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Algebra in the Fifth Grade Mathematics Program

Kathy Bohac
Valparaiso, Nebraska

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Abstract

In this action research study of my classroom of fifth grade students, I investigated the incorporation of more algebraic concepts in their mathematics curriculum. Due to the restructuring of mathematics courses at the secondary level, my district has suggested that more algebraic concepts be included in the intermediate elementary mathematics curriculum. I discovered that the fifth grade students were not only capable of, but also enjoyed solving algebra equations. As a result of this research, I plan to continue to use the Hands On Equations program each year to enhance the current mathematics curriculum and to improve the fifth graders' algebraic skills so they are better prepared for their secondary math classes. My fifth graders experienced increased confidence and success with this multi-sensory program.

I teach in a rural school in Nebraska in a town with a population of about 400. My school has been consolidated for many years. I teach fourth and fifth grade in the K-12 building. A satellite school in a neighboring town is a K-6 building. This year there were six fourth graders and eight fifth graders in my classroom. This is the first year since I have taught in this school system that I have had two grades in the same classroom at the same time. The class sizes in my school vary and this year I just happened to have the two small classes. Changes in the school system are influenced by student enrollment. Due to changing class sizes, changes have been made in courses at the secondary level. This has affected the elementary program as well. However the restructuring of courses has led to changes in my classroom which I incorporated into my research project.

The topic of my inquiry is incorporating more algebraic concepts in my fifth grade mathematics program. I was lead to the selection of this topic through curriculum decisions made in my district. The secondary math course offerings have changed resulting in the elimination of one Pre-Algebra course. The secondary teachers believe that these objectives could be met prior to junior high. The secondary teachers contacted the elementary teachers expressing the need to teach more algebra concepts in the intermediate elementary grades.

Currently, I am fairly pleased with the mathematics curriculum in my fifth grade class. Their textbooks already interject quips of Algebra in our daily lessons. They are referred to as the "Algebra Connection." This is actually algebra embedded in the text in the form of word problems. While solving word problems is valuable and necessary, my students did not know how to set up or solve algebra equations. Due to my district's changing courses, learning to solve equations was included in the objectives needed to be taught in the fifth grade. Ideally, I

specifically wanted to enhance our current mathematics program with consistent, progressive, age- and grade-appropriate algebra objectives.

Two years ago my district's intermediate elementary teachers attended a workshop that demonstrated the Hands On Equations program by Dr. Henry Borenson. I was impressed with the multi-sensory approach of this program. Through the use of manipulatives, students learn to solve algebra equations. I thought this would be a good fit that easily could be incorporated into the current fifth grade mathematics curriculum to meet my district's needs. I was even more confident about trying this program because the National Council of Teachers of Mathematics (NCTM) Principles, Process Standards and Content Standards (2000) include Algebra as one of the five Content Standards and it would enhance my current fifth grade mathematics curriculum.

Problem Statement

Incorporating more algebraic concepts in my fifth grade mathematics program is worth knowing more about for numerous reasons. First, it is important to me because of the structure of the math classes in the district in which I am teaching. I want to teach more Algebra concepts, and I want my students to learn more Algebra concepts so they can have a firm mathematical foundation as they enter their secondary classes. Enhancing my program to meet my district's needs is necessary and attainable in my classroom.

With or without the necessity of the change to meet my district's requirements, I would still welcome more Algebra in my mathematics program for the benefit of the students as well as myself. This is a major goal of any action research project. "By now it should be evident that educational change that enhances the lives of children is a main goal of action research. But action research can also enhance the lives of the professionals" (Mills, 2007, p. 10). I want my students' performance in Algebra classes to improve, and I desire to be a better teacher.

My problem fits well into the three levels of knowledge. In my practice, teaching more Algebra to my students would create more interactions between the teacher and students, the fifth grade curriculum would be enhanced and hopefully the students' learning would be affected in that they would be better prepared for future Algebra classes. This flows right into the immediate community of teachers as the secondary teachers in my district support the effort. Theirs is the specific community that will be affected by my desired outcome: better Algebra skills for my students. While this is very specific to my district, to the larger community of educators, it may not be an Algebra issue, but maybe the way I alter my fifth grade curriculum may encourage others to enhance theirs in this or another (NCTM Content) area.

