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Abstract: This article examines the Korean classroom teachers' beliefs about mathematics education in elementary schools. Their perceptions about contributing factors to Korean students' high achievement scores in international comparative studies in the area of mathematics are explored. Elementary classroom teachers were surveyed using the researcher-made questionnaire (Teacher Perception about Mathematics Curriculum) and 141 teachers completed the questionnaire. The data collected was analyzed by a descriptive analysis. The results reveal that the majority of classroom teachers agreed that real life applications, processing skills, using concrete instructional manipulatives, and conceptual knowledge are very important in teaching children mathematics. Most of teachers participating in this study were aware of the fact that Korean students ranked in the top percentile in the international comparative students' mathematics achievement studies. The teachers claimed that Korean students still heavily focus on practice and drill computational skills, private lessons at the after school program and parents' high expectation of their child's education, and active involvement in his/her education generated the high scores in mathematics.

Keywords: conceptual knowledge; constructivist myths; drill and practice; Instructional methods; Korea; Korean Teachers; Teacher Beliefs; Teacher perceptions; Student achievement

Introduction

According to various international comparative studies of students' achievement ;[i.e. the Third International Mathematics and Science Study (TIMSS, 1995 & 1999); the Trends in International Mathematics and Science Study (TIMSS, 2003); the Program for International Student Assessment (PISA, 2003); and the Organization for Economic Co-operation and Development (OECD, 2006)] Korean school students performed at a very high mean score in mathematics. Particularly in 2003, Korean 8th graders ranked 2nd in mathematics among 46 countries participating in TIMSS and their achievement scores had been continuously improving. These results encouraged Korean educators, especially mathematics educators, to reflect on strength and weakness in terms of Korean mathematics education including the national curriculum and instructional methods. The whole educational environment was analyzed, in order to retain and even to improve students' mathematics achievement scores.

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The TIMSS 1995 report indicated that Korean mathematics education had serious issues to be addressed. In spite of Korean students' successful achievement, students did not have positive dispositions towards mathematics. This issue has been validated by the PISA 2003 report. According to this report, Korean students' intrinsic interest in mathematics was very low and their self-concept and self-efficacy levels were in the lowest group. Sixty two percent of Korean students participated in the study reported that they did not think they did well in mathematics (Leung, 2002) and Korean students' anxiety in mathematics was very high (5^{th} among 41 countries participating in PISA 2003). Interestingly, the PISA (2003) results showed that students' self-esteem in mathematics does not equate to high scores. This brought a discussion by some researchers in the United States claiming that schools need not be fun to be effective, and schools should work on academics rather than focus on feelings and happiness of students. Students' true self-esteem will be fulfilled by true achievement (in Mathews, 2006). However, Korean educators considered their students' affective characteristics as one of the areas that needed to improve and strived to develop a particular program for nurturing students' affective disposition in mathematics. This educational movement impacted the 7^{th} national mathematics curriculum revision issued in 1998 (Lew, 2004).

Korean schools use a national curriculum. This mathematics curriculum has been developed and revised by a committee consisting of educational leaders among classroom teachers in different grade levels, mathematics educators, and researchers from academic institutes under the authorization of the Ministry of Education and Human Resources Development (MEHRD). The current Korean mathematics curriculum, which is the 7^{th} national curriculum, was revised in 1998 (Lew, 2004) and implemented since 2000 (Paik, 2004). The *Report on Mathematics Education in Korea* presented by the Korean research team at the 10^{th} International Conference of Mathematics Education (ICME-10) in 2004 claims that the main focus of the 7^{th} national mathematics curriculum was that it was "learner centered." This approach actively planned to implement the curriculum in a stepwise and level-reference manner, emphasizing learner's voluntary and positive learning activity, and provoking learner's interests in mathematics (Paik, p. 14). If this direction was clear and effectively implemented in actual classrooms, the PISA 2003 results should be different from what the TIMSS 1995 reported.

In the United States, the National Council of Teachers of Mathematics (NCTM) published the *Curriculum and Evaluation Standards for School Mathematics* (1989). Since then, an agenda for the reform of school mathematics has focused on "mathematics as sense-making," as well as the importance of all students in grades K-12 studying a common core of broadly useful mathematics (Janvier, 1990). These ideas were affirmed in another publication by the NCTM, the *Principles and Standards for School Mathematics* (2000); that suggests learners should be provided with the autonomy to select activities that blend with their interests and prior experiences to build mathematical connections through active learning. The NCTM standards have been based upon a learning theory termed Constructivism, which is supported by cognitive theorists, such as Jean Piaget, Lev Vygotsky, and Jerome Bruner, who advocated that children must construct their own knowledge through interaction with the physical and social environments (DeVries & Kohlberg, 1987, Heddens & Speer, 2006).

