A COMPARISON OF TRADITIONAL SCIENCE INSTRUCTION WITH HANDS-ON ACTIVITIES TO TRADITIONAL TEXTBOOK SCIENCE INSTRUCTION WITH WORKSHEETS

by

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A Research Paper

Submitted in Partial Fulfillment of the

Requirements for the

Master of Science Degree

With a Major in

Education

Approved: 2 Semester Credits

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July, 2000

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Abstract

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Education Dr. Howard Parkhurst 11/00

American Psychological Association Format

The purpose of this research paper was to investigate two different teaching methods to determine which method of science instruction is more beneficial to the elementary science student.

This study was conducted during the fourth quarter of the 1999-2000 school year. The subjects were third grade students enrolled in two separate classrooms in a small rural western Wisconsin school district.

Data was collected through a pretest and a posttest. Scores were compared to determine the outcome of the study. Statistical analysis of the raw scores was completed by L. Applebaugn. The means, standard deviation and tValue was calculated by using a one-tailed t-test.

Overall, the students in the hands-on group achieved higher scores than those in the worksheet group. Conclusions drawn from the data show a significant difference in achievements of the hands-on group with a means score of 94% in contrast to the

worksheet group's means of 82% using the .05 level of statistical significance.

Another important difference between the two groups was their the standard deviation scores.

The hands-on group's standard deviation was 5.44 in contrast to the worksheet group's standard deviation score of 15.3. This difference shows that the majority of the students who learned by using hands-on activities achieved at the higher level when compared to those who learned by using the worksheets.

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Chapter 1

Introduction

As schools are becoming more accountable through state-wide testing, it is becoming increasingly important that we assess the methods that we are using to teach our students and to use the methods that are found to be most reliable. The statewide tests are asking more higher level thinking questions rather than basic knowledge level questions. Because of this, it is important that we teach our students more than just the basic concepts, but also how to use abilities such as classifying, comparing, identifying, describing, predicting, hypothesizing, inferring, sequencing, and summarizing (Thompson, 1990). It is important for our students to gain these abilities, not only because they are being tested, but because these are abilities they will need to be successful in many areas of their schooling and of their lives.

In the past, schools have tried different methods of teaching science. Many schools were and some still are teaching science using the traditional science textbook along with the worksheets that accompanied the text. This method had very little hands-on learning associated with it. In years past, John Dewey and Jerome Bruner had similarities in their beliefs on how students learned best

through inquiry-discovery. "Bruner's work emphasized the importance of understanding the structure of a subject being studied, the need for active learning as the basis for true understanding, and the value of inductive reasoning in learning. (Woolfolk, 1998). John Dewey's view was "that ideas must be tested through experimentation, that people learn best through questioning and hands-on experiences...(McNergney & Herbert 1998). More recently, many schools have adopted curriculums that either replace the worksheets with hands-on activities or supplement the worksheets with such activities. Science teachers need to realize that teaching in the new millennium will require them to leave the "traditional" 50s science classroom because the students from the 90s find it difficult to discipline themselves to a "pencil and paper" classroom. This is because over the past 20 years, American children have learned to interact more physically with their world. (McGraw, 1999). This change in the method of teaching science can be related to Dewey and Bruner's ideas in instruction. However, this method also incorporates the use of modern technology. The use of the computer includes educational games and the Internet and the use of educational television (Ridgeway, 1998). The change in the method of teaching science in this study will be evaluated

to determine whether this is a more beneficial way to teach science than the previously used methods. Research will help determine whether it tends to help students gain the knowledge and skills needed to be successful on the statewide tests. Success on the tests will be an indicator of what the students are learning and achieving.

Not only will the research serve to help students' scores go up, but just as importantly, it will serve as a motivator for teachers who have been reluctant to add the hands-on activities to their science lessons. Hands-on teaching is definitely more time-consuming for teachers. Materials need to be gathered and there is often a set-up time needed for stations. After the activity, there is time needed for clean-up which sometimes needs to be done by the instructor so that the students' time is being used for the learning of the activity and not set-up or clean-up. It also sometimes requires more knowledge of the material, and, last, anything new sometimes comes with resistance. With research, which will be later cited, to support and illustrate the benefits of hands-on activities, it may be more likely that there will be less teacher resistance to this teaching method and a more positive attitude toward the extra work required for the instruction.

An example of a lesson teaching about friction in a simple machines' unit would be as follows for the group being taught using the textbook with worksheet. The students would talk about what they already know about friction and the instructor would record this information on the board. New vocabulary words that the readers will encounter would then be taught. Next, the students would take turns reading from the textbook out loud. After the reading was completed, the instructor would refer to the board to verify what previous knowledge was correct and what knowledge needed clarifying. The students would discuss the reading and ask any questions they might have. They would then be given a worksheet that would ask for the definition of friction, ask if more or less friction occurs between rough surfaces, ask what can be done to reduce friction, and last, ask how machines depend on friction in order to work. The worksheet will be corrected by the instructor and returned to the student. The student will keep it in a folder for review before the test.

An example of a lesson on friction in the simple machines unit for the other group being taught by using the textbook and an activity or experiment would be as follows. The students would talk about what they already know about friction, and the instructor