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Testing Instrumentation Validity for Measuring Teachers' Attitudes Toward Manipulative Use in the Elementary Classroom.

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Abstract: In this study a survey instrument was developed to test elementary teachers' attitudes towards incorporating manipulatives in their math lessons frequently. Though the benefits of using math manipulatives has been reported, there seems to be a disconnect between the benefits of manipulative use and the number of teachers integrating them in their lessons on a daily basis. In this study a total of 22 regular education teachers in kindergarten through sixth grade and five learning support teachers in grades first through sixth from a rural elementary school were given a survey instrument to test its validity and reveal some trends in teachers' views on manipulative use as well as possible causation for their views. Findings from the study show that though many teachers feel comfortable using and incorporating manipulatives into their lessons, many have not had adequate preservice or inservice training in their use. Therefore, the lack of daily use of incorporating manipulatives may be connected to the lack of adequate training that teachers have received.

What Are Math Manipulatives?

There are many different definitions for the term manipulative. One such definition defines a math manipulative as, "concrete models that incorporate mathematical concepts, appeal to several senses and can be touched and moved around by students" (Hynes, 1986, p.11) An additional definition from the same time period states that, "Manipulative materials are objects that appeal to the senses and can be touched, moved about, rearranged, and otherwise handled by children…. They can be objects from the environment, such as money or measuring instruments, or materials specifically designed to teach mathematical concepts, such as base-ten blocks and balances" (Kennedy, 1986, p.6). Another definition by Swan and Marshall states, "A mathematics manipulative material is an object that can be handled by an individual in a sensory manner during which conscious and unconscious mathematical thinking will be fostered" (2010, p.14). All these definitions have one thing in common; they state that math manipulatives are a tool that is helpful for hands-on sensory learning. Math manipulatives help students to visualize math problems and

guides them in the process of hands-on learning and later to thinking abstractly about math concepts. Manipulatives create a virtual world of mathematics and allow students to go beyond thinking in terms of symbols to understanding the deeper meaning of math concepts. So why is it that so few educators use them on a consistent basis?

The Benefits of Manipulative Use

"Mathematical manipulatives offer students a way of understanding abstract mathematical concepts by enabling them to connect the concepts to more informal concrete ideas" (Uribe-Flo´rez & Wilkins, 2010, p. 363). There have been many studies done to show the benefits of incorporating math manipulatives into math lessons; "the use of manipulatives to promote student learning is considered a best practice pedagogical technique" (Moch, 2001, p.82). However, incorporating them properly into a shared learning environment and appropriately guiding students in their use is easier said than done. As stated by Ball (1992), "Teaching with manipulatives is not just a matter of pedagogical strategy and technique. Few well educated adults-not just teachers-can devise or use legitimate representations for many elementary mathematical concepts and procedures" (p.47). Studies have also shown that many preservice and cooperating teachers (who are often seen as examples of excellent educators) often carry misconceptions about certain mathematical concepts, which they in turn pass down and perpetuate the cycle of teaching misconceptions to their students. In a study done by Green, Piel, and Flowers (2008) on reversing education majors arithmetic misconceptions using manipulatives, many preservice teachers carried misconceptions with all four arithmetic operations and though they were able to correctly solve many mathematical computations, few could demonstrate their answers correctly by using manipulatives. This evidence further reinforces that, "using a manipulative approach to mathematics instruction requires the knowledge, skills, and experience necessary to respond to students who are learning mathematics in this environment" (Hatfield, 1994, p.303).

Another barrier to the appropriate use of manipulatives in mathematics classrooms is the trend of dwindling usage of manipulatives from the primary elementary grades (k-3) to the intermediate elementary grades (4-6). Even with the same access to a variety of different manipulatives primary teachers use of different manipulatives has been shown to be significantly higher than that of intermediate level teachers (Hatfield, 1994). It seems that some teachers' beliefs towards manipulative appropriateness changes through the elementary grades and could be related to the absence of teachers' knowledge about suitable intermediate level manipulatives; for example, fraction bars or centimeter cubes. Some studies have shown that teachers in the upper elementary grades

feel that older students have the ability to reason abstractly and therefore have less of a need for manipulative use (Uribe-Flo´rez & Wilkins, 2010). This shows that teachers' beliefs greatly influence their frequency and use of manipulatives in their classrooms. Also, the factor of grade level taught and manipulative use could also be related to years of teaching experience; some studies have shown that more experienced teachers tend to use manipulatives more frequently compared to novice teachers (Uribe-Flo´rez & Wilkins, 2010). However, this factor could also be related to the type of preservice or inservice training the teacher has received, as well as, the novice teacher's disadvantage of less experience working in and organizing a classroom and being overwhelmed by the many responsibilities involved with teaching for the first time.

Other factors such as understanding the benefits of manipulative use for students of different intelligence levels are also related to incorporating them into math lessons. Manipulatives are beneficial to students of regular intelligence as well as those with learning disabilities, showing their ability to be used in a multitude of classroom settings, whether it be inclusion or pull out. In a study by Moch (2001) when working with 60 fifth grade students, for only 90 minutes twice a week, she was able to see improvements in both the students' sematic and episodic memory (two brain systems related to retention). Also, by coaching the classroom teachers on ways to properly incorporate manipulatives and, "by facilitating students' self-instruction and systematic problem solving strategies in mathematics, teachers achieved improved performances for elementary students with learning disabilities. Therefore, activities that teachers planned using manipulatives not only benefitted regular students but also met the needs of inclusion students without additional modification" (Moch, 2001, p.84).

