Increasing Mathematical Scores

With Mathematical Manipulatives

A Special Project

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With Mathematical Manipulatives

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ABSTRACT

To examine if mathematical manipulatives coupled with *Harcourt-Brace Mathematics* and *Investigations in Number, Data, and Space* curricula could increase mathematics scores, 26 fifth grade students were tested using pre and post assessments in Northwest Evaluation Association's *Measure of Academic Progress* assessment during the 2006-2007 school year. Identical assessments were given to the group seven months apart to provide enough data and collection time, and then measured by a *t-test*. Students were engaged for one-hour daily mathematics instruction with supplemental manipulatives. The research proved that instruction with mathematical manipulatives produced significant gains in mathematics scores. Further research is needed, with different variables; to prove mathematical manipulatives will impact student mathematics scores significantly.

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CHAPTER 1

Introduction

Background for the Project

According to the *No Child Left Behind* legislation, significant numbers of students did not understand and were unable to explain or show mastery of mathematics as shown by the Washington Assessment of Student Learning. Results of the 2004-2005 state Washington Assessment of Student Learning score in mathematics showed 57% of fourth grade students in Washington State scored proficient. Nationally, 36% of fourth grade students scored proficient on the 2005 National Assessment of Educational Progress annual assessment. Fourth grade students tested nationally scored higher in 2005 than in any other year (National Assessment of Educational Progress, 2005). While test scores have improved on the state level and national level, the percentage of proficient students were well below the goal of 100% mandated by No Child Left Behind legislation (U.S. Department of Education, 2005).

Government officials, business leaders and national commissions had warned Americans that students' low performance in basic skills had posed a serious threat to the American economy (Newmann, Bryk and Nagaoka, 2001). Standards based education reform had recognized the potential result of an undereducated population. The recognized result became educational reform with accountability. Student learning accountability led states to adopt standards for student learning. State adopted standards were procured mainly from national councils in specific subject areas and specific grade levels.

Mathematics standards in Washington State were closely aligned with the National Council of Teachers of Mathematics standards (Executive summary: Evaluation of the Washington State EALRs for reading, mathematics, and science, 2003). Standards for Washington State were developed into essential academic learning requirements and more specific, grade level expectations. The grade level expectations had been aligned with the *Washington Assessment of Student Learning*. Another assessment used to measure student learning was the Northwest Evaluation Association's assessment. The assessment used in this study was the *Measure of Academic Progress*. The *Measure of Academic Progress* assessment was closely aligned with the *Washington Assessment of Student Learning* assessment. Results from the *Measure of Academic Progress* assessment were used to make state level decisions concerning Adequate Yearly Progress mandated by *No Child Left Behind* legislation (Dahlin, 2004).

Statement of the Problem

The question this researcher looked to answer was, can students in the fifth grade participating in the use of mathematics manipulatives make greater than expected gains in mathematics as measured by fall 2006 and spring 2007 *Measure of Academic Progress* assessments? Therefore a comparison was made between fall Measure of Academic Progress assessments and spring *Measure of Academic Progress* assessments and comparisons between established benchmarks for fifth grade students.

Purpose of the Project

The study investigated the effects of implemented supplemental mathematic manipulatives on *Measure of Academic Progress* assessment scores of fifth grade students. *Investigations in Number, Data and Space* curriculum and *Harcourt Brace Mathematics* was used for instruction. The author predicted using *Investigations in Number, Data and Space* coupled with mathematic manipulatives and *Harcourt Brace Mathematics* curriculum would significantly improve Measure of Academic Progress scores in fifth grade students.

Delimitations

This researcher compared the mathematics *Measure of Academic Progress* assessment gains within a typical fifth grade classroom. The study took place from the fall of 2006 to the spring of 2007 in a small rural community with a population of 16,800 located in Eastern Washington State. The elementary school where the research was conducted had approximately 480 students with demographics of 57% Caucasian, 38% Hispanic, 1.7% Black, 1% Asian and 1.5% American Indian. There were 68.8% of students on the free and reduced lunch program which indicated a high population of low socioeconomic status students. Special education students were 14.5% of the population. Transitional Bilingual student population was 15.5% and 12.9% were classified as Migrant Students (Office of Superintendent of Public Instruction, 2007).

