The elementary school teachers' belief of integrating calculator into mathematic instruction

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Abstract: *This study uses a questionnaire to investigate elementary school teachers' beliefs of applying calculators in teaching mathematics. Participates were 131 elementary school teachers in Taoyuan County. The questionnaire used to collect data was revised from the instrument designed by Brown et al.(2007). Elementary school teachers' beliefs of applying calculators in teaching mathematics were divided into three factors: Catalyst beliefs, teacher knowledge and crutch beliefs. The result showed that elementary school teachers in Taoyuan County do not seem to agree with using calculators in teaching mathematics. Elementary school teachers thought that calculators could not promote students' learning of mathematics and students will depend on using calculators and they impede students' learning. Meanwhile, the teachers thought that they had low teaching efficiency when using the calculator in their classes. The other result indicated that teachers who had technology efficiency of information tools, who participated in related training activities, and who had the willing to popularize the calculator application into mathematical teaching in classes agreed to the idea that using calculators can promote mathematical learning, and can help students construct not only knowledge, but also increase conceptual practice and desire .*

1. Introduction

Research Purpose and Background

Knowing how to use the calculator is one of the most basic skills to have in the world today. In the past, the calculator played a minimal role in the curriculum of primary schools. The calculator was placed in a separate unit where students used them to make big calculations or to check their answers. However, the National Council of Teachers of Mathematics (NCTM, 1989, 2000) in the United States revised their original curriculum standards, and claimed that the calculator must now be incorporated into the curriculum of primary schools. In 2007, the Ministry of Education in Singapore also announced their plans to incorporate calculators into their educational policies of mathematics. When they explained the benefits of using the calculator when learning math, the calculator became a hot discussion topic by the public, which allowed the government to push for actual implementations and practical changes to the teaching of mathematics (Ministry of Education, 2007). Therefore, the integration of the calculator into math courses in international education is now a growing trend.

In 1993, when Taiwan announced their new standards for the math curriculum and revised their grade one to nine curriculums, they also emphasized that teachers should use calculators when they teach. This advice shows that Taiwanese educational policies are gradually placing more emphasis on incorporating the calculator into math courses and general applications. However, there is a problem. After all, the teachers have control over the course that they teach, including what kind of outside resources they would like to incorporate into the class material. Generally, the teachers' choices are
based on what they personally think about the outside resources; therefore, the teachers would choose to follow their beliefs as opposed to the given educational curriculum (Brinkerhoff, 2006). The question arises: Although the use of the calculator has already become an important educational

policy for the math curriculum of primary schools, do the teachers actually believe this as well, and have they practically and effectively incorporated calculators into their teachings?

Research shows that the use of the calculator has remained relatively low. For example, results of a sample survey conducted on fourth graders in the U.S. show that 37% of the students rarely or never used calculators in their studies (Grouws et al., 2004). This survey further explained that one of the main reasons for the low use of calculators is due to the teachers' beliefs (Albion & Ertmer, 2002; Brinkerhoff, 2006). Although there has been related research on this topic in other countries, there has been none in Taiwan. Accordingly, this research paper aims to investigate Taiwanese primary school teachers and discover what they feel about using calculators in their teachings, in order to serve as the basis for further research on this topic.

Research Objective and Research Question

This research uses questionnaires to explore the beliefs that the primary school teachers have towards integrating calculators into the math curriculum. The purpose of this study is to answer the question: What do primary school teachers feel towards integrating calculators into the math curriculum?

2. Literature Review

Integrating the calculator into the study of math will become the future trend in education, not only because the calculator can easily go beyond the limits of mental math, but also because it allows the students to discover the patterns and nature of numbers through its accuracy. Psychologically, presenting math concepts in different ways and incorporating the use of outside resources can affect the external cognitive load of the students. Minimizing the students' external cognitive load can make their learning more efficient; thus, the calculator offers several benefits to learning. The most basic advantage is that it decreases students' psychological concern of making simple math mistakes. Additionally, incorporating the calculator into different educational activities can also increase the students' motivation to explore and to discover, as well as to enhance their thinking abilities in the process of using the calculator.