The history of Korean mathematics curriculum clearly shows that it was influenced by the reform movement in the USA. The 1st curriculum (1955-1963) was called "real life centered curriculum" which was influenced by Progressivism in the USA. The 2nd curriculum (1964-1972) was characterized as "mathematics structure centered," the 3rd one (1973-1981) as "new math oriented," the 4th curriculum (1982-1988) as "back to basics," the 5th one (1989-1994), as "problem solving oriented," the 6th curriculum (1995-1999) as "problem solving and informational society oriented," and finally the 7th curriculum (2000-present) was characterized as "learner centered" (Paik, 2004, p. 12). This reveals that the sequence of mathematics history in Korea is very similar to the US mathematics history and reform movement. This implies that Korean educators and classroom teachers should be aware of the current mathematics reform movement within the international context. Classroom teachers especially need to explore the current reform movement to help students develop their mathematical knowledge (NCTM, 1989). Teachers' perceptions are directly related to mathematics education since their role is an essential part of curriculum when curriculum is defined as "all the experiences children have under the guidance of teachers (Caswel & Campbell, 1935, p. 66). Further, there are various studies reporting that teacher beliefs and instructional methods are significant variables in improving students' achievement (e.g., Rowan, Correnti, & Miller, 2002). Teacher beliefs about mathematics play a crucial role in shaping the teacher's instructional choices (Shuhua, 2000) as well as correlating with higher students' achievement (Love & Kruger, 2005). Given research findings and growing research interest in Asian mathematics education after international comparative studies reported Asian students outperformed their western counterparts in mathematics, this article investigates Korean elementary classroom teachers' perceptions about mathematics education and speculation regarding factors that contribute to Korean students' high achievement scores.

Purpose

This survey study was conducted to investigate Korean elementary classroom teachers' perceptions regarding mathematics education. Two research questions guided this study: 1) What are teacher perceptions of Korean mathematics education? 2) What do Korean classroom teachers believe regarding the contributing factors to Korean students' high achievement scores in the international comparative studies?

Method

Participants

Classroom teachers were randomly selected by convenient sampling from the public elementary schools in the Chullabuk-do provincial school district which is located in the southwestern area of Korea. Participating teachers represented grades 1 through grade 6 (the Korean elementary school includes grade 6 at the elementary level) in 21 elementary schools. Two hundred teachers were selected and 141 of those classroom teachers (101 female, 40 male) completed and returned the questionnaire (70.5% response rate). Among them, 19 were first grade classroom teachers (13.5%), 22 second grade (15.6%), 21 third grade (14.9%), 18 fourth grade (12.8%), 31 fifth grade (22%), and 30 sixth grade (21.3%) classroom teachers. The mean of their teaching experience was 13.38 years. The mean class size was 33.45 students. . The mean teacher age was 36.66 years. One hundred twelve (79.4%) held a bachelor's degree and

Twenty- three (16.3%) held a master's degree. Six teachers (4.3%) were currently enrolled in a graduate program in pursuit of a master's degree in education.

Instrument

The 26-item 3 part survey instrument entitled "Teachers' Perceptions about Mathematics Education "(TPMC) was developed based on a comprehensive review of the Korean mathematics education and the current mathematics reform movement literature. This process to develop the instrument helped to establish face validity of the questionnaire. The first part contained questions about participants' demographic information, i.e., gender, age, teaching experience, grade level, and class size. The second part had 10 likert scale questions (agree, not sure, disagree) about their instructional pedagogy in mathematics education. For example, teachers were asked if real life application skills are the most important for the children to learn from their instruction in mathematics class. The Third part consisted of two open-ended questions and a forced-answer question (yes, no). The open-ended questions were asking their opinion about their instructional pedagogy and the factors they believe contribute to Korean students' high scores in the international mathematics comparative studies. The forced-answer question asked if the teachers were aware of the fact that Korean school students ranked high in the international mathematics comparative studies, such as the Trends in International Mathematics and Science Study (TIMSS). The survey questionnaire was developed in English first and translated by the researcher into Korean. The Korean version of the questionnaire was reviewed by an associated principal, with a master's degree in mathematics education and a classroom teacher with a particular interest in mathematics education. With the classroom teacher's assistance, the first draft of the questionnaire was given to thirty seven classroom teachers at a public school in a suburban area of Chonju city, Chullabuk-do, Korea. Based on the responses of the teachers, the final draft of the questionnaire was established.