Literature Review

In the restructuring of my school district's secondary mathematics curriculum, it was determined that more algebra concepts are going to have to be addressed in the elementary program, particularly in the fifth and sixth grades. It is encouraging that in relationship to the NCTM Principles, Process Standards and Content Standards, Algebra is one of the five Content Standards. When my students experience the success of solving the algebraic problems and equations, they are better prepared for more intense algebra coursework as they enter the secondary program. In investigating this topic, I have focused on three basic themes. First, I focus on the level of student understanding of algebra concepts; they have already experienced some algebra in their regular curriculum, but more is needed. Second, I focus on student attitudes toward learning algebra. Finally, I focus on the amount of algebraic concepts included in fifth grade math. Incorporating more algebra in my fifth grade mathematics program is a reasonable and necessary goal.

Level of Student Understanding of Algebra Concepts

Recent changes in national and state standards have made it necessary for schools to incorporate more vigor into elementary mathematics programs. My district is no different, and as a result, more algebraic concepts need to be incorporated into our curriculum. Spielhagen (2006) examined the long-term effects of completing algebra in the eighth grade by all students in a large school district due to its recently modified long-standing mathematics curriculum. This district consisted of 36 elementary schools, 11 middle schools, and 11 high schools varying in diversity and socioeconomic composition. It was found that participation in the early access eighth grade algebra course led to further attainment in the quantity and quality of mathematics courses taken after the algebra experience. This indicates that the elementary students' level of understanding does support learning more algebraic concepts in the curriculum. This idea appears to be consistent throughout the research articles I have read.

NCTM (2000) contends that although Algebra is a word that has not commonly been heard in grades 3-5 classrooms, the mathematical investigations and conversations of students in these grades frequently include algebraic reasoning. These experiences and conversations provide rich contexts for advancing mathematical understanding and are also an important precursor to the more formalized study in the middle and secondary grades. In looking at my fifth graders' level of understanding of algebra concepts, I have observed their exposure to numerous algebraic exercises embedded throughout their lessons. America's National Council of Mathematics is spearheading the drive to begin teaching some high school math concepts, algebra in particular, to children as young as 6 (Ghazi, 2000). Elementary students are very capable of understanding algebraic concepts in elementary grades.

To further illustrate how important and necessary it is to incorporate more algebra in elementary mathematics programs, Spielhagen (2006) points out that the NCTM also advised schools to increase the rigor of mathematics instruction in the elementary and intermediate grades, as well as middle school mathematics classes before eighth grade, in order to create an infrastructure of readiness among the student population and open doors to algebra study for more students in eighth grade. While there is consistency in these articles concerning algebra at the elementary level, researchers also contend that instruction needs to be changed. Research done by Carpenter, Levi, Franke and Zeringue (2005) focuses on understanding children's conceptions and misconceptions related to relational thinking, how conceptions develop how teachers might foster the development of relational thinking and the use of relational thinking to learn arithmetic and how professional development can support the teaching of relational thinking. Due to my own involvement in professional development, I have been making a conscientious effort to shift from traditional arithmetic instruction to focus more on procedural fluencies that promote relational thinking. I realize how valuable this is to my students. Recent changes in national and state mathematics standards have increased the level of algebraic thinking taught in younger grades (Spielhagen, 2006).

In my fifth grade mathematics curriculum, algebra concepts are presented in word problems and various exercises that promote algebraic thinking. However, my students were not making the connection that they were actually doing "algebra." Even though a few lessons were presented as setting up equations, my students failed to make the connection. They simply saw them as word problems and missed the equation in finding the solutions to the problems. Carpenter, Levi, Franke and Zeringue (2005) characterized what they call relational thinking to include looking at expressions and equations in their entirety rather than as procedures to be

carried out step by step. For eight years, they have studied how to provide opportunities for elementary students to engage in relational thinking to learn arithmetic. While I have practiced some of these ideas in my instruction, I thought my students were still missing the idea of equations.

Student Attitudes toward Learning Algebra

In an effort to look at student attitudes toward learning algebra, I found more information about teacher attitudes. Nathan and Koedinger (2000) examined the congruence of teachers' beliefs about mathematical problem solving with respect to the students' actual problem solving performance and then investigated the possible influences that can effect teachers' instructional decisions. The subjects of this study were 105 high school, middle school and elementary teachers. Results indicated that regardless of instructional grade level, teachers accurately predict that arithmetic problems will be easier for students to solve than matched algebra problems and teachers generally expect that symbolic problems are easier for students than verbal problems. However, there was evidence that mathematics teachers operate with views of teaching and students' reasoning that do not always match student performance. Changes in national and state standards have encouraged the need to shift from a more traditional approach where students rely on memorization of facts and algorithms to more algebraic thinking. Nathan and Koedinger (2000) further state that the emphasis on students' reasoning and problem solving over memorization also means that teachers should see students' methods as paramount to their thinking, and well-articulated logical approaches should overshadow the correctness of an answer that cannot be clearly justified. This is my ambition in my classroom as my attitude has changed since my involvement in professional development.