In the past, although there have been claims that using calculators will decrease the students' calculation abilities, much research now not only shows that using calculators in primary schools will not decrease their abilities, but can actually help students learn basic math concepts and increase their skills to solve problem sets. Calculators can even help students discover new problem-solving strategies, which allow people in general to possess increasingly positive attitudes towards the use of calculators. Hembree and Dessart (1992) conducted research that evaluated 79 studies on the effects of incorporating calculator applications into course materials. Results show that when the students use calculators, their performances on problem-solving improve. The research further explains that using calculators in primary school education can help students improve by allowing them to tackle the problem sets using the right methods and problem-solving strategies. The calculator not only allows students who are slower at learning to have time to solve the problem sets, but also allows them to further understand the basic concepts behind the math problems (Southwell, 1988). Some research results also support the incorporation of the calculator into math education due to its feasibility and relevance (Liu, 1994; Yang, 2004).

However, countries in the East and the West do not necessarily incorporate the same amount of material related to the calculator into the math curriculum. There are two major trends: The first trend explains in detail how to incorporate the calculator into math education, epitomized by countries such as the United Kingdom, the U.S., and Singapore; the other simply mentions how to use the calculator to solve problem sets but mostly overlooks the role of the calculator, which is the phenomenon in Japan, South Korea, and China. Currently, Taiwan is leaning towards the latter

trend, where it is still not common for primary school math educators to emphasize using the calculator as a supporting resource. The failure of the education reform policy is often attributed to the difference between the belief of the teachers and the education policies. For teachers to change their teaching methods usually requires self-intuition. They need to first become personally aware of the new tools and concepts in order for them to accept and execute the changes (Dale & Trish, 2001). In other words, since the teachers have the ultimate say in their teaching methods and supporting materials, whether or not the calculator will be incorporated as a learning tool is entirely dependent on the teachers' beliefs. How the teacher feels about a new tool is dependent; however, on their professional experience with the tool, the tool's effects on the student, and other factors; therefore, if the teacher does not have confidence in his or her own professional knowledge of using the calculator and integrating it into math education, and does not believe that the calculator can help the students learn better, then it will be difficult for the teacher to take the initiative to use the calculator in his or her teaching. Understanding the beliefs of the teachers is; therefore, the first step in promoting the use of the calculator in math education.

In recent years, some research has been done on the use of the calculator in math education as well as related studies on the beliefs of the teachers pertaining to the use of the calculator. For example, there was a poll (Yeo, 2008) that surveyed the leaders of the mathematics department in 43 primary schools in Singapore. Results show that the leaders believe the calculator is beneficial to beginner level math, and they also agree that students have a better understanding of math and find it more entertaining when using the calculator. In addition, their self-described beliefs, knowledge, and teaching experience all match the factors mentioned in the Ministry of Education in Singapore's 2007 statement on the use of calculators for fifth and sixth grade in primary school. Adabor (2008) surveyed 179 primary and high school math teachers in Ghana, and discovered that the majority (84%) of the teachers surveyed believe that students should learn how to use the calculator. Eighty percent (80%) of these teachers also feel that before allowing the students to use calculators, the students need to first grasp the basic concepts and logic of math. Furthermore, in response to the suggestions made by NCTM, a researcher conducted a study on primary school teachers, and discovered that in the region researched, the majority of the math teachers use the calculator 6.6% more time than average. Compared to other units, the calculator appears more in sections on numbers and quantity (Miller, 2003). The teachers also admitted that it does not matter whether the calculator facilitates or hinders the students' learning; a teacher's belief towards the calculator is the determining factor, along with the teacher's own education level on the amount of calculator use. As mentioned above, integrating the calculator into math curriculums has gradually gained importance in international education. Whether Taiwan's education policies will follow and promote these ideas and whether the calculator will help the students learn mathematics make the teachers' beliefs an important question. The researcher believes that it is important to first explore this topic on a broad scale and then to investigate it in detail.