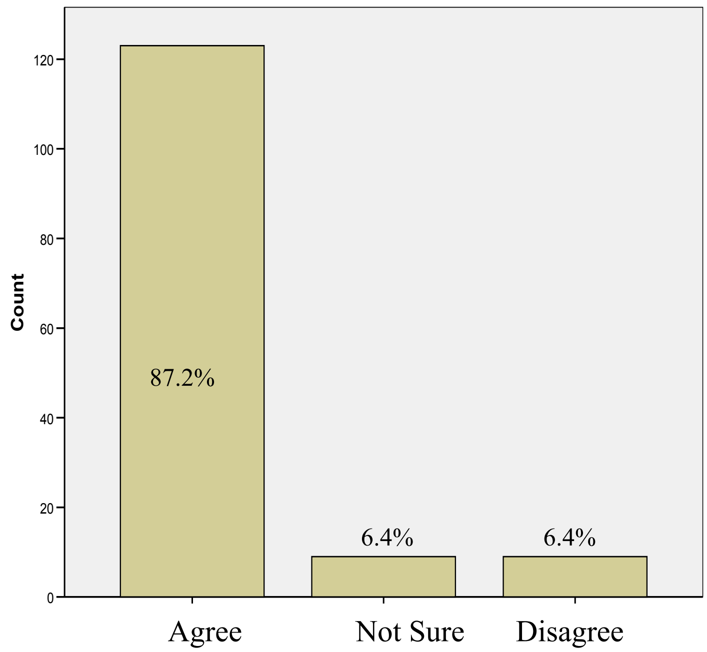
The questionnaire along with a letter explaining the purpose of the study and participant consent form was distributed from late May to late June, 2005. The questionnaire went to 24 elementary schools within Chullabuk-do provincial area with the assistance of the principals and associate principals. The questionnaires, completed anonymously by the classroom teachers, were collected by the principals and associate principals during the period of July and November of 2005. SPSS 14.0 for windows was used for data entry and analysis. A descriptive analysis utilizing frequencies and cross tabulation was employed to analyze the data to examine the purposes of this study.

Results

Teacher's beliefs about the educational pedagogy

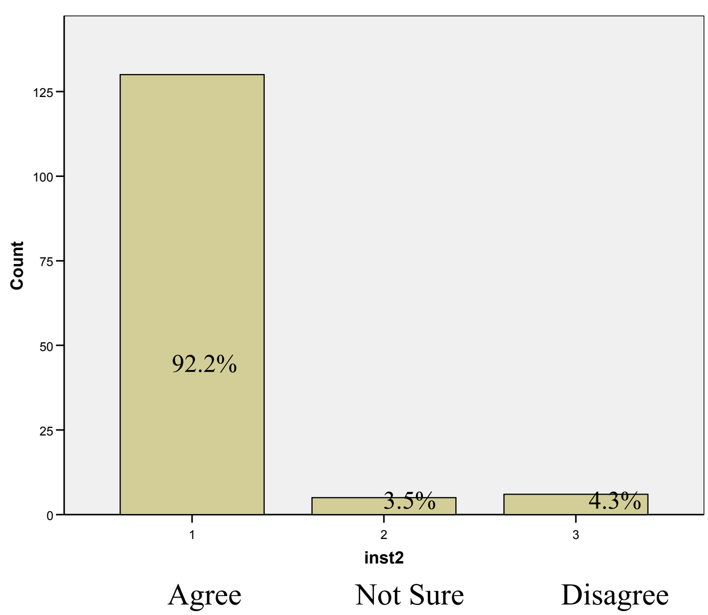
Using the SPSS 14.0 descriptive analysis and frequency of responses, one hundred twenty three teachers (87.2%) agreed that teaching children to apply mathematics knowledge and skills to real life is the most important skill. Nine teachers (6.4%) said they were not sure or disagree with the statement (see Figure 1).

Figure 1. Real life application is the most important in mathematics education.



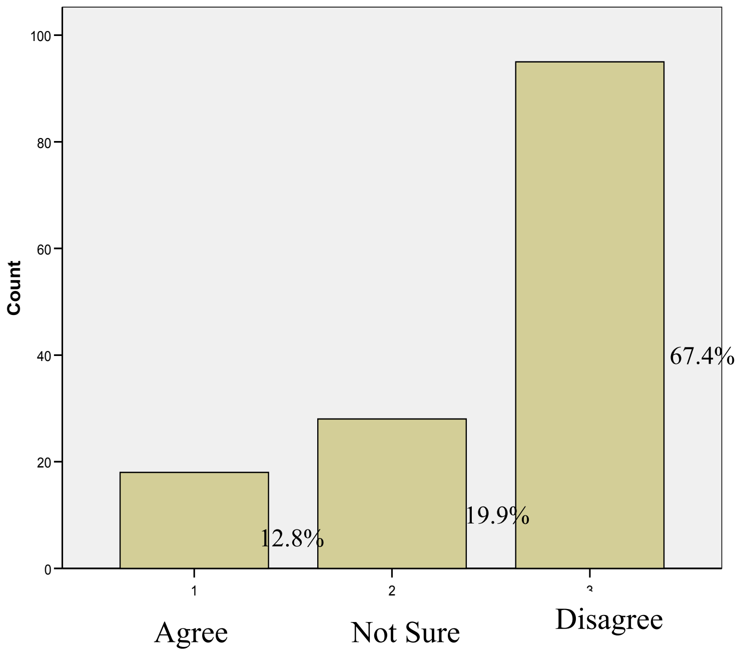
One hundred thirty teachers (92.2%) responded that they agree with the statement, "teaching students to see process while solving problem is the most import." Five teachers (3.5%) said they were unsure and six teachers (4.2%) disagreed (see Figure 2).