Another example related to student attitudes in algebra was a case study conducted by Blanton and Kaput (2005) that examined the classroom practice of a third grade teacher for one year. Blanton and Kaput explored in what ways and to what extent the teacher was able to build a classroom that supported the development of students' algebraic reasoning skills. Results found that the teacher was able to integrate algebraic reasoning into instruction in both planned and spontaneous ways that led to positive shifts in students' algebraic reasoning skills. The teacher in this study was participating in a five-year professional development project that was designed to develop teachers' abilities to identify and strategically build upon students' attempts to reason algebraically. She not only executed the planned algebraic reasoning tasks, but also became even more successful in instances of spontaneous algebraic reasoning. For example, common elementary algebraic reasoning problems include the table problem and handshake problem. During the holiday season, this teacher adapted the handshake problem to the gifts given in the 12 Days of Christmas song. This motivates the students and elicits a positive attitude toward algebra.

As illustrated, the teacher in the Blanton and Kaput (2005) study strived to shift her students to think algebraically. This shift was evident in all the articles I read in order for the students to find success. Carpenter, Levi, Franke and Zeringue (2005) interviewed two third grade students. While the instructor's goal was to have her students use relational thinking based on the distributive property to reason about a number sentence, in one case, a student ran into difficulty when she had forgotten a basic multiplication fact. However, because of using the distributive property, the student was able to correct herself. In interviewing the other student, he was able to use relational thinking based on the distributive property to reason the number sentences clearly.

Both students were able to experience success using the relational thinking, which fosters a positive attitude toward algebra.

In these studies, I see change. Through the research, I can see that teachers' attitudes are changing as they encourage the shift from traditional ways of student thinking to more algebraic reasoning. I think positive student attitudes come with confidence in their performance and reflect from teacher attitudes. I think the positive change in attitude develops as we get the students more comfortable with algebra in the younger grades.

Amount of Algebraic Concepts Included in Fifth Grade Math

In my district, algebraic concepts taught in fifth-grade have been driven by the fifth grade textbooks. Nathan and Koedinger (2000) believe the discord between teachers' reform-based beliefs and their instructional decisions appears to be influenced by textbook organization, which institutionalizes the symbol precedence view. This is because widely-used pre-algebra and algebra textbooks introduce new material in a symbolic format and then later assign word equations and story problems as challenge activities. The fifth grade elementary textbooks tend to do the same. However, as teachers, we really need to be adhering to our national and state standards. Though I really do like our textbooks, for algebra for third through fifth grade, the NCTM (2000) recommends:

1. Identify or build numerical and geometric patterns;
2. Describe patterns verbally and represent them with tables or symbols;
3. Look for and apply relationships between varying quantities to make predictions;
4. Make and explain generalizations that seem to always work in particular situations;
5. Use graphs to describe patterns and make predictions;
6. Explore number properties;

7. Use invented notation, standard symbols, and variables to express a pattern generalization or situation (159).

These concepts are built into the fifth-grade mathematics curriculum, which heavily relies on the textbook Mathematics: The Path to Math Success (Silver Burdett Ginn, 1999). However while the textbook covers the concepts, pedagogy depends heavily upon teachers. This is consistent throughout the articles I read. The teacher's flexibility, creativity and openness make a difference as demonstrated in the Blanton and Kaput (2005) where the teacher was so willing to spontaneously incorporate algebra whenever an opportunity was presented.

Nathan and Koedinger (2000) suggest much about these ideas can be summarized in a few principles: (a) Teachers should focus on students' solution process more than the product of their calculations, (b) there are many ways to approach a given problem, (c) invented solution methods can be affective, (d) teachers should encourage students to invent methods and perform other activities that foster knowledge construction, and (e) the use of alternative solution approaches is indicative of students' adaptive methods of reasoning. As I am teaching, I employ these principles through our "Problem of the Day" activities. The fun of it is when the students take turns explaining how they arrived at the solution. They know that many times there is more than one way to solve the problem and if they used the same process, they try to think of other ways the problem could be solved. The principles Nathan and Koedinger (2000) suggested support Blanton and Kaput (2005) when they offer that the algebraic reasoning embedded in finding, describing, justifying, and symbolizing mathematical relationships between quantities that vary is crucial to elementary school mathematics because it creates conceptual underpinnings for the more formalized functional thinking that occurs in later grades. When looking at the amount of algebraic concepts included in my fifth grade math, I am fortunate to

have the NCTM (2000) recommendations and I feel confident that I am on the right track with the pedagogical suggestions of the research I have considered.

