714
4	6.3	5	0.26825
5	1.575	2	0.11468
6	2.1	3	0.38571
Total	21	21	0.77778