Purpose of the Current Study

As stated formerly there have been many reports that demonstrate the student benefits of using manipulatives in math lessons. However, there seems to be a disconnect between the benefits of these learning tools and the number of teachers incorporating them. Things such as years of teaching experience, grade level taught, lack of professional development and improper preservice training, understanding benefits for students of different intelligences, and understanding ways in which manipulatives can be used are all factors effecting teachers' attitudes towards manipulative use. This study plans to test instrumentation that will be used to show the relationship between the previous factors and their effect on teachers' attitudes and the privation of manipulative use.

The following research questions guided the creation of the instrument:

1. What is the relationship between grade level taught and the use of manipulatives in math lessons?

2. What is the relationship between years of teaching experience and the use of manipulatives in math lessons?

3. Are teachers given enough experience with learning how to teach with manipulatives in their preservice programs and or inservice training?

4. Do teachers feel inadequate in how to incorporate math manipulatives in their daily lessons due to lack of preservice programs and or inservice training?

5. Do teachers know the benefits of using manipulatives for students of all different intelligence levels?

6. Do teachers have misconceptions about the appropriateness of using manipulatives according to grade level and math concept taught?

7. Do teachers have misconceptions about the power of manipulatives and their different uses as tools?

8. Do teachers find it difficult and or time consuming to incorporate manipulatives into their math lessons?

Through these research questions I plan on testing the validity of the created instrument and to bring insight into the field of mathematics education as to reasons for teachers' attitudes towards math manipulative use on a daily basis.

Literature Review and Background to the Current Study

Support for Manipulative Use

"Learning theories suggest that children whose mathematical learning is firmly grounded in manipulative experiences will be more likely to bridge the gap between the world in which they live and the abstract world of mathematics" (Kennedy, 1986, p.6). For this very reason many studies have been conducted to show the great benefits students attain from the use of hands on learning with manipulatives. It is however not sufficient for students to simply observe a demonstration of the use of an aid by their instructor; manipulatives are called just that because students need to be engaged in actively manipulating the aid (Hynes, 1986). It is also a necessary role of the teacher, "to use these concrete models to foster understanding of the abstract, relate pictures of the models to aid in the movement toward the abstract, and provide practice at the abstract level to insure mastery of a concept or skill" (Hynes, 1986, p.11).

As said by Moch, "manipulatives work" (2001, p.81)! Many teacher's shy away from manipulative use yet, "the amount of time that is wasted re-teaching concepts far outweighs the amount of time required to teach the concepts more effectively in the first place" (Moch, 2001, p.83). In her study she worked with 60 fifth grade students, in which almost one-third of the students were identified as

"exceptional education students" who required special services. She worked with these students twice a week for ninety minute periods over a course of seven weeks covering 12 math lessons using manipulatives; a pre-test and post-test were given to show growth through manipulative use. The outcomes were positive showing a growth from a 49% class average on the pre-test to a 59% class average on the post-test, which is quite remarkable in itself but even more impressive when one examines that these students had an unstable classroom environment with more than 3 different substitute teachers all in a matter of four weeks and that one-third of the students were classified as having learning difficulties. It is clear that even with minimal exposure, students of all intelligence levels can benefit greatly from the use of manipulatives.

In a paper by Boggan et al. (2010) about using manipulatives to teach elementary mathematics they state that, "educational research indicated that the most valuable learning occurs when students actively construct their own mathematical understanding, which is often accomplished through the use of manipulatives" (p.2). The paper describes ways in which to use manipulatives that align with certain math concepts and standards. For example, using counters, place-value mats and base-ten blocks to teach numbers and operations or using pattern blocks, attribute blocks, and scales to help students learn basic algebra skills. There are countless ways to use a variety of manipulatives but it is important to know which manipulatives are appropriate for teaching the desired math concepts and how to properly use the manipulatives in teaching that concept. Research is filled with papers discussing the numerous ways to use manipulatives and the benefits obtained by their proper use, nevertheless some researchers feel that improper use is more of a hindrance than no use at all.

Skeptics to Manipulative Use

In an article entitled "Magical Hopes" by Ball (1992) she discusses reflecting on an experience in her third grade classroom where her student's used drawings to help explain the concept of even numbers being numbers that can be split in half evenly and odd numbers being numbers that cannot be split up evenly. When doing so she found through their drawings that her students still had some misconceptions about what makes a number even or odd. Ball recalls that when she shared this story with other educators, one of the first things they always ask her is if they used manipulatives to work out the problem, not just drawings. Ball was not convinced that manipulatives could have helped her students because the manipulatives could have been put into the same groups as those in the students' drawings who had misconceptions. Ball brings up an important issue that manipulatives do not automatically present the user with a correct answer simply through their use. Ball feels that,

"One of the reasons that we as adults may overstate the power of concrete representations to deliver accurate mathematical messages is that we are "seeing" concepts that we already understand. That is, we who already have the conventional mathematical understandings can "see" correct ideas in the mathematical representations. But for children who do not have the same mathematical understandings that we have, other things can reasonably be "seen"" (p.17).

It is a valid point that manipulatives are not always the answer to solving students' misconceptions.