Conclusion

Through the research that I have read, one of the most prevalent ideas is that mathematics is in the process of change. Educators are recognizing the need to move from more traditional ways of teaching that emphasized drill and practice of computations to the kinds of knowledge students need to learn algebra with understanding. The studies where more algebraic concepts were included in current mathematics programs demonstrated success for the students as they achieved their goals. Changes in our national and state standards have promoted this change and it has been beneficial to students. I agree with the statement Spielhagen (2006) makes when he says recent efforts to increase the rigor of mathematics curriculum for all students have made progress toward both improving mathematics literacy and increasing the equity of course offerings across all student populations. Having had the opportunity of professional development in mathematics, I feel like I am on the right track as I try to emphasize algebraic thinking in my classroom, but I am not "there" yet.

My district is also in the process of change. Carpenter, Levi, Franke and Zeringue (2005) boldly state that in the current American curriculum, there is a serious discontinuity between the arithmetic that students learn in elementary school and the algebra they are expected to learn in the upper grades. My district fits this belief, but this is what we are addressing right now. This is the driving force behind my goal to teach more algebraic concepts to my fifth graders. I want them to be better prepared for the classes they will be taking in middle school. While I encourage the algebraic thinking in my math class, I realize that my fifth grade students are lacking in understanding of basic algebra equations.

From the research, I have learned that students are very capable of learning this concept in the elementary grades. I know my students are capable; they just have not had a lot of exposure to the actual equations as my focus has been on their strategies in solving word problems and I have not stressed the equations. “But in the US, a new philosophy of demystifying algebra – a subject that traditionally terrifies pupils – by starting children younger is producing highly encouraging results” (Ghazi, 2000, p. 5).

The Hands On Equations system uses manipulatives to teach algebra equations to elementary students. Students benefit from the multi-sensory approach to learning algebra equations. In my fifth grade class, my students range in academic ability and performance. Hands On Equations is designed to accommodate these differences. While I am addressing the changing structure of mathematics according to national and state standards, I realize a gap in our math program. When Carpenter, Levi, Franke and Zeringue (2005) discussed relational thinking to include looking at expressions and equations in their entirety rather than as procedures to be carried out step by step, as mentioned early on in this paper, I realized that we are looking at our problems in their entirety and need to consider the step by step. While this might be deemed as good, I would like them to be able to put the information into an equation even if it is after they have solved it. My project addresses the NCTM Algebra Standard and the Hands on Equation system could be used in any fifth grade classroom.

Purpose Statement

The intent of my study was to find out if my fifth grade students could successfully solve equations. Their math textbook does include algebra in the form of word problems and has one lesson on putting the word problems into equations. Due to the changing of course requirements in my district, my students needed to be exposed to algebra concepts that would have been taught

in the pre-algebra class that was dropped. While the students are required to do word problems daily, they had never learned to solve equations as they would in secondary courses.

The purpose of this study is to increase the amount of exposure to and practice of algebra skills in fifth grade mathematics, in order to better prepare my students for secondary mathematics coursework. In my inquiry, I am seeking to understand if my fifth graders will be able to comprehend the process of solving algebra equations. Even though this is a small class, there are still a wide variety of learning styles, ability levels and needs. I want to know if all the fifth grade students in my class will experience solving equations successfully with the Hands On Equations program.

My research questions are:

1. What happens to my teaching when I enhance my fifth grade mathematics instruction to include more algebraic concepts?
2. What will happen to my students' attitude toward algebra when I increase the amount of algebraic concepts in fifth grade mathematics?
3. What happens to student understanding of algebraic concepts when I increase the amount of algebraic concepts studied in fifth grade mathematics?