Figure 2. Process is very important in teaching mathematics



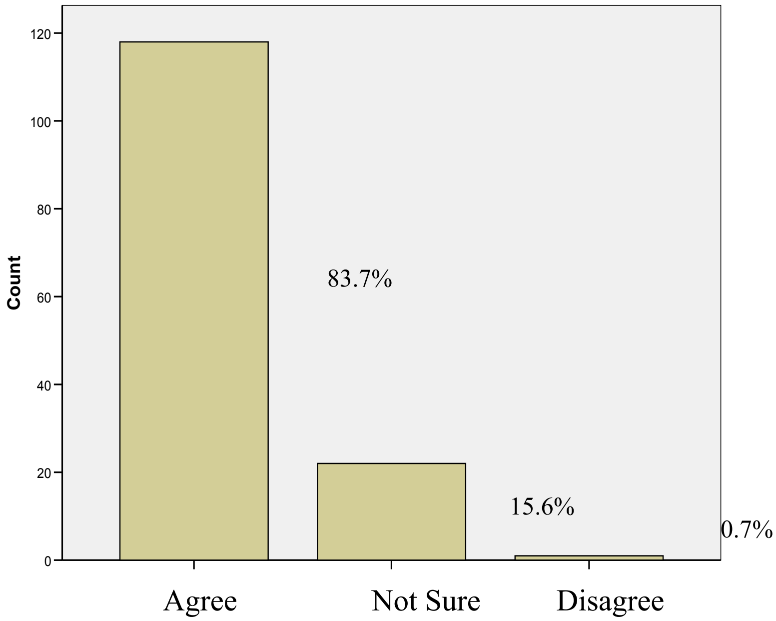
Regarding the statement "The most important thing is for students to memorize algorithms and use them to solve problems in mathematics education," ninety five teachers (67.4%) answered "Disagree," twenty eight teachers (19.9%), "Not sure," and eighteen teachers (12.8%) answered "Agree" (see Figure 3).

Figure 3. It is important to memorize algorithm to solve mathematics problems.



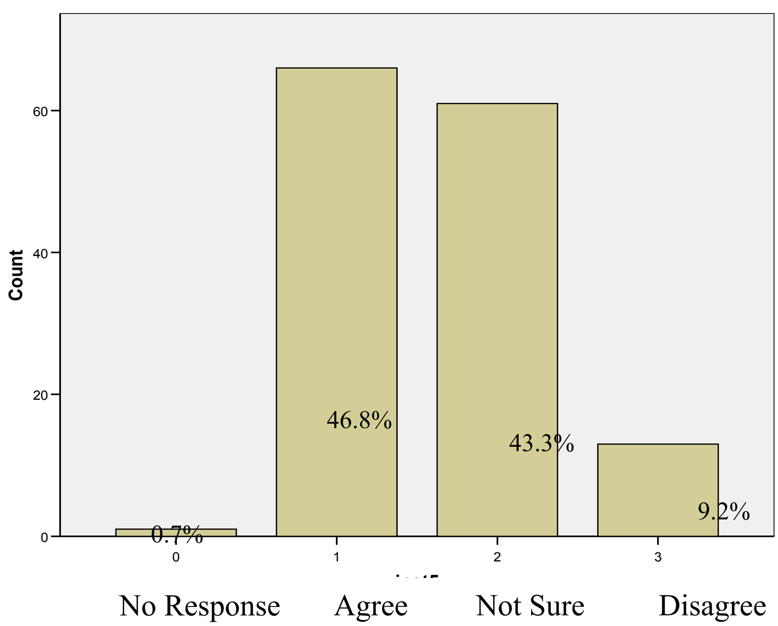
When classroom teachers were asked if various concrete manipulatives should be used to illustrate mathematical concepts for the students, one hundred eighteen teachers (83.7%) replied that they agreed, twenty two teachers (15.6%) were not sure and one teacher (0.7%) replied "Disagree" (see Figure 4).

Figure 4. To teach mathematics, we need to explain concepts using concrete materials.



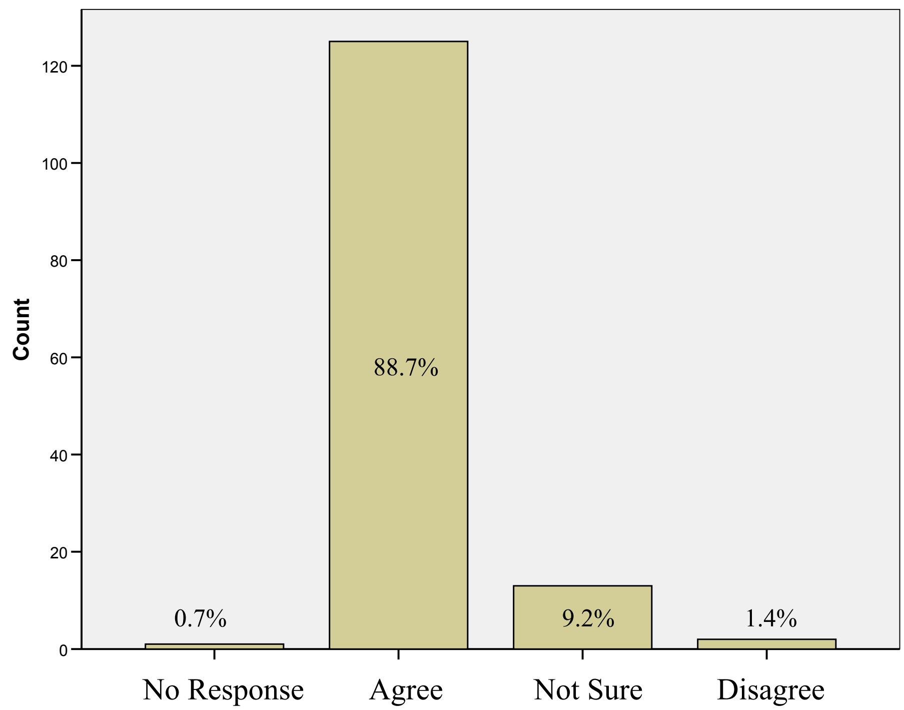
Sixty six teachers (46.8%) did feel confident explaining mathematics concepts to the students using various instructional manipulatives (i.e., small counters & Base-10 blocks). Sixty one teachers (43.3%) were not sure if they were confident or not; and thirteen teachers (9.2%) were not confident in teaching mathematics using different concrete instructional materials. One teacher (0.7%) did not provide an answer (see Figure 5).