There are other researchers who hold similar views as Ball. In a study by Puchner et al. (2008) in three of four lessons using manipulatives that were taught to groups in second, third, sixth, and eighth grades, "manipulative use was turned into an end in and of itself, rather than a tool leading to better understanding (p.321). In the lessons taught to the students, many did not know how to properly use the manipulatives and instead solved the problems first by using the traditional algorithm methods and then used the manipulatives to show the same answer. The students were not interested in exploring the manipulatives in order to develop deeper mathematical thinking, they were more concerned with getting the answer and solving it the quickest way they knew. The researchers were convinced that the manipulatives were more of a hindrance to the students than support. Some students seemed confused when using the manipulatives and others were unable to use them to accurately show how they solved a problem. Though, this report shows that manipulatives were not helpful to these students for the particular lessons that were taught, it is important to note that many of the students already knew the concepts being imparted. This made it difficult for the students to unlearn the traditional problem solving methods they were taught in order to explore a new method through manipulative use. This shows the many obstacles that are apparent when trying to appropriately incorporate manipulatives into math lessons. If students are not familiar with using manipulatives and are not taught how to explore math concepts and ideas in more than one way then manipulatives will be of little use to them.

Obstacles for Manipulative Use

Though the benefits of manipulative use are known throughout the teaching community, the number of teachers who consistently use a variety of manipulatives on a daily basis is minute. Another trend apparent in the research regarding manipulative use is the decline in their use from the lower grades to the intermediate grades. This begs the question, what are teachers' attitudes towards manipulatives that may be deterring them from their use?

For example, in a study done by Gilbert and Bush (1988) about teacher's familiarity, availability, and use of manipulative devices, it was found that

though teachers had access to a variety of manipulative devices and were familiar with these devices, they discovered that many educators used only a few types of manipulatives in their classrooms. Teachers in this study reported they had a multitude of manipulatives available to them, yet listed availability as one of the biggest hindrances to more frequent manipulative use in their classroom (the second largest hindrance was time). Though, availability was not a factor considered in this current study (due to each teacher's access to manipulative kits) the inconsistency in teachers' responses may be due to other factors such as a lack of detailed knowledge about using certain manipulatives.

In a similar study conducted by Hatfield (1994) that examined manipulative use among cooperating teachers, actual use by teachers was also low with respect to the high degree of familiarity and availability reported. This study also showed that when comparing grade level and manipulative use, "manipulative use declined as grade level increased from kindergarten to sixth grade" (307). This is a disappointing factor due to the fact that as students get older and are presented with more difficult mathematical tasks, many can still benefit from the use of concrete objects to help build abstract mathematical understandings. It was also a concern of Hatfield that cooperating teachers, who are seen as exemplary educators, may be perpetuating a cycle of minimal manipulative usage with their preservice teachers.

In a study by Quinn (1998) on the influence of mathematics courses on preservice teachers' pedagogical beliefs concerning manipulatives, many of the preservice teachers "remarked positively about the use of manpulatives" (p.237). These teachers felt that their college mathematics methods courses provided them with "important knowledge and experience concerning the use of manipulatives" (p.237) and they felt they "learned mathematical content through the use of manipulatives" (p.238). However, these preservice teachers also reported concerns that they may have trouble implementing manipulatives in their future classrooms due to time constraints, classroom management issues, and students still felt they needed to learn more about manipulatives after completing their mathematics course. These concerns are valid and can be associated with another study by Green et al. (2008) about reversing education majors' misconceptions with short-term instruction using manipulatives. In this particular study the authors examined how they could change mathematical misconceptions that preservice teachers held by using manipulative based instruction over five classes. This study showed that though many students arithmetic misconceptions ran deep, they were however reversible when engaged in problem solving through the use of representational and concrete manipulatives. "A recurrent barrier to deep understanding and skillful pedagogy is that most teachers teach the same way they were taught in elementary and high

school rather than as they learned in undergraduate teacher-education programs" (Bauersfeld, 1998; De´sautels, 2000; Green et al., 2008). The researchers also found that not only did the manipulative use reverse many misconceptions the preservice teachers' held but also improved the accuracy and depth of their arithmetic knowledge (Green et al., 2008, p.241). It seems as though attitudes towards manipulative use develop early in preservice teachers' mathematics courses. Though those attitudes may be positive, through the research we can see that perhaps one mathematics course is not sufficient. Teachers may need to be exposed to more enriching experiences with manipulative use in order to debunk their earlier learned misconceptions and build their confidence in proper manipulative use in the classroom.

In a study by Howard et al. (1997) aimed at both primary and secondary teachers' beliefs towards manipulative use in the teaching and learning of mathematics it was noted that similar trends to prior research were discovered. Unsurprising to the researchers' was the decrease in frequency of manipulative use from the primary to secondary grades. "An analysis of teacher use of manipulatives across primary school years indicates a significant decrease in the use from years five through sixth when compared with years kindergarten through fourth" (p.6). Therefore, the researchers thought it only logical that the trend would continue and manipulative use would continue to decline in the secondary grades. A fascinating discovery made in this study was that a high percentage of the primary (97%) and secondary (87%) teachers reported they had confidence in their ability to use the manipulatives available to them. On the other hand, 47% of the primary respondents and 66% of the secondary respondents reported they would like more training in manipulative use. This discrepancy shows a need for teachers to receive more high quality training in the proper use of a variety of manipulatives.