Method

My study began in the spring semester of 2009. On February 19, I surveyed my students in regard to their attitudes about algebra using a Likert scale before starting the Hands On Equations lessons (Appendix A). Also on February 19, I asked my students to write their first journal for this project explaining what they think algebra is. On February 23, the students were given the pretest (Appendix B). They were anxious for the next day as that was their first lesson in the Hands On Equations program. Each week for the next six weeks, the students were taught

the rest of the seven lessons in this program (see Appendix C for a sample lesson). I was concerned about having only seven lessons; however, due to a snow day and student absences, this turned out to be a good number of lessons to have. If I would have gone any later with the lessons, my students would have been doing this project during their week of achievement testing. Throughout this time, the students were asked to journal about the project. During the week of March 24-27, the fifth graders were interviewed about the project. Upon reading comments made in their journals, additional problems from a junior high algebra textbook were given to the students to further challenge them (Appendix D). Their post-test was completed on April 8, 2009 (Appendix E). Following the post-test, the students were given the same survey they did prior to the project. Throughout the entire project, I also kept a journal about the project, including the logistics, student performance and other pertinent information about this research project.

Everything from this project was collected, separated and filed in individual student folders. The surveys were collected upon completion. Each student worksheet was gathered after each lesson as well as the pre-test and post-test. The student interviews were taped by an audio tape recorder. Students were asked to journal on loose leaf notebook paper or on the back of their lesson worksheet. I continuously collected this material and organized it in a folder for each student. I kept the folders so that none would be "lost," or left at home, etc. I used the computer for my own journal, just to make it easier to access for additional information and completing analytic reviews. I also kept a calendar with the dates of each event throughout the entire research project.

When analyzing the data, I was very anxious to compare the pre-test and post-test to determine whether my students grasped the concepts. However, the lessons and supplemental

problems I added provided the opportunity for me to see how my students were processing what they were learning. The surveys and their journals helped me to monitor their attitude about this algebra project. My own journaling enabled me to stay on track with the project and take note of my students' progress, discoveries, issues and concerns throughout the project.

Findings

While executing my research project, a typical day was anything but typical. Since I have a self contained classroom, there is also flexibility. Prior to actually teaching the lessons using the Hands On Equation program, both classes were in the room. The fourth graders worked on assignments while the fifth graders completed their surveys, pre-test and journals. However, for the actual Hands On Equation Lessons, I was fortunate to collaborate with the Title One teacher and our Speech Pathologist; they would take the fourth graders out of the room at that time so I was able to have the fifth grade alone. Everyone involved was "flexible" as I never had a specific amount of required time for a lesson; we did it for however long it took.

In my first research question I inquired about what happens to my teaching when I enhance my fifth grade mathematics instruction to include more algebraic concepts. I discovered I was making some significant changes. Teaching is about the students. In my analytic memo on March 22, 2009, I wrote, "Throughout this project, my awareness of how my students are performing is increasing. I have made every effort to consider where my students are at academically. I am gearing my instruction more toward my students' needs." Although this is a small class, I am very much aware of the different ability levels of the students. The Hands On Equations program addresses various student learning styles and ability levels by its multi-sensory presentation.

With my background in Special Education, I know how crucial consistency is. Even if the checking process included in the Hands On Equations program takes longer, I want to be thorough in every step. Tuesday, April 7, 2009, I wrote in my journal: "I am being very careful to include all steps of the process. Each lesson we do the problems with the manipulatives, pictorially on the blackboard and then actually solve it as in a regular algebra class. I want to be careful to cover each component."

To address the needs of some of my students who were grasping it more quickly, I had to bring in extra problems to keep them challenged as much as possible. After the third lesson, I realized that I needed to seek a basic algebra book for those who needed more challenging problems. All of the fifth graders successfully solved the extra problems on the worksheet I created (Appendix D). Examples of typical problems on their worksheet from this algebra book were $2x + 5 = 25$ or $8x + 9 = 33$. Travis[1] stated in his journal, "My favorite problems are the ones from the book (3-10-09)."

When I asked my students in their interviews, "Why do you think we have focused on algebra concepts in fifth grade math this year?" Almost all of them mentioned so that they would be more prepared for Junior High and High School math. I never mentioned to them that our district has made some course changes at the secondary level which was a big part of why I chose this project, but this is exactly what I desired. In the process of "stepping up" my fifth graders' math program, my teaching was also "stepping up." I realize the value of this program and intend to continue it every year.