Assumptions

In the past, mathematical instruction varied by school, district and state. The adoption of research based mathematical curriculum eliminated much variability in mathematical instruction. The researcher assumed teachers were properly trained in all

areas of mathematics and adhered to research based mathematical curriculum. Greater than expected gains in mathematical problem solving would occur when coupled with the manipulatives this researcher had adopted as measured by the *Measure of Academic Progress* assessment used at the author's school.

Hypothesis

Fifth grade students receiving mathematical instruction with manipulatives will make greater than expected gains in mathematics as tested by the pre and post *Measure of Academic Progress* assessment.

Null Hypothesis

Fifth grade students receiving mathematical instruction with manipulatives will not make greater than expected gains in mathematics as tested by the pre and post *Measure of Academic Progress* assessment.

Significance of the Project

This research study focused on the use of a scientifically based mathematical curriculum with the aide of mathematical manipulatives. *Investigations* curriculum and *Harcourt Brace Mathematics* was used to instruct and assess students in this research project. The author was concerned about mathematical reasoning and the understanding of concepts in fifth grade students. The author knew that future success in mathematics depended upon sound understanding of mathematical concepts.

Procedure

The treatment classroom used for this study was a self contained fifth grade room in an elementary school. All subjects were taught in this classroom except for music and physical education. Mathematics was taught an average of one hour each day.

The curriculum used in this classroom, *Investigations in Number, Data, and Space* was developed at Technical Education Research Centers and published by Pearson Scott Foresman. The other curriculum used in this classroom was *Harcourt Brace Mathematics*. Both curriculums were research based and adopted curriculum in the researcher's school district.

The treatment classroom was taught from the *Investigations* curriculum using the planning guide provided by the *Investigations* curriculum for one unit of study. The unit of study took on average three weeks of intensive study. Studying from the *Harcourt Brace Mathematics* curriculum followed the *Investigations* unit of study. The *Harcourt Brace Mathematics* unit of study mirrored the *Investigations* unit of study. Students received the same concepts through two different curricula. The *Harcourt Brace Mathematics* unit of study lasted on average two or three weeks. The pattern of study alternated throughout the school year.

Manipulatives used in the classroom included base ten blocks. Base ten blocks consisted of small individual cubes representing the ones place value. The tens place value was represented by a stack of ones unit cubes fused together in a long bar with the demarcations of the ones units imprinted or carved in the stack. The hundreds place value was represented by a flat square of ones units, ten by ten with the demarcations of the ones units present. The thousands place value was represented by a cube of ones

units fused together ten units high, ten units long and ten units wide with the demarcations present showing the ones units.

Square tiles were used in the classroom. The tiles were one-centimeter squares and four millimeters thick. Interlocking plastic cubes were used as well. Square wooden blocks were also used in some instances in the classroom.

Manipulative materials were available and used through out the units of study in each of the curriculums used. Instruction on how to use the manipulatives was given to the treatment group.

Definition of Terms

Manipulatives: Tangible items used to represent mathematical symbols, functions and ideas.

Acronyms

AYP. Adequate Yearly Progress.

EALR. Essential Academic Learning Requirement.

GLE. Grade Level Expectations.

MAP. Measure of Academic Progress.

NAEP. National Assessment of Educational Progress.

NCLB. No Child Left Behind Act.

NCTM. National Council of Teachers of Mathematics.

NWEA. Northwest Evaluation Association.

TAC. National Technical Advisory.

TERC. Technical Education Research Centers

WASL. Washington Assessment of Student Learning.

CHAPTER 2

Review of Selected Literature

Introduction

The origin of public concern about mathematics education was traced to the Union of Soviet Socialist Republic's launching of the satellite Sputnik October 4, 1957. Confidence in American mathematics and science education after the launch of Sputnik in 1957 accelerated the transformation of the mathematics curriculum in the 1960s (Blair, Gamson, Thorne, & Baker, 2005).

The National Commission on Excellence in Education was chartered in the summer of 1981. The commission was responsible for reviewing the quality of education in the nation's public and private schools, colleges, and universities. The commission published a report in 1983 called *A Nation at Risk*. The report indicated many areas of risk in the nation's education system. Among the indicated areas was needed improvement in mathematics education. The report, *A Nation at Risk*, was the catalyst for the evolution in achievement testing and standards-based education reform (Jorgensen & Hoffmann, 2003).