A study conducted by Swan and Marshall (2010) that mirrored the study by Howard et al. (1997) was done to see if the introduction of virtual manipulatives and pictures of mathematical manipulatives were impacting how manipulatives are used today (p.13). On the surveys given to teachers most noted that they used manipulatives because they, "heighten interest; helped engage students; enjoyment; "fun"; provide motivation" (2010, p.16). This was very similar to Howard et al.'s study which stated that most teachers used manipulatives because they felt that students benefit from using them and they feel the students enjoy using them (1997, p.6). This is troubling because the authors believe that, "unless teachers have a clear understanding of how manipulatives assist children learn, they are likely to make only token use of them, which may be detrimental to learning" (Swan & Marshall, 2010, p. 16). Teachers

in the current study were also familiar with a variety of manipulatives but less than 50% used them on a daily basis in grade one and that number declined down to less than 5% in grade seven. An interesting anomaly in this study was that though teachers reported their confidence in using manipulatives, less than 10% of respondents had received any professional development in manipulative use and more surprisingly only 19% of respondents said they would like more help with using manipulatives. If teachers do not understand the importance manipulatives have to mathematical learning and understanding, they may lose the interest to seek the knowledge for their proper use.

One of the more recent studies in this field that is quite similar to this present study is by Uribe-Flo´rez and Wilkins (2010). In this particular study the relationship between teachers' grade level taught and manipulative use, teachers' age and manipulative use, teachers' beliefs and manipulative use, and how these relationships can be used as predictors of manipulative use were examined. This study showed, like many before it, that manipulative use declines through the primary grades. Also, teachers' beliefs on concrete experiences, hands-on activities, and older students' abilities to think abstractly are all predictors of teachers' manipulative use. Although age was not a predictor of use, grade level was and it was shown that experienced teachers used manipulatives more than novice teachers; a fact that could be explained by the more experienced teachers familiarity and comfort in their classroom, as well as the likely hood of receiving more inservice training than a novice teacher.

Manipulatives are valuable math tools; though their use does not intrinsically transmit knowledge to its user, they allow students to explore abstract concepts in a concrete way. This can only be done effectively through guidance from teachers who have adequate training in proper manipulative use and can foster learning through their use when teaching new mathematic concepts. Repeated exposure to manipulatives is necessary for students to understand how to use manipulatives and feel comfortable with them; research has shown that it is worthwhile in terms of the growth in students' mathematical thinking that can be seen in students of all intelligence levels.

Methodology

Creating the Instrument

The goal of the study was to create a survey instrument that would effectively answer the research questions. The survey consisted of three parts. The first section of the survey addressed teachers' background information such as years of teaching experience and grade level taught. It also addressed frequency of manipulative use with the answer choices of, "every day", "a few times a week", "a few times a month", and "a few times a

year". Lastly, there were two questions pertaining to the presence and adequacy of teachers' preservice and inservice training with math manipulatives.

The second portion of the survey consisted of statements rated on a 4 point Likert scale with the options of "Strongly Agree", "Agree", "Disagree", and "Strongly Disagree". The neutral choice was not included because it was intended to have the teachers take either a positive or negative attitude towards the second set of questions. These questions pertained to teachers views on the benefits and appropriateness of math manipulatives for their students, obstacles that impede frequent manipulative use, teachers knowledge of math concepts that can be taught with manipulatives, and teachers confidence in their ability to use manipulatives to demonstrate math concepts.

The third portion of the survey gave three statements regarding how teachers were using manipulatives in the classroom; they were as follows: "1. I allow my students to use manipulatives during a test. 2. I demonstrate math concepts for my students using manipulatives. 3. My students have the option to use manipulatives when they need help with a math concept." Teachers rated these answers on a 3point Likert scale with the choices of, "Seldom or Never", "Sometimes", and "Most or all of the time".

Subjects

The participants in the study were 22 regular education and 5 learning support teachers from a rural K-6 elementary school. Participants were all classroom teachers who teach math for at least one period a day. The participants varied in years of teaching experience from 3 to 30 years; a range of 27 years.

Procedure

The survey instrument (Appendix A) was placed in the school mailboxes (located in the schools office) of the 27 elementary classroom teachers. A short cover letter explaining the purpose of the validity study was attached to each survey. Teachers were asked to anonymously fill out the survey in order to test the validity of the instrument and gain insight into teachers' attitudes towards the use of math manipulatives in the classroom. Teachers were asked to not place their names on the survey in order to encourage candid responses towards manipulative use. Respondents had two weeks to turn in the surveys to the researcher's mailbox. Reminder announcements were made over the schools public-address system towards the end of the two weeks to remind and encourage teachers to turn in their surveys. Some surveys had to be returned to grade level teams because teachers forgot to fill out the backs of the surveys. Once teachers looked at the hand writing on the surveys they were able to identify their own survey, fill out the back portion of the survey if they had forgotten to, and turn it in once again to the researcher's

mailbox. Responses were received from 19 teachers, which was a return rate of 70%. After the two week period extra copies of the survey were placed in the schools office and an announcement was made that any teachers who had lost their survey and or still wanted to turn in their survey had three additional days to do so; no additional surveys were received.

Data Management

Once, all surveys were collected the results were placed on an electronic word document copy of the created survey. First, the range of teaching experience was found by subtracting the lowest years of teaching experience by the highest years of teaching experience, which gave a range of 27 years. Next, percentages for each question were calculated by taking the number of teachers who choose a specific answer choice and dividing that number by the total number of teachers who returned the survey. Once, the percentages had been calculated the numbers were analyzed to look for any common trends in the data pertaining to the research questions. For the research questions pertaining to relationships between two variables, data was placed into two columns of an excel spread sheet and turned into a scatterplot. Due to the small sample size used to test the validity of the instrument it was difficult to see any trends in the data. A trend line was then added to the scatterplot to show more clearly if the relationships were positive or negative between teacher's experience and grade level taught and manipulative use.