In my research project I was also concerned about what will happen to my students' attitude toward algebra when I increase the amount of algebraic concepts in fifth grade mathematics. My study survey (Appendix A) yielded two findings: first that my students' attitudes did not change

[1] All names are pseudonyms.

that much from the pre-project survey to the post-project survey (Appendix G), and secondly they have a fairly positive attitude about algebra. On the pre-project survey, the average score for the statement "I like algebra" was "2," which corresponded to "agree." The standard deviation for this score was 0.53 keeping in mind the "1" score meant "strongly agree," which was the average for the post-test with a standard deviation of 0.35. Other positive choices from the survey were "I believe algebra is useful," which the students marked an average of 1.86 with a standard deviation of 0.35, and "I believe I can work to become better at algebra" with an average of 1.29 and a standard deviation of 0.45.

The results of the student survey might have been a little misleading as my students thought they knew much more than they actually did before doing this project. On February 19, 2009, Jeff wrote in his journal:

> Algebra is a fun and tricky kind of math. It is a kind of problem that leaves numbers in (he meant out of) a problem for example: 8 x n = 64 = 64 ÷ n = n. This (is) a kind of algebra problem. Do you know it? Of course you do! The answer is 8. n = 8. Some problems are bigger and harder. Some people should try this. You will know when it's algebra because a number is replaced by an n.

Even though he is stating some key elements, when I gave them the pre-test, he was one of the first students to verbalize that "this is hard." Of course he was one who got a 38% on his pre-test, so he as well as the majority of the students really did not have a grasp on solving equations. That same day, in her journal entry, Anne wrote, "The pre-test was hard. I really didn't get it. I was freaked out. The x was right next to a number. It was like this: 2x = 8. I was stumped."

The students' enthusiasm was strongly stated in their journals. Travis is a bright student; he wrote in his February 24, 2009, journal entry, "This is easy, I finally learned how to use the scale

the correct way. This form of algebra is a little more difficult than what we do in our daily math class and I like this better than daily math. I can't wait for it to get more challenging." On March 10, 2009, Anne wrote, "My favorite project is this one out of all the projects we did in fifth grade. It is really fun. I can't wait until we get to level 3 of this project."

The fifth graders talked about this research project very openly in the student interviews. They all agreed it was easy and fun. One of my students was willing to give up recess to work on equations. In the interview, Kaitlyn stated, "The best part about math is algebra and to push the whoomp button and the worst part about math is long division." To explain the whoomp button, my students are rewarded for checking division with multiplication by pressing the whoomp button that says "whoomp there it is, whoomp there it is, etc." In her journal entry, Anne wrote, "I came into the room hating math, but will leave loving it."

The Hands On Equations program has provided a confidence throughout this project. My awareness of how my students are performing is increasing. My fifth graders have gained a confidence that I can only hope they will carry on with them into their secondary school years. They actually think algebra is fun! From my Friday, March 6, 2009, journal I recorded how excited I was about my students' comments from their journals. For example, Gavin wrote, "This is a BLAST! I love this from day one. Bigger numbers are more fun." Dallen wrote, "Algebra is now really fun. I understand a lot and want to learn more. It gets easier every time. I can't wait till we get more challenging stuff!" In the student interviews, when I asked them what they like best about math, even though they did mention some other things, the most consistent response was algebra. I realize that this is what they were involved in at the time so they would be apt to respond as such anyway, but their journal entries, interview questions and responses on the

survey are consistent with their positive attitude. I do have to admit – I feel it too. They are so confident. It is neat to see them RACE to the blackboard to sign up to present problems.

Finally I wanted to know what happens to student understanding of algebraic concepts when I increase the amount of algebraic concepts studied in fifth grade mathematics. The pre-test and post-test yielded positive results. On the pre-test of eight problems from the Hands On Mathematics program, my students averaged 36% correct with a standard deviation of 4.5%. The pre-test did not require the "check" element, and I realize the students would not have known how to do it at that point anyway. On the post-test, they all scored 100% in solving for x. On the posttest, I asked students to do the checking component. They averaged 97% on the checking component. Once they did learn the "check" step, it assured them that their answer was correct. In my own teaching, I now realize how important that step is. I know to require it even when we do the problems from the algebra book that is not part of this program for my research project.