The report, *A Nation at Risk*, started the nation's current education system reform. President George W. Bush signed into law the No Child Left Behind Act of 2001. The No Child Left Behind Act required accountability of student learning in the nation's schools. Individual states were required to develop standards, align assessments, reporting procedures and accountability systems. States that showed adequate progress toward improved student learning were given more flexibility and control over how federal funds were used (Jorgensen & Hoffmann, 2003).

The State of Washington enacted the Education Reform Law of 1993. This law required the state to create an assessment system that tested all students. The assessment was to be administered annually in certain grades that measured performance against state adopted standards. The assessment served as one basis of accountability for students, schools and districts. The assessment was known as the *Washington Assessment of Student Learning*. The assessment fulfilled the federal requirement of the No Child Left Behind Act of 2001 (Office of Superintendent of Public Instruction, 2007).

Investigations Curriculum

The curriculum *Investigations in Number, Data, and Space* was developed at Technical Education Research Centers and published by Pearson Scott Foresman. The curriculum was designed to support students to make sense of mathematics and to become mathematical thinkers. The focus of this curriculum was to achieve computational fluency. Subsets of the curriculum included rational numbers, geometry, measurement, data, early algebra and connections between subsets. Reasoning and communications of mathematical concepts was also emphasized.

Investigations in Number, Data and Space was aligned with the NCTM Curriculum Focal Points. *Investigations in Number, Data and Space* was based on experience from research and practice. The curriculum was based on extensive classroom testing and took seriously the time students needed to develop a strong conceptual foundation and skill set needed for successful application of mathematical concepts.

Pearson Scott Foresman developed a three-phase validation research plan. Phase one documented *Investigations in Number, Data and Space* academic research base. Authors of *Investigations in Number, Data and Space* were selected for contributions to the field of mathematics, teaching and learning. Phase two tested *Investigations in Number, Data and Space* in actual classroom settings. Phase three documented the performance of the program during a full academic year (Simpson, 2004).

Pearson Scott Foresman conducted numerous pretest-posttest studies that measured academic growth in mathematics over time. Pretest-posttest studies were conducted in nineteen states to measure validity of *Investigations in Number, Data and Space*. Academic growth over time was measured by local, state and national assessments that varied by location. Pretest-posttest results from all studies showed positive results. Pretest-posttest studies taken as a whole demonstrated success across a wide range of student populations (Simpson, 2004).

Research on the Use of Concrete Objects to Teach Mathematics

Researchers and teachers suggested that concrete objects promoted connections between mathematical concepts and everyday experiences (Uttal, Scudder and DeLoache, 1997). Student's mathematical achievement improved with long term use of manipulatives provided by teachers skilled in manipulative instruction (Sowell, 1989). Research suggested the main factor that contributed to the success of manipulative use in mathematical instruction was the direct teaching of how the manipulative related to the mathematical concept being taught.

Mathematical manipulatives had false assumptions that were often made. Manipulatives alone had not conveyed mathematical meaning, not created connections to abstract ideas and were complex and involved in interpretation. (English and Halford, 1995). Research conducted on children age 30 months showed the children had not grasped the relationship between a scale model of a room and the life sized room (Uttal, et. al., 1997). Educators had thought children understood the direct connection between manipulatives used in mathematics and the concept being taught. Research conducted by DeLoache and colleagues had suggested the manipulative used and the concept taught was not always understood (as cited in Uttal, et. al., 1997).

Manipulatives physical nature alone could not carry the meaning of the mathematical concept. Manipulatives were to be used with careful thought about the concept being taught. Mathematical manipulatives were to be used in context of educational lessons that actively engaged children's thinking along with teacher guidance. Researchers had suggested the term manipulative needed to be expanded to include computer manipulatives. Computer manipulatives had been suggested to be more efficacious than the physical manipulatives (Clements, 1999).

Computer programs provided students with manipulatives that could be used on the computer monitor. Computer programs were an advantage in that the program could easily be accessed via the internet without cost. Teachers not trained in the use of the computer programs was a disadvantage.

WASL

The *Washington State Basic Education Act* of 1993 provided a framework for improving student achievement. The framework provided four learning goals which led to learning standards called EALRs. The standards were developed for reading, communications, writing, mathematics, science, social studies, health and fitness and the arts. An assessment system was developed to measure student progress and established accountability in Washington's education system (Office of Superintendent of Public Instruction, Washington State's Essential Academic Learning Requirements, 2004). The assessment instrument used in Washington State was the WASL.