3. Research Method

Research Method and Samples

The purpose of this research is to investigate what primary school teachers feel about incorporating calculators into the math curriculum. This research used questionnaires and selective samples. It surveyed fourteen primary schools in Taoyuan, which includes 131 teachers in total.

Research Tools

This research used the questionnaire "Teachers' Beliefs in Calculator Use in Primary School Math" written by the researcher. The first section of the questionnaire collected the basic information of the participants. The second section used the questionnaire written by Brown and

others (2007) on the beliefs, knowledge, and practices of the teachers regarding the use of calculators as the blueprint. The original questionnaire measured the answers on a five-point scale, included 20 scenarios that can be divided into four categories: Catalyst beliefs, teacher knowledge, crutch beliefs, and teacher practices. After experts conducted a validity check on the questionnaire, the researcher decided to take out two questions from the original questionnaire, which included Question 4, "In class, does a student who has experience using a calculator for more than one year perform better in math than a student who does not have such an experience?" and Question 12, "Since some students have calculators at home and some do not, would the use of calculators in the classroom create an unequal situation?" The researcher also edited and adjusted the remaining questions according to the situation in Taiwan. In the end, the questionnaire contained 18 questions and used Likert's four-point scale.

After collecting the samples, the researcher conducted a factor analysis using the largest variation analysis method and obtained three factors. Factor one is "catalyst beliefs" with questions from 1 to 6; factor two is "crutch beliefs" with questions 7, 9, 15 to 18; and factor three is "teacher knowledge" with questions from 12 to 14. Since the increase in the proportion of the total load factor was not high for "teacher practices," the researcher decided to take out this factor, thus taking out questions 8, 10, and 11. The total cumulative loading is 62.738. The Cronbach's Alpha value for the section on beliefs is.851, which is slightly higher prior to deleting the questions. Every question used 3 points as the key value to determine the significance of the data. The three factors have scores of 18, 18, and 9 respectively, with the total score being 45. These scores were used for analysis and interpretation. In terms of the scoring, the higher the score, the more the teacher supports using calculators in math education. For factor one "catalyst belief" and factor three "teacher knowledge," the higher the score, the more the teacher agrees that the calculator is beneficial and positive for the study of math and that calculators can make studying more efficient. For factor two "crutch beliefs," the higher the average score, the more the teacher believes that the calculator will lower not only the students' dependency, but also the obstacles faced when learning.

Implementation Process

After establishing the research purpose and question, the researcher started to translate and form the research tool scale into a questionnaire in November 2008. Primary school math teachers from Hsinchu City and Taoyuan County, and professors from the Department of Applied Mathematics of a private university conducted a professional review on the questionnaires, and edited the descriptions for and the numbers of the questions. The questionnaire was finalized in January 2009, and the field work was carried out in February. The researcher sent out 140 questionnaires, and planned to stop collecting questionnaires after 100 were returned. By March, data collection had been completed, and the researcher continued with descriptive and statistical analysis, as well as research discussion.

With regards to the source of data collection, the researcher received help from 14 graduate students studying at the Graduate School of Education at Chung Yuan Christian University who are working as primary school teachers. The teachers looked for ten other teachers in the school they are teaching at, with a total of 140 participants, all full-time primary school teachers. Participant teachers agreed to take the questionnaire, and by March, the researcher received back 131 questionnaires.

Data Analysis

Hypothesis: Primary school teachers who have different backgrounds will have different beliefs and opinions about incorporating the calculator into math education.

Analysis Method: This research uses the statistical analysis software SPSS to compute the data and evaluate the results. For different variables, the program tests the data using the One Way ANOVA analysis.

4. Results

Basic Information of the Research Samples

Results of this research were gathered from 131 samples, as organized in Table 1.