While I was pleased with the post-test results, I found some valuable information in the student interviews. Throughout my research project, I was concerned that the Hands On Equations program might not encourage the students to apply their new skills of solving equations to word problems. In the interviews, I asked students to write a word problem as an equation and explain how they do it (see Appendix F, interview question number 6). I was surprised when I saw students were able transfer their skills of setting up and solving equations to the word problem I gave them. Jeff set his equation up like: "$6 \cdot x = \$72$" and then he checked his answer "$72 = 72$ √." Travis set up his equation "$72 \div 6 = x$." Anne set up her equation "$6x = 72$." Patti and Dallen set up their equations "$x \cdot 6 = \$72$." Gavin set his up "$72 = 6 \cdot x$ and $x = 12$." Kaitlyn wrote "$6 \times 12 = 72$." I was not expecting this result. I was expecting my students to

be so engrossed in the mechanics of solving equations that they would not be able to apply the skill in solving word problems.

My students have gained the understanding to solve and check the first level algebra problems from the Hands On Equation program. They are also able to solve and check selected corresponding equations from the Junior High algebra book that was part of my project. Their level of understanding has increased throughout this project. My fifth graders were so confident going into the post-test. On March 20, 2009, I gave them a pop quiz consisting of 10 problems I selected from the algebra book I had brought in to enhance this project. My fifth graders scored an average of 84% (one low grade pulled this average down). In their interviews I asked them what algebra is, Kaitlyn said it was to find the answer for the x. Anne said, "It is finding x or any other letter to balance it." Jeff said "It was finding the x in the equation." My students have learned how to solve algebra equations and are eager to learn more. While certainly Algebra is more than solving linear equations, my students now have begun to develop a good conception of 'variable,' which will prepare them for deeper algebraic concepts in the future.

Conclusions

When the teachers were discussing how best to address the restructuring of our intermediate elementary math program, I recall thinking: we are already teaching algebra in our math curriculum. The "algebra connection" already exists in our basal math series; it is age and grade appropriate. Through this project and its findings, I have learned how effective the Hands On Equation program with my supplemental materials is. It has enhanced our fifth grade mathematics program. I have witnessed my students flourish in this project. They have gained a level of confidence that I did not realize they could achieve. My fifth graders have experienced success in solving equations that I had never considered teaching them before.

My research supports much of the scholarly literature I studied for this project. I agree with Carpenter, Levi, Franke and Zeringue (2005) as they boldly state that in the current American curriculum, there is a serious discontinuity between the arithmetic that students learn in elementary school and the algebra they are expected to learn in the upper grades. The very purpose of my project was to bridge the gap between elementary and secondary algebra. Bringing the Hands On Equations Program and my supplemental materials into my classroom is a big step in the right direction not only as Carpenter, Levi, Franke and Zeringue (2005) suggest, but also to meet the NCTM standards in math. My research project supports the NCTM (2000) recommendations for algebra for third through fifth grade.

I was pleased with the performance of my fifth grade students on the algebra, their positive attitude and enthusiasm. I am fortunate to have been involved with this research project as it was such a positive experience for me too. Mills, 2007 summed up my attitude about including more algebraic concepts in fifth grade when he said, "By now it should be evident that educational change that enhances the lives of children is a main goal of action research. But action research can also enhance the lives of the professionals." I believe the lives of all of us involved in this project have been enhanced.

Implications

As a result of my research project, I have learned that I am going to use the Hands On Equations and my supplemental materials to enhance my mathematics program every year. I have learned how important the "check" step or putting the value for x back into the equation is to see if it works. The check step is built so nicely into the Hands On Equations program. I required my students to do the "check" step even on the supplemental material I brought in. I want to be consistent in requiring it because it is such a good way to ensure correctness. This

year the fifth grade students enjoyed the project and I know the forthcoming classes will too. I am excited about their success and value this project.

Another action as a result of my research project is that I would like to contact the secondary teachers again and share what was done in my project and its outcome. I would like to know if this program actually does increase student performance in algebra when they get into the secondary grades. I have the opportunity to work closely with the other intermediate teachers in both elementary centers of our district. They have dabbled with the Hands On Equations program. I would like to share my research project with them and discuss the idea of refining this project to meet our districts math curriculum needs in the fifth and sixth grades and possibly bring it down to the fourth grade level. My fifth graders have benefited academically from this project. I have benefited from this project. It is a good fit for our district's math curriculum needs.

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ZDM is: The International Journal on Mathematics Education

Name: _____ Date:_____

Study Survey

Directions: Respond to the following statements by rating how much you agree or disagree with what is said: strongly agree (SA), agree (A), undecided (U), disagree (D), or strongly disagree SD).