The WASL was an assessment used to measure student growth in mathematics and reading. The WASL assessment was validated by the TAC. The TAC concluded the WASL had met the relevant standards of validity as prescribed by the National Standards for Educational and Psychological Testing (TAC, 2004).

Northwest Evaluation Association

The NWEA organization was a non-profit entity involved in improving teaching and learning. The MAP assessment was the tool used to measure student achievement. The MAP assessment for mathematics was a valid and reliable test (NWEA 2004).

NWEA tested reliability using test-retest and a type of parallel forms reliability, both of which were spread across seven to twelve months. Typical reliability tests were spread over a period of two to three weeks. The Pearson product-moment correlation coefficient (r) was used to measure reliability. Minimum acceptable correlation was considered to be .80; 1.00 was a perfect correlation. Since NWEA used a larger time

spread between tests, values of (r) below .80 would not seem unreasonable. The MAP assessment Pearson product-moment correlation coefficient (r) was between .84 and .94 which proved the MAP test was reliable (NWEA, 2004).

National Assessment of Educational Progress

The NAEP assessment was a national assessment used to measure educational progress in the United States. Students in the fourth grade were assessed in the area of mathematics in 2005.

Legislators mandated NAEP to provide ongoing evaluation of the NAEP assessment to establish reliability. The National Center for Educational Statistics had established various panels of technical experts to study NAEP. The National Academy of Sciences had also conducted evaluations. At the present time, the Buros Center for Testing in collaboration with the University of Massachusetts, Center for Educational Assessment and the University of Georgia were conducting an external evaluation of NAEP (National Center for Education Statistics, 2007).

The National Research Council conducted a three year evaluation of NAEP. The NRC analyzed four key topics which included NAEP's assessment development, content validity, design and use, and the design of education indicator systems. The NRC's report represented the authors' views. Recommendations were made to NAEP. There was no evidence of validity or reliability statistics in the NRC's evaluation (Nambury, 2000)

CHAPTER 3

Methodology and Treatment of Data

Introduction

The researcher investigated the relationship between the use of mathematical manipulatives and student achievement in mathematics as measured by fall 2006 and spring 2007 *Measure of Academic Progress* assessments. Therefore a comparison was made between fall *Measure of Academic Progress* assessments and spring *Measure of Academic Progress* assessments and comparisons between established benchmarks for fifth grade students.

Methodology

The quasi-experimental study was conducted in a fifth grade classroom in a public school in Eastern Washington. The project was a quantitative academic study. The researcher gathered the quantitative data from the *Measure of Academic Progress* assessment given in the fall of 2006 and spring of 2007. The assessments were gathered in the same school year.

Participants

This researcher compared the mathematics *Measure of Academic Progress* assessment gains within a typical fifth grade classroom. The study took place from the fall of 2006 to the spring of 2007 in a small rural community with a population of 16,800 located in Eastern Washington State. The elementary school where the research was conducted had approximately 480 students with demographics of 57% Caucasian, 38% Hispanic, 1.7% Black, 1% Asian and 1.5% American Indian. There were 68.8% of students on the free and reduced lunch program, which indicated a high population of low

socioeconomic status students. Special education students were 14.5% of the population. Transitional Bilingual student population was 15.5% and 12.9% were classified as Migrant Students.

Participants in the study were 26 students from the same classroom at one Eastern Washington elementary school. A majority of the students came from lower-income families and were receiving free and reduced lunch. Many of the families were supported by only one head of household, and some lived in homes of relatives. This was a self-contained classroom where the homeroom teacher kept all students for mathematics instruction. The teacher in the classroom had been teaching one year at the researcher's school and had been teaching one year at a different Eastern Washington school similar in demographics. This teacher had also received extensive training in how to integrate an assortment of teaching strategies into the mathematics curriculum. The training included workshops and seminars throughout the school year and summer that focused on how to align the curriculum to meet the curriculum based learning targets the state had mandated.

Instruments

The researcher used the MAP mathematics assessment in the project. The NWEA tested reliability using test-retest and a type of parallel forms reliability, both of which were spread across seven to twelve months. Typical reliability tests were spread over a period of two to three weeks. The Pearson product-moment correlation coefficient (r) was used to measure reliability. Minimum acceptable correlation was considered to be .80; 1.00 was a perfect correlation. Since NWEA used a larger time spread between tests,

values of (r) below .80 would not seem unreasonable. The MAP assessment Pearson product-moment correlation coefficient (r) was between .84 and .94 which proved the MAP test was reliable (NWEA 2004).