Figure 5. I am confident explaining mathematics concepts to the students using manipulatives.



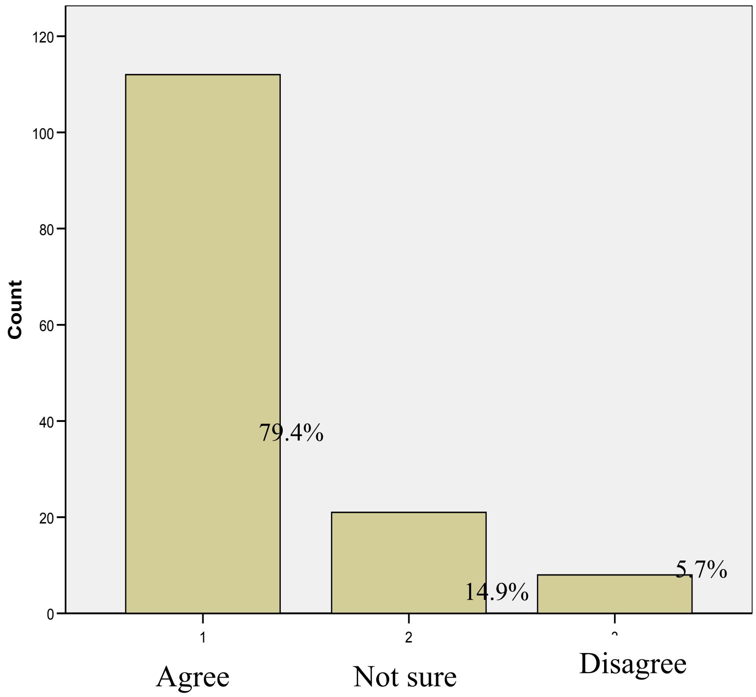
One hundred twenty five teachers (88.7 %) believed that concrete examples should be demonstrated first and then information related to abstract knowledge added to help students understand concepts. Thirteen teachers (9.2%) were not sure about it and two teachers (1.4%) disagreed with this statement. One teacher (0.7%) did not answer to the question (see Figure 6).

Figure 6. I need to help children develop abstract knowledge from concrete examples by illustrating the concept using concrete models.



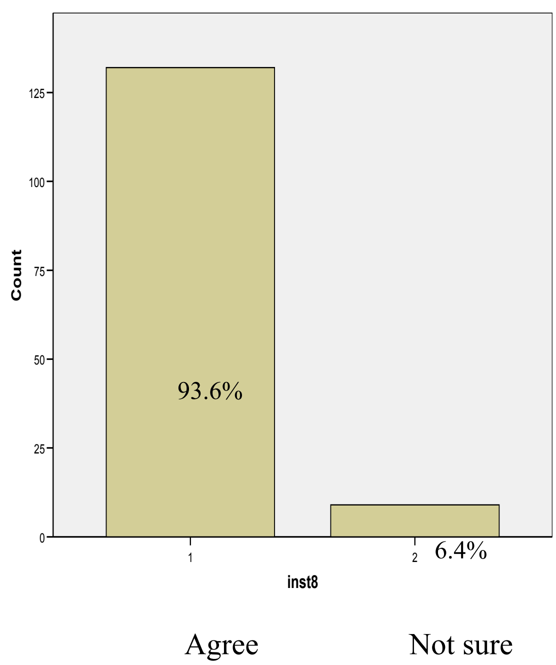
In terms of using concrete objects to introduce a new concept, one hundred twelve teachers (79.4%) said that concrete instructional materials must always be used when students learn new concepts. Twenty one teachers (14.9%) were not sure and eight teachers (5.7%) did not think it was an appropriate way to help students build concept (See Figure 7).

Figure 7. When introducing a new concept, we always need to use concrete objects.