1. I like **algebra.**

SA A U D SD

2. I believe **algebra** is useful.

SA A U D SD

3. I believe I can work to become better at **algebra.**

SA A U D SD

4. The students who get the right answer to a problem first are the smartest.

SA A U D SD

5. It is important to know why I got an answer right.

SA A U D SD

6. It is important to know why I got an answer wrong.

SA A U D SD

7. People are either good or bad at **algebra**. There is very little they can do to change that.

SA A U D SD

8. My teacher's questions help me think about the **algebra** we are doing.

SA A U D SD

Answer the questions below.

9. How do you know when you "get it" in **algebra**?

10. What do you do when you don't understand a problem?

11. Did you ask any of your classmates questions during the lesson?

12. Is there anything else you want me to know about you and your work in **algebra** this year?

Appendix A

Appendix B

PRE-TEST QUESTIONS

1. $2x = 8$
2. $x + 3 = 7$
3. $2x + 2 = 8$
4. $3x = x + 6$
5. $4x + 3 = 3x + 6$
6. $2(2x + 1) = 2x + 6$
7. $x + 3x = x + x + 10$
8. $4x - 3x + 9 = 2x + 6$

Appendix C

HANDS-ON EQUATIONS®

Lesson #4 **Name:**_____

Classwork Sheet **Grade:** _____

Use your Hands-On Equations Kit to solve:

New Work

1. $x + 2x + 5 = x + 19$ $x =$ *Check:* _____
2. $x + 2x + 14 = 5x + 2$ $x =$ *Check:* _____
3. $x + 4 + 2x = x + 20$ $x =$ *Check:* _____
4. $x + 2 + 2x = x + 12$ $x =$ *Check:* _____

Previous Work

5. ▲▲▲▲ 1 = 9 $x =$ *Check:* _____
6. ▲ 2 ▲ = ▲ 8 $x =$ *Check:* _____
7. $5x = 3x + 10$ $x =$ *Check:* _____
8. $3x + x = 2x + 2$ $x =$ *Check:* _____
9. $2x + 4 + 2x = x + 10$ $x =$ *Check:* _____
10. $x + 2 + 2x + 3 = 4x$ $x =$ *Check:* _____

Appendix D

Name: _____ Date: _____

1. $3x = 12$

2. $6x = 42$

3. $x - 4 = 10$

4. $x + 2 = 7$

5. $2x + 4 = 12$

6. $6x + 3 = 33$

7. $4x + 9x - 6x = 42$

8. $6x - 4x + x = 18$

9. $13x + 5 - 4x = 23$

10. $8x - 5x + 7 = 19$

Appendix E

POST-TEST QUESTIONS

1. $2x = 10$
2. $x + 3 = 8$
3. $2x + 2 = 10$
4. $3x = x + 4$
5. $4x + 3 = 3x + 9$
6. $2(2x + 1) = 2x + 8$
7. $x + 3x = x + x + 18$
8. $4x - 3x + 5 = 2x + 3$

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Appendix F

K. Bohac Student Interview Questions

1. What do you like best about Math? What do you like least about Math?

2. What is algebra?

3. Why do you think we have focused more on algebra concepts this year in fifth grade Math?

4. This semester I have made some changes in my teaching practices. What advice would you give me about continuing these changes next year?

5. What would you tell someone who is new to our class what it takes to be successful in this Math class?

6. I would like you to work on this problem, trying to write down all your steps and explain what you are thinking. Afterwards, I'll ask you how you decided what to do to solve this problem:

> Emma is saving money to buy a bike that costs $72. She wants to buy the bike after saving the same amount of money each week for 6 weeks. How much money does she need to save each week?

Can you write this problem as an equation?

7. Is there anything you want to know from me?

8. Is there anything else I should know about you to better understand your algebra skills in math or your overall math experience in my class?

Appendix G

KEY				
1	**2**	**3**	**4**	**5**
SA	**A**	**U**	**D**	**SD**

Student Survey Table

	Pre Survey	Pre Survey	Post Survey	Post Survey
Question	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
1	**2**	**0.53**	**1.142**	**0.35**
2	**1.857**	**0.35**	**1.714**	**0.45**
3	**1.286**	**0.45**	**1.57**	**0.49**
4	**3.571**	**0.49**	**4.71**	**0.45**
5	**2.143**	**0.83**	**1.57**	**0.49**
6	**2**	**0.0**	**1.428**	**0.49**
7	**4.571**	**0.49**	**4.571**	**1.36**
8	**2**	**0.53**	**1.857**	**0.64**