Findings

The results from Table 1 show the relationship between elementary (K-6) grade level taught (x) and the frequency of teachers' manipulative use (y). Kindergarten was coded as grade zero and each consecutive grade was coded with its corresponding numeral. A trend line was inserted into the Figure 1 scatterplot, in order to more clearly show the relationship between the two variables. Frequency of manipulative use was coded by assigning answers a number from 1 to 4. The number four was used to represent the answer "everyday", the number three to represent "a few times a week", the number two to represent "a few times a month", and the number one to represent "a few times a year". The trend line showed that as grade level increased from kindergarten to sixth grade there was a decrease in manipulative use. This supports the prior research findings by Hatfield (1994), Howard et al. (1997), Swan and Marshall (2010) and Uribe-Flo´rez and Wilkins (2010). However, this finding was somewhat surprising in this case due to the fact that 63% of all the respondents "Strongly Agreed" and 37% of all the respondents "Agreed" that, "Manipulative use in math is appropriate for all elementary grades K-6."

Grade Taught (x)	Manipulative Use (y)
0	2
0	3
1	4
1	3
2	3
2	3
2	3
3	1
3	2
3	4
4	1
4	2
4	2
4	1
5	2
5	3
5	3
5	2
6	3

Table 1
Relationship between teachers' grade level taught and their frequency of manipulative use.

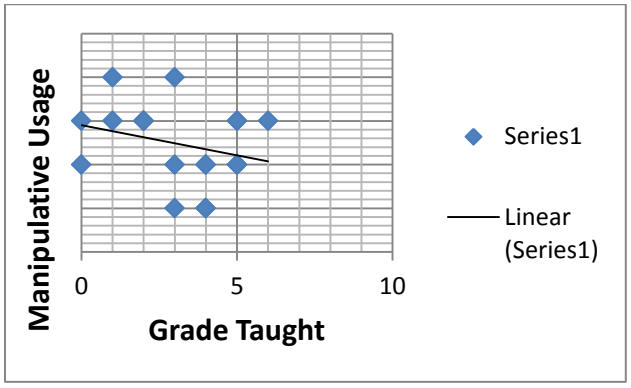

Figure 1. Relationship between teachers' grade level taught and their frequency of manipulative use.

The results from Table 2 show the relationship between years of teaching experience (x) and the frequency of teachers' manipulative use (y). Years of teaching experienced ranged from 3 to 30 years. Frequency of manipulative use was again coded by assigning answers a number from 1 to 4. The number four to represent the answer "everyday", the number three to represent "a few times a week", the number two to represent "a few times a month", and the number one to represent "a few times a year". In comparing these two variables it is seen that the trend line in Figure 2 shows a positive relationship between years of teaching experience and frequency of manipulative use. As the years of teaching experience increases, so does the frequency of teachers' manipulative use. These findings are not corroborated by the research done by Gilbert & Bush (1988) stating that "experienced teachers tend to use manipulative devices less often than inexperienced teachers" (p.464). However, they are substantiated by the more recent research by Uribe-Flo´rez & Wilkins (2010) stating that, "experienced teachers tend to use manipulatives more often than novice teachers" (p.369).

Years Teaching (x)	Manipulative Use (y)
3	3
4	3
5	4
5	1
6	2
6	2
9	1
10	2
11	2
13	3
13	1
13	2
14	3
17	2
18	3
20	3
22	3
25	4
30	3

Table 2
Relationship between teachers' years of teaching experience and frequency of manipulative use.

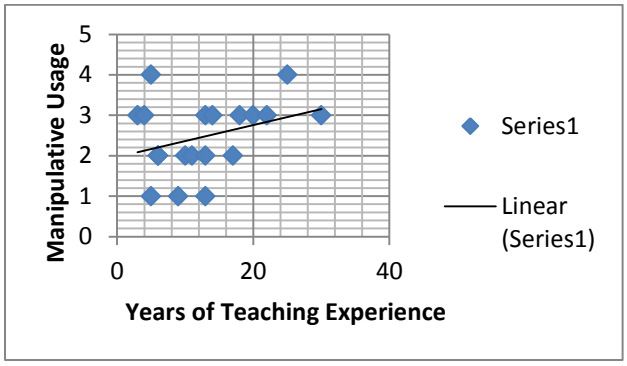

Figure 2. Relationship between teachers' years of teaching experience and frequency of manipulative use.

Table 3 shows the percentage of teachers who received manipulative use training in their preservice teaching programs, as well as their ratings of its adequacy. Table 3 also shows the percentage of teachers who received inservice training on incorporating math manipulatives into their lessons and the adequacy of that training. Surprisingly, more than half of the respondent teachers did not receive manipulative use training in their preservice teaching programs and of the 47% who did, 11% did not feel their training was adequate. Even more surprising is the lack of inservice training teachers received. Only 37% of teachers responded "yes" to receiving inservice training on incorporating math manipulatives into their lessons and of those 37% there were 29% who did not think their training was adequate.

This undoubtedly shows that there is a major lack of opportunities for preservice and professional teachers to have rich experiences with manipulatives. This data also corresponds to the research done by Swan and Marshall (2010) where they reported that in their study on teachers' manipulative use, "fewer than 10% of respondents indicated that they had undertaken professional development on the use of manipulatives" (p.18).