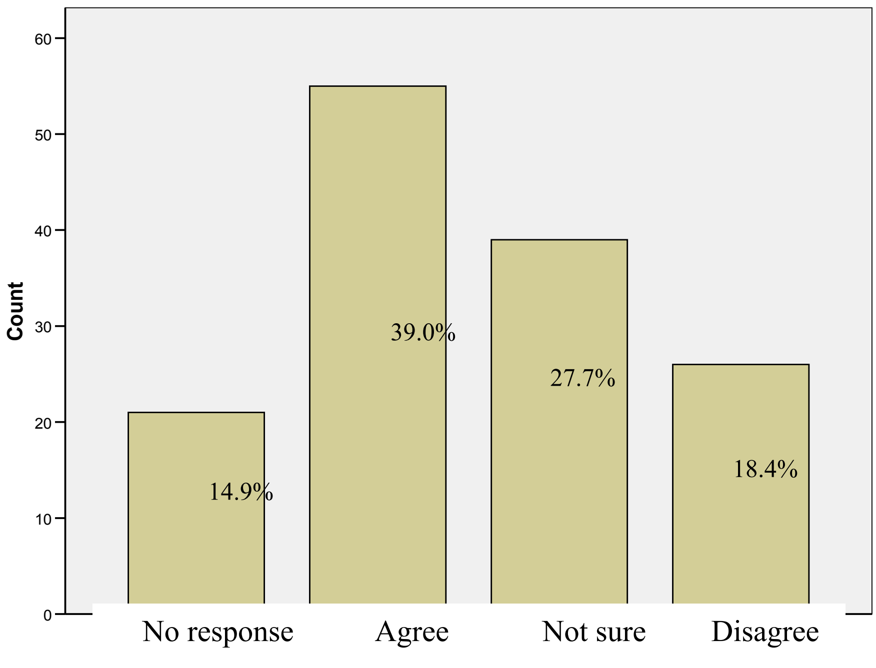
One hundred thirty two teachers (93.6%) thought both conceptual and procedural knowledge are equally important in teaching students mathematics. Only nine teachers (6.4%) were not able to answer either way. There were no teachers who disagreed with this statement (see Figure 8).

Figure 8. In mathematics education, conceptual knowledge is very important.



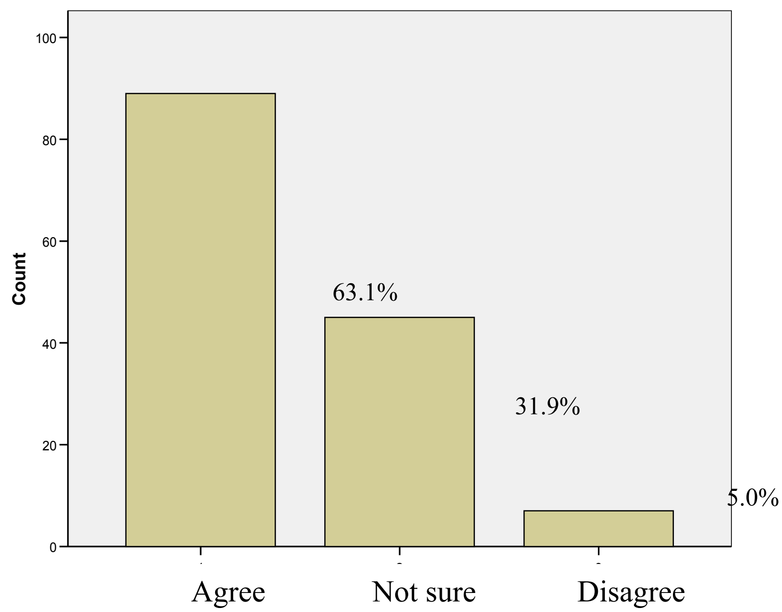
Teachers were also asked if algorithm was very important for mathematics education. Fifty five teachers (39%) agreed, thirty nine teachers (27.7%) were not sure, and twenty six teachers (18.4%) disagreed with the idea. Twenty -one teachers (14.9%) did not answer the question (see Figure 9).

Figure 9. In mathematics education, procedural knowledge is very important.



Eighty-nine teachers (63.1%) felt the students learn mathematics well through their instructional methods. Forty five teachers (31.9%) did not know if their instructional methods were effective and seven teachers (5.0%) replied they did not feel their instructional methods help students learn mathematics (see Figure 10).

Figure 10. I feel my students learn mathematics well through my instructional methods.



Teachers' educational pedagogy

In answer to a question regarding what is the most important thing they need to teach students in mathematics education, sixty one (26.6%) of total (229) responses indicated that the concept is the most important for the students to acquire. Fifty-nine responses (25.8%) indicated that understanding principles is the most important, and twenty responses (8.7%) indicated that understanding process was most important. Eighteen (7.9%) responded that helping students have fun with mathematics to increase interest in it, and seventeen (7.4%) said that students should develop problem solving skills. Sixteen teachers (6.9%) said that students should build logical thinking skills and fifteen (6.6%) said that real life application is very important in mathematics education. Other responses (between 0.4 - 3.9%) included that students' basic computational skills, using concrete manipulatives in teaching mathematics, allowing students to be self-motivated, helping students construct algorithms on their own, investing skills, cooperative learning skills, and memorizing facts were most important (see Table 1).