Design

The MAP mathematics assessment was given to the fifth grade class during the second week of September 2006. The MAP mathematics assessment was given again to the same fifth grade class during the second week of April 2007. A *t*-test was done to compare the students' achievement gains from September to April.

Procedure

The teacher in the treatment classroom was extensively trained in the strategies and curriculum that was used. As the year progressed, the teacher integrated a variety of mathematical tools and teaching manipulatives into the curriculum. The teacher also used a document camera, the united streaming program, and downloadable programs that had shown computer manipulatives to the students.

The curriculum used in this classroom, *Investigations in Number, Data, and Space* was developed at Technical Education Research Centers and published by Scott Foresman/Pearson. The other curriculum used in this classroom was *Harcourt Brace Mathematics*. Both curriculums were research based and adopted curriculum in the researcher's school district.

The treatment classroom was taught from the *Investigations* curriculum using the planning guide provided by the *Investigations* curriculum for one unit of study. The unit of study took an average of three weeks of intensive study. Studying from the *Harcourt Brace Mathematics* curriculum followed the *Investigations* unit of study. The *Harcourt*

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Manipulative materials were available and used through out the units of study in each of the curriculums used. Instruction on how to use the manipulatives was given to the treatment group.

Treatment of Data

The MAP mathematics assessment was given to the fifth grade class during the second week of September 2006. The MAP mathematics assessment was given again to the same fifth grade class during the second week of April 2007. A *t*-test was done to compare the students' achievement gains from September to April.

Summary

Fifth grade students in a self-contained classroom were given the MAP assessment during the second week of September 2006. *Harcourt-Brace Mathematics* and *Investigations in Number, Data, and Space* curricula was used to instruct students. The curricula were rotated between the two on average of three weeks. Mathematical manipulatives were used to enhance instruction in both curricula. The MAP assessment was administered again during the second week of May 2007. A *t*-test was used to compare the individual student September scores with the individual student May scores.

Chapter 4

Analysis of the Data

Introduction

The researcher investigated the relationship between the use of mathematical manipulatives and student achievement in mathematics as measured by fall 2006 and spring 2007 *Measure of Academic Progress* assessments. Therefore a comparison was made between fall *Measure of Academic Progress* assessments and spring *Measure of Academic Progress* assessments and comparisons between established benchmarks for fifth grade students.

Description of the Environment

This researcher compared the mathematics *Measure of Academic Progress* assessment gains within a typical fifth grade classroom. The classroom was comprised of 26 students which consisted of 13 male and 13 female students. The study took place from the fall of 2006 to the spring of 2007 in a small rural community with a population of 16,800 located in Eastern Washington State. The elementary school where the research was conducted had approximately 480 students with demographics of 57% Caucasian, 38% Hispanic, 1.7% Black, 1% Asian and 1.5% American Indian. There were 68.8% of students on the free and reduced lunch program which indicated a high population of low socioeconomic status students. Special education students were 14.5%

of the population. Transitional Bilingual student population was 15.5% and 12.9% were classified as Migrant Students (Office of Superintendent of Public Instruction, 2007).

Hypothesis/Research Question

Fifth grade students receiving mathematical instruction with manipulatives will make greater than expected gains in mathematics as tested by the pre and post *Measure of Academic Progress* assessment.

Null Hypothesis

Fifth grade students receiving mathematical instruction with manipulatives will not make greater than expected gains in mathematics as tested by the pre and post *Measure of Academic Progress* assessment.

Results of the Study

Table 1.

t-test of pre and post MAP test for fifth grade students

Test	N	M	SD
Pre	26	206.71	13.79
Post	26	216.32	14.29
df = 25		t = 6.41	p < .001

After comparing the students' pretest and posttest MAP assessment scores, Table 1 indicated the results for the researcher's fifth grade class. The null hypothesis was rejected. Table 1 showed that there was statistical significance in the students' mathematical progress between September, 2006 and May, 2007.

Findings

The results indicated that mathematical manupulatives combined with *Investigations in Number, Data, and Space* and *Harcourt Brace Mathematics* curriculum had led to increased mathematics scores by students as measured by the pretest and posttest for all of the students in the study. The number sense, algebraic sense, geometric sense, measurement, probability and statistics strands all seemed to improve significantly in the students. The participants in the study appeared to make significant progress in all areas of the mathematics program from September to May as indicated by the MAP assessment.