Table 1: Basic Information Organizational Chart

Sex	Male 25	Female 106	
Age	Above 30 years old 95	Less than 30 years old 36	
Highest Level of Education	University 106	Graduate School 25	
Years in the Field of Education	Less than 5 Years: 25	6 to 10 Years: 58	More than 11 Years: 48
Participated in Related Research or Activity	11 (Highest Frequency: One person participated in 6 related activities or research)		
Interested in Participating in Related Research or Training in the Future	108		
Agreed to Promote Calculator Use in Primary School Math Courses	91		

With regards to the data received for the two parts on “Interested or Not Interested in Participating in Related Research or Training in the Future” and “Agree or Disagree to Promote Calculator Use in Primary School Math Courses,” the participants have inconsistent reactions. For example, even if the participant is interested in participating in related research, he or she might not agree to the promotion of calculator use in primary school math courses, and vice versa. There were 24 participants who showed such inconsistencies, which took up about 18.32% of the total sample.

Participants’ Opinions on Calculator Use in Math Education

By conducting descriptive data analysis on the information collected from participants on the scales table—as shown in Table 2 below—results indicate that under normal distribution, using the difference between the key value to the total score, the average score for factor one “catalyst beliefs” and factor three “teacher knowledge” is close to one standard deviation, and the average score for factor two “crutch beliefs” is close to two standard deviation. The data showed that the majority of the participants tend to disagree that the calculator in general does not apply to catalyst beliefs and teacher knowledge, but most of them agree that it applies to crutch beliefs.

Table 2: Descriptive Statistics on the Subscale Scores for Different Factors and the Total Score

	Number of People	Average	Standard Deviation
Factor One	124	16.2997 < 18	3.19
Factor Two	124	12.4036 < 18	2.96
Factor Three	124	8.0763 < 9	1.77
Total	124	36.8750 < 45	5.59

To test the hypothesis of this research, the researcher used the data gathered from the subscale table and the basic information of the participants and conducted a one way ANOVA test. Results showed that for the variables "Interested or Not Interested in Participating in Related Research or Training in the Future" and "Agree or Disagree to Promote Calculator Use in Primary School Math Courses", there was a significant difference for factor one "catalyst beliefs" (F=9.709, p-value=.002 < .05; F=35.481, p-value=.000<.05). This result matched the research hypothesis. As for the other variables, including sex, age, highest level of education, years in the field of education, main grade level taught, "Participated or Not Participated in Related Research or Activity in the Past", there was no significant difference in the beliefs of the teachers on the use of calculators.

5. Conclusion and Recommendations

For the section on the basic information of the research samples, only 8% of the total teachers have participated in related research or activities in the use of calculators in math applications. However, for the two questions on "Interested or Not Interested in Participating in Related Research or Training in the Future" and "Agree or Disagree to Promote Calculator Use in Primary School Math Courses," although there were a higher proportion of participants that had positive responses, there were also some participants who interestingly showed inconsistent responses. To explain the reason for this phenomenon requires further data collection.

In conclusion, the teachers tend to oppose calculator use in math education and believe that the calculator cannot enhance students' understanding of math concepts. At the same time, they also feel that in the process of using the calculator, the students will develop a dependency on the calculator, and the use of the calculator itself will become an impediment to learning. The teachers themselves also believe that use of the calculator will also lower the efficiency level of teaching. Only teachers who have participated in related studies or activities in the past, and teachers who agree to the promotion of calculator use in class activity believe that the calculator can enhance studying; these teachers hold a relatively more positive attitude towards the use of the calculator in primary school math education.

The results gathered from this research are not completely the same as the results gathered from the research conducted on Singaporean teachers using the subscale table. Only under certain sections do the teachers from the Taoyuan area and the Singaporean teachers have positive attitudes towards this discussion topic. The results of this study show that the attitudes in Taiwan, Japan, South Korea, China, and countries in the East are more conservative. In the future, if related departmental units would like to promote calculator use in primary school math education, they might want to imitate the educational policies of the countries in the West, and they should also host similar research activities and encourage the participation of the teachers. Through these events, the teachers can understand the meaning and significance of using calculators in primary school math

education. Only when both of these reasons change the opposing attitudes held by the teachers can widespread calculator use in primary schools become a reality.

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