These findings were also curious because though there is a clear lack of adequate training with manipulatives, 32% of teachers "strongly agreed" and 58% "agreed" to the statement, "I am confident in my ability to demonstrate math concepts with manipulatives". Teachers' confidence in their ability to use math manipulatives with their students may be a hindrance because they could be teaching their students math misconceptions. This is similar to the preservice teachers in the study by Green et al. where many of the teachers had misconceptions about how to properly demonstrate solving different math concepts correctly with manipulatives; even though they came up with the correct solutions to the problems. Though the current respondents may feel confident using manipulatives to demonstrate math concepts and may be computing the correct answers in their demonstrations to students, it is still likely that their demonstrations may lack the correct explicit procedure and language necessary for students to thoroughly understand how to use manipulatives themselves.

	Yes	No
Preservice Training	47%	53%
Adequacy of Training	89%	11%
Inservice Training	37%	63%
Adequacy of Training	71%	29%

Table 3 Teachers' manipulative use training and its adequacy.

Table 4 displays the results for the survey item stating, "Math manipulatives are beneficial for all students". The majority of teachers (89%) felt that manipulatives were beneficial for all students and only 11% felt that they were not beneficial. None of the teachers "strongly disagreed" about the benefits of manipulatives for all students. These results express that teachers have a positive belief towards manipulatives as a tool that is helpful for all students of different intelligence levels. However, the data is also somewhat contradicting when comparing it with the percentage of teachers who actually use manipulatives on a daily basis in their classroom; which in the case of this study was only 10% of teachers.

Strongly Agree	Agree	Disagree	Strongly Disagree
47%	42%	11%	0%

Table 4 Survey statement: "Math manipulatives are beneficial for all students".

Table 5 displays the results regarding teachers' misconceptions about the appropriateness of using manipulatives according to grade level and math concepts taught. Item 2 from the table corresponds to the second question in the second section of the survey stating, "Math manipulatives can be used to teach all elementary math concepts (i.e. addition, subtraction, multiplication, division, & fractions)". Item 3 from the table corresponds with the third question in the second section of the survey stating, "Manipulative use in math is appropriate for all elementary grades K-6". Results for both of these survey items were identical. 100% of the respondents either "strongly agreed" or "agreed" that manipulatives are appropriate to use to teach all grade levels and math concepts. Though teachers seem to have a strong belief that manipulatives are useful in teaching any elementary grade as well as any elementary concept, it is still unclear why manipulative usage dwindles as grade level increases.

	Strongly Agree	Agree	Disagree	Strongly Disagree
Item 2	63%	37%	0%	0%
Item 3	63%	37%	0%	0%

Table 5 Teachers' misconceptions about the appropriateness of using manipulatives according to grade level and math concepts taught.

Table 6 corresponds to the third section of the survey that deals with whether or not teachers have misconceptions about the power of manipulatives and their different uses as tools. The following survey statements were used to answer this research question: "1. I allow my

students to use manipulatives during a test. 2. I demonstrate math concepts for students using manipulatives. 3. My students have the option to use manipulatives when they need help with a math concept." Over half of the respondents rarely or never allowed their students to use manipulatives during a test which parallels to Ball's (1992) work regarding teachers' false beliefs towards the power of manipulatives. Manipulatives are a useful hands-on tool; however, correct answers are not simply achieved just through their usage. Students have to be taught how to properly use manipulatives to obtain answers and must work out the problem correctly with these tools in order to achieve an accurate answer. If used incorrectly manipulatives will not help students achieve the proper answer.

For item two, the majority of teachers said that they only sometimes demonstrate math concepts for their students using manipulatives. Respondents in this survey expressed relatively high confidence in their ability to demonstrate math concepts using manipulatives, yet only 37% of the teachers consistently use them to do so. This may also be tied to a false belief that demonstration is not always necessary and that allowing students to simply use manipulatives on their own is enough.

For item three, more than half of the respondent teachers said that they allowed their students to use manipulatives when they are struggling with a math concept. Yet a large number (42%) said that they only sometimes allowed their students to use manipulatives when struggling with a math concept. This shows again that teachers may not truly understand the full benefit and uses of manipulatives as much as they are stating they do. Or perhaps this could be related to the false beliefs that manipulatives give answers and teachers may want students to try other avenues when struggling with a math concept.

	Seldom or Never	Sometimes	Most or all of the time
Item 1	53%	37%	10%
Item 2	5%	58%	37%
Item 3	5%	42%	53%

Table 6 Teachers' misconceptions about the power of manipulatives and their different uses as tools.

Table 7 relates to teachers' beliefs towards obstacles that impede them from using manipulatives. Item four asked teachers if they felt it was difficult to incorporate math manipulatives into their lessons and item six asked teachers if they felt they had enough time to use manipulatives in their math lessons. For both items, the majority of teachers said they disagreed that they did not have time to use manipulatives and disagreed that they found it difficult to incorporate manipulatives into their lessons. However, there were still a significant amount of teachers (26%) that did not feel they had enough time to incorporate manipulatives. Also, 21% of teachers said they found it difficult to incorporate

manipulatives into their lessons. Both these factors could be tied to this specific group of teachers' lack of experience with adequate preservive and inservice training with manipulatives. With more appropriate and in-depth training on how to properly incorporate manipulatives in the classroom, teachers may change their minds and take the view of Moch, (2001) that "the amount of time that is wasted re-teaching concepts far outweighs the amount of time required to teach the concepts more effectively in the first place" (p.81).

	Strongly Agree	Agree	Disagree	Strongly Disagree
Item 4	0%	21%	47%	32%
Item 6	5%	26%	47%	21%

Table 7 Teachers' beliefs towards obstacles that impede them from using manipulatives.