While the study group did show significant mathematical growth, the results cannot be attributed solely to the manipulatives combined with *Investigations in Number, Data, and Space* and *Harcourt Brace Mathematics* curriculum. There were other strategies included in teaching of mathematics that the teacher implemented to aid the success and growth of the students in the mathematics program.

Discussion

The results supported findings of many research articles that the use of mathematical manipulatives significantly increased student learning of mathematics. Much of the research stated that the use of manipulatives should start in kindergarten and continue through high school. The type of manipulative should also be consistent from grade to grade.

Summary

Students in the study classroom showed improvement in mathematics, as shown by the MAP assessment, from September 2006 to May 2007. The null hypothesis was

rejected as the mathematical manipulatives combined with *Investigations in Number, Data, and Space* and *Harcourt Brace Mathematics* curriculum seemed to have been significant contributors to an increase in students mathematics scores and achievement.

Chapter 5

Summary, Conclusions and Recommendations

Introduction

With the need to have each student meeting state standards mandated by the NCLB program there has been an increased need to have programs with scientific backing and research basis for planning all curriculums. Government officials, business leaders and national commissions had warned Americans that students' low performance in basic skills had posed a serious threat to the American economy (Newmann, Bryk and Nagaoka, 2001). Standards based education reform had recognized the potential result of an undereducated population. The recognized result became educational reform with accountability. Student learning accountability led states to adopt standards for student learning. State adopted standards were procured mainly from national councils in specific subject areas and specific grade levels.

Mathematics standards in Washington State were closely aligned with the *National Council of Teachers of Mathematics standards* (Executive summary: Evaluation of the Washington State EALRs for reading, mathematics, and science, 2003). Standards for Washington State were developed into essential academic learning requirements and more specific, grade level expectations. The grade level expectations had been aligned with the *Washington Assessment of Student Learning*. Another assessment used to measure student learning was the Northwest Evaluation Association's assessment. The assessment used in this study was the *Measure of Academic Progress*. The *Measure of Academic Progress* assessment was closely aligned with the *Washington Assessment of Student Learning* assessment. Results from the *Measure of Academic*

Progress assessment were used to make state level decisions concerning Adequate Yearly Progress mandated by *No Child Left Behind* legislation (Dahlin, 2004).

Summary

Fifth grade students in a self-contained classroom were given the MAP assessment during the second week of September 2006. *Harcourt-Brace Mathematics* and *Investigations in Number, Data, and Space* curricula was used to instruct students. The curricula were rotated between the two on average of three weeks. Mathematical manipulatives were used to enhance instruction in both curricula. The MAP assessment was administered again during the second week of May 2007. A *t*-test was used to compare the individual student September scores with the individual student May scores.

Conclusions

In conclusion, the use of mathematical manipulative coupled with *Harcourt-Brace Mathematics* and *Investigations in Number, Data, and Space* curricula were very effective in raising elementary student mathematics achievement in this study. This conclusion was based on the results of the MAP assessments scores. The treatment group progressed quite significantly, and showed much higher scores than expected in the post MAP test administered in the spring of 2007. Motivation among students was high as new skills were gained and routines were set down. Students were aware that a variety of teaching strategies would be used to help gain better skills and to motivate the students with new input in the form of games and methods.

Recommendations

Future research needs to be done to gather more data on the growth of student mathematics scores from the use of manipulatives. Conflicting research on the use and introduction of manipulatives is prevalent. This researcher recommends studies on the use of manipulatives that are consistent across grade levels. The use of the same mathematical manipulatives across grade levels may be easier for students to understand. Research must be conducted on children's understanding of the connection between the mathematical manipulative and the mathematical concept being taught.

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Appendix

Table 2: *t-test* MAP pre and post test scores

	Pretest	Posttest
A	208	225
B	208	210
C	191	207
D	202	192
E	195	201
F	210	222
G	228	235
H	225	235
I	203	206
J	199	204
K	208	224
L	200	203
M	222	237
N	201	208
O	184	205
P	205	218
Q	194	199
R	182	200
S	220	225
T	220	239
U	208	221
V	212	218
W	201	232
X	243	246
Y	186	198
Z	215	218