Table 1. What is the most important thing you need to teach mathematics in the elementary classroom?

	Items Teachers Think the Most Important in Teaching Math	**No. of Response**	**Percent (%)**
1	Understanding concepts	61	26.6
2	Understanding principles	59	25.8
3	Understanding process	20	8.7
4	Fun math and student's interest	18	7.9
5	Developing problem solving skills	17	7.4
6	Building logical thinking skills	16	6.9
7	Real life application	15	6.6
8	Basic computational skills	9	3.9
9	Using concrete manipulative	7	3.1
10	Student's self-motivation	2	0.9
	Construct algorithm	2	0.9
11	Investigation skills	1	0.4
	Cooperative learning	1	0.4
	Memorizing facts	1	0.4
Total Responses from Teachers		229	

Teachers' beliefs about Korean students' high score in mathematics

When asked if teachers were aware that Korean students achieved high scores in the international comparative studies in the area of mathematics, the majority of 141 teachers (93.6%) indicated they knew. Seven teachers (5.0%) were not sure and two teachers (1.4%) did not respond to the question.

The last open-ended question examined the teachers' speculations about why Korean students rank high in the international comparative studies in mathematics. Forty-three responses from teachers (22.1%) indicated that Korean students practice computational skills through repeatedly solving various mathematics problems. Twenty seven responses from teachers (13.8%) said private lessons at the after school program made students' gain high achievement scores because many Korean students take private lessons or tutoring sessions for mathematics. These private programs teach students mathematics at a higher grade level than the students are taught in school. These students who receive these special lessons demonstrate higher mathematical academic skills than those who did not attended private programs. Twenty four responses from teachers (12.3%) claimed parents' high expectation of their child's education resulted in students putting more effort into getting a higher grade in mathematics. Fourteen responses from teachers (7.2%) alleged that students think mathematics is very important for their success in school and focus on the study of it. Twelve of the responses from teachers (6.2%) indicated that parents' active involvement in their child's education attributed to Korean students' high achievement scores. Ten responses (5.1%) stated that the zeal of education and competitive college entrance exams generated students' high scores. Other responses (between 0.5% - 4.6%) included that students' hard work; that success results from mathematics skills taught in early childhood settings; that well developed mathematics curriculum; and that students were inherently smart and test-wise. Teacher and parents' perception about math as an important subject, as well as the teacher's hard work were also cited (see Table 2).

Table 2. Why do you think Korean students achieved high scores in the international mathematics assessment comparative studies?

	Factors contributing to students' high achievement	**No. of Response**	**Percent (%)**
1	Focus on practice and drill in solving problems	43	22.1
2	Private lessons at the after school programs	27	13.8
3	Parent's high expectation on child's education	24	12.3
4	Think math is very important and focus on it	14	7.2
5	Parent active involvement in child's education	12	6.2
6	Zeal of education in the society	10	5.1
	Preparing for college entrance exam	10	5.1
7	Student's hard work	9	4.6
8	Math taught in early childhood setting	8	4.1
9	Well developed math curriculum	7	3.6
10	Students are smart	6	3.1
11	Students are test-wise	5	2.6
	Various competitive math contests	5	2.6
12	Curriculum is difficult in content	3	1.5
13	Understanding principles	2	1.0
	Teacher & parent think math is important	2	1.0
	Teacher's hard work	2	1.0
14	TIMSS does not assess creativity	1	0.5
	Korean nationalism	1	0.5
	Gifted education	1	0.5
	Individual Excellency/superior	1	0.5
	Test result is only from upper academic level students	1	0.5
	Competitive society	1	0.5
Total Responses from Teachers		195	

Discussions and Conclusions

The findings of this study indicate that Korean elementary classroom teachers' educational pedagogy is based on Constructivism, which proposes that children construct their own knowledge of mathematics. The majority of the teachers (87.5%: mean for all questions) thought real life application and understanding the process of problem solving aided learning. The believe that use of concrete materials to explain mathematical concepts and connection between conceptual understanding and abstract knowledge are important, as well as recognizing that conceptual knowledge is very important in mathematics education. In the Constructivist classrooms, students learn through action, discovery-oriented activities and guided questions and discussions (DeVries & Kohlberg, 1987).

When teachers were asked to provide their speculation regarding the contributing factors to Korean students' high mathematics achievements in international comparative studies, the top three responses were: (1) Korean mathematics education still focuses on practice and drills computational skills; (2) private lessons in after school programs are common; (3) parents' high expectations for their child's education influence children's performance.