Discussion

The development of the instrument in this study was created to be used as a self-reported measurement of teachers' attitudes towards manipulative use. There is strong evidence that the instrument is valid according to the data collected that corresponds to previous research studies on manipulative use. The instrument suggests that though elementary teachers believe that manipulatives are beneficial, very few incorporate them into their lessons on a daily basis. It also shows that there is a profuse lack of satisfactory preservice and inservice training for teachers in proper manipulative use; which may be the reason for the lack of their daily use in math lessons. The instrument also confirms that teachers have misconceptions about the power of manipulatives and how they can be used as tools.

According to the research question, "What is the relationship between grade level taught and the use of manipulatives in math lessons" the data shows that there is a downward trend in manipulative use from Kindergarten to Sixth grade. This data supports prior findings that have been discovered over the past 16 years by Hatfield (1994), Howard et al. (1997), Swan and Marshall (2010) and Uribe-Flo´rez and Wilkins (2010). It is still unclear however, why 100% of the respondents either "Strongly Agreed" or "Agreed" that, "Manipulative use in math is appropriate for all elementary grades K-6". If teachers hold the belief that manipulatives are appropriate for all elementary grade levels, then why is there a decline in the frequency of their use as the grades progress? It is possible that due to insufficient manipulative training, upper elementary teachers may not be aware of the age appropriate math manipulatives available for their grade level. Perhaps also the availability of age appropriate manipulatives, as well as, upper level curriculum that encourages their use could be a factor of why intermediate elementary teachers use them less. However, curriculum and availability were not used as factors in this instrument. Though these factors may impede manipulative use, there are

still non-textbook resources available on manipulative use and resources on how to create your own age appropriate manipulative materials. A way to make this data clearer for future research could be to adapt the statement from, "Manipulative use in math is appropriate for all elementary grades K-6." to "Manipulative use in math is more appropriate for the lower elementary grades than the upper elementary grades."

According to the research question, "What is the relationship between years of teaching experience and the use of manipulatives in math lessons" the data shows that there is an increase in teachers' manipulative use as their teaching experience increases. As previously stated these findings are not supported by the 1988 research done by Gilbert and Bush, which states experienced teachers use manipulatives less frequently than inexperienced teachers. This may be due to the fact that manipulative use was becoming a popular educational trend in the 1980's and that is when a majority of the research began on manipulative use. It is likely that the inexperienced teachers in Gilbert and Bush's study had more preservice training on their use than the veteran teachers. This being due to the rise in popularity of hands-on learning and thusly why the inexperienced teachers used them more often. However, more recent research done in 2010 by Uribe-Flo´rez and Wilkins states that experienced teachers use manipulatives more than inexperienced teachers. These mixed results could be due to teachers' different background experiences with manipulative training. Other factors explaining inexperienced teachers' lower frequency of use could be due to novice teachers need to adjust to their new environment and organizing their classrooms.

According to the research question, "Are teachers given enough experience with learning how to teach with manipulatives in their preservice programs and or inservice training" the data shows overwhelmingly that inadequate experience is given. This lack of valuable experience does not however seem to be an uncommon occurrence. Swan and Marshall (2010) also reported in their research that a very small amount of the teachers in their study had received professional development on manipulative use. What is troubling in the current study is that this lack of proper training has not affected teachers' confidence in their ability to demonstrate math concepts with manipulatives. According to the research question, "Do teachers feel inadequate in how to incorporate math manipulatives in their daily lessons due to lack of preservice programs and or inservice training" 90% of respondent teachers felt confident in their abilities to demonstrate math concepts with manipulatives. Similar results were obtained in the study by Howard et al. (1997) in which teachers expressed confidence in manipulative use yet also expressed they felt they could

benefit from further training in manipulative use. Howard et al. came to the conclusion that, "much of the acceptance of manipulatives by teachers may be based in practice and have little theoretical underpinning" (1997, p.9). This brings us back to the findings by Green et al. (2008) that ascertained that many preservice teachers have misconceptions about how to properly demonstrate math concepts with manipulatives. To gain better insight into teachers' beliefs towards their manipulative training and how it affects their confidence with using manipulatives, it might be helpful to add a question to the instrument stating, "I feel my teaching could benefit from training on how to properly demonstrate math concepts and use manipulatives in my math lessons" or "I would feel greater confidence in my ability to use manipulatives in the classroom with more adequate training". These questions could provide further insight into the reasons why teachers' lack of training has not affected their confidence in their ability to demonstrate math concepts with manipulatives. Without further information on teachers beliefs towards their training and their confidence levels, teachers may unknowingly be teaching their students mathematical misconceptions through manipulative use.

According to the research question, "Do teachers know the benefits of using manipulatives for students of all different intelligence levels" a majority of the teachers (89%) agreed that math manipulatives benefit all students. What is contradicting to this information is the minute amount of teachers who use manipulatives daily (10%). Research states, "that using manipulatives is especially useful for teaching low-achievers, students with learning disabilities, and English language learners" (Boggan et al., 2010, p.5). With the daily use of hand-on materials in their math lessons, teachers can better familiarize their students in their proper usage of manipulatives and see growth in students' achievement through their use. The data about manipulatives' benefits for all students and the daily use of manipulatives may correspond to the questions regarding manipulatives different uses as tools. Further, implicating that teachers may not know the various ways in which manipulatives can be incorporated into their lessons.

According to the research question, "Do teachers have misconceptions about the appropriateness of using manipulatives according to grade level and math concept taught" all teachers in the current study indicated that manipulatives can be used in all elementary grades K-6 to teach all elementary math concepts. Yet it is still reported that manipulative usage decreases as grade level increases. This may be due to the lack of training upper elementary teachers have received on using manipulatives with higher level math concepts such as fractions. Another factor could be teachers' misunderstanding of how the increased

frequency of manipulative use can benefit their students' math performance. Furthermore, though teachers agreed that manipulatives are appropriate to use in all grade levels, this question does not ask teachers beliefs towards the importance of manipulative use in all grade levels. This relates to the prior research by Uribe-Flo´rez and Wilkins (2010) that showed teachers who agreed with the statement, "Since older students can reason abstractly, the use of manipulatives becomes less necessary" used manipulative less than those who disagreed with the statement. Though teachers agree manipulatives can be used to teach all elementary concepts and it is appropriate to do so, a question may need to be added to the current instrument on the importance of continuing manipulative use in the upper elementary grades.

According to the research question, "Do teachers have misconceptions about the power of manipulatives and their different uses as tools" results show that teachers have false beliefs about the power of manipulatives and do not fully understand the benefits of their different uses as tools. Over half of the respondent teachers reported that they do not allow their students to use manipulatives during a test. Though manipulatives are a helpful tool when they are used properly, they do not give answers simply through their presence. Manipulatives have to be manipulated by their users in order to help them obtain a correct answer. If students are not taught how to properly operate the different manipulatives it is unlikely that they will help a student to reach a correct answer when solving a math problem. By allowing students to use manipulatives during testing, struggling students will have a better chance at improving their math scores and may have lessened anxiety due to the support provided by the math manipulatives.

Manipulatives' helpfulness to students is based on the students' ability to use them correctly; this corresponds to how often teachers use manipulatives to demonstrate different math concepts. Almost 60% percent of the respondent teachers stated that they only "sometimes" use math manipulatives to demonstrate math concepts for their students. If students are not shown a demonstration on how to use the different types of manipulatives as an aid in problem solving various math concepts, they will be of little use to the students.

Only slightly over half of all respondent teachers said that they allow their students "most or all of the time" to use manipulatives when they need help with a math concept. This further shows that teachers may not fully understand the remedial help manipulatives can provide struggling students. By allowing students to use manipulatives as support tools teachers could save instructional time by not having to re-teach concepts. This response could also relate to teachers' false belief of the power of manipulatives

and their concern about manipulatives giving students answers and not allowing for problem solving to occur.

According to the research question, "Do teachers find it difficult and or time consuming to incorporate manipulatives into their math lessons" a majority of teachers (almost 80%) did not find it difficult and most teachers (almost 70%) felt they had enough time to use manipulatives in their lessons. When coding these results I noticed that some teachers wrote the word "time" next to their answers for the item, "It is difficult to incorporate manipulatives with my math lessons". Since teachers were later asked about time it was not necessary for them to write in this explanation. However, to make the instrument clearer for teachers I suggest placing the previous question after the question about having enough time to use manipulative in order to avoid written in responses. (See Appendix A)

Though teachers may not feel they have difficulty incorporating manipulatives into their lessons and may feel they have enough time to do so, this could be related to teachers frequency of use. Since, most of the respondents use manipulatives only a few times a week, they may not feel that it takes up too much of their time. Also, since most are not incorporating them daily, they may not find it as difficult to incorporate them into their lessons. It is also unclear if teachers are incorporating manipulatives effectively into their lessons due to teachers' lack of training.

In conclusion the created instrument was able to provide answers and insight into many of the research questions. However, additional items may need to be added to the instrument in order to make some of the results of the study clearer. Overall, the instrument results corresponded with results from previous research studies and shed some light into topics that have not yet been explored in regards to teachers' beliefs and manipulative use.

Teacher Attitudes Towards the Use of Math Manipulatives.

Appendix A

Current grade you teach**:** _____

(Please note if you teach in a specialized classroom.)

How many years have you been a teacher? _____

I use manipulatives in my math lessons… ☐ everyday ☐ a few times a week

☐ a few times a month ☐ a few times a year

Did you have training in math manipulative use in your preservice teaching program?

☐ yes ☐ no

If yes, do you feel that your training was adequate? ☐ yes ☐ no

Have you ever had inservice training on incorporating manipulatives in your math lessons?

☐ yes ☐ no

If yes, do you feel that your training was adequate? ☐ yes ☐ no

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	Strongly Agree	Agree	Disagree	Strongly Disagree
1. Math manipulatives are beneficial for all students.	☐	☐	☐	☐
2. Math manipulatives can be used to teach all elementary math concepts (ie. addition, subtraction, multiplication, division, & fractions).	☐	☐	☐	☐
3. Manipulative use in math is appropriate for all elementary grades K-6.	☐	☐	☐	☐
4. It is difficult to incorporate manipulatives with my math lessons.	☐	☐	☐	☐
5. I am confident in my ability to demonstrate math concepts with manipulatives.	☐	☐	☐	☐
6. I do not have time to use manipulatives with my math lessons.	☐	☐	☐	☐

	Seldom or Never.	Sometimes.	Most or all of the time.
1. I allow my students to use manipulatives during a test.	☐	☐	☐
2. I demonstrate math concepts for students using manipulatives.	☐	☐	☐
3. My students have the option to use manipulatives when they need help with a math concept.	☐	☐	☐

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