This study has revealed that Korean elementary classroom teachers were well aware of the current mathematics reform movement based on Constructivism. They used Constructivist theory to influence their educational pedagogy. However, interestingly, these teachers identified that the first factor contributing to students' high mathematics achievement is emphasizing computational skills in mathematics education. This implies that Korean classrooms teachers use traditional instructional methods in their actual classrooms that focus on computational skills even though the majority of Korean teachers' educational pedagogy in this study was founded Constructivist approach. A study conducted by Shuhua (2000) reported that teachers' pedagogical beliefs about mathematics play a significant role in shaping their instructional practice, but Korean elementary teachers did not seem to practice Constructivist instructional methods in the classrooms, even though they believed that Constructivist-based teaching is very important. Kutz (1991) indicated that, in actuality, classroom teachers tend to be neither traditionalist nor Constructivist in the sense that they teach in ways that they were taught and in ways that seem to work. The decision about how to teach is based on one's own teacher education, learning theory, tradition, socialization into the school system, past schooling, and student reactions to teaching practice. As a result, many classroom teachers blend the learning theories of the traditionalist and Constructivist literature, but more closely follow those practices characterized by the traditionalist learning theories. A traditionalist approach is based on the behaviorist theory, where the classroom is dominated by teacher talk (Goodlad, 1984) and the teachers rely heavily on textbooks, drills, and worksheets (Ben-Peretz, 1990). Teachers try to discover whether students know the right answers (Brooks & Brooks, 1993). The instructional emphasis lies in the outward production of responses. These descriptors explain why Korean elementary classroom teachers are using a traditionalist approach that emphasizes practices and drills in their actual classrooms, in spite their educational pedagogy was based on Constructivism.

The second factor, claimed by Korean elementary school teachers, was that private lessons students received in after-school programs influence student success. This obviously influences high achievement scores in mathematics competition because the tutors or instructors in the private programs could not help focusing on speed and accuracy to prepare students to solve problems quickly. Parents who pay for the private lessons expect success in their child's mathematics scores on the exams. Because of this, students are trained to be test-wise by mastering algorithms. In school, teachers have students who already know the answers even before the concept are explained because these students have already mastered algorithms through the private tutoring. This issue might generate Korean elementary school teachers' reluctance to incorporate the Constructivist way of teaching using concrete objects to teach concepts. Sherman and Richardson (1995) studied elementary school teachers' beliefs and practices related to teaching mathematics with manipulatives. They reported that teachers tended to choose traditionalist approach due to concerns about discipline and classroom management issues. If teachers have students who represent a wide range of mathematics abilities, teachers spend more time controlling the class than practicing their effective instructional methods, especially since Korea was reported to have the highest student-to-teacher ratio (approximately 33 students per class) in elementary classrooms among the 40 countries in the Trends in International Mathematics and Science Study (TIMSS) in 2003. The mean class size of the teachers who participated in this study was 33.45 students.

The third contributing factor indicated by the Korean elementary teachers was parents' high expectation of child's education. One of the explanations discussed in other research studies in terms of this factor is the Confucian Heritage Culture (CHC) referred by Biggs' study "*Western misconceptions of the Confucian-Heritage Learning Culture* (1996, p. 46). As in other East Asian countries, Koreans share a common cultural value underlying this CHC. The values under CHC include a strong emphasis on the importance of education, high expectation for students to achieve, attribution of achievement more to effort than to innate ability, and a serious attitude towards study (Park, 2004, p. 91). Koreans place a very high value on academic credentials and on securing a good education for their children. Parents' self-esteem was intimately tied to the academic success or failure of their children. Another explanation for Korean parents' high educational expectation centers on the extremely competitive national college entrance examination. Mathematics is one of the four areas that are assessed on the college entrance examination. Because of this reason, students must be successful in mathematics and schools tend to place a relatively high importance on the subject of mathematics (Park, 2004). This fiercely competitive nature of the Korean educational system has made students' academic success, especially for mathematics, an all-consuming enterprise for most families, requiring much time, energy, money, and sacrifice, with the mother assigned to this task full time (Kim, 1996). Most Korean children from the elementary and even from the preschool level had to attend after-school private tutoring sessions as Korean elementary teachers said in the early section of this study. This often precipitated a soaring financial burden for the whole family. Due to this financial sacrifice of their parents and family members, Korean parents expect their children to achieve academic success by excelling in school. The child brings honor to the family while preparing for future educational and occupational success that would improve the family's social status and ensure financial support for the parents as well as the individual and his/her family (Serafica, 1990). With this high value placed on education and the family's sacrifice for education, parents and students consider education very seriously and put forth their efforts in doing well in mathematics. This resulted in Korean students getting more effective instruction and practice in mathematics.

The results of this study projected some common factors that were discussed in the report done by Park (2004). She listed the factors contributing to Korean students' high achievement in mathematics as: 1) College examination and selection; 2) Korean number system; 3) Attitudes of students towards tests; 4) Pragmatism and repetitive learning; 5) Competence of mathematics teachers; and 6) Competence cycle. Issues about the college examination and selection and attitudes of students towards test are very closely related to what the Korean elementary classroom teachers suggested in this study. Another report done by Fuchs and Wobmann (2004) examined the PISA data regarding the accounts for international differences in student performance and concluded that student characteristics, family backgrounds, home inputs, resources and teachers, and institutions all contribute significantly to differences in students' educational achievement. The issues reported by these reports share the same baseline and are intertwined among contributing factors to mathematics education, but used different terms to categorize the factors. This study attempted to investigate factors that attribute to Korean students' high achievement scores in mathematics education, but this research showed that it would be very hard to find single or distinctive factors since all the factors contribute in an interactive way with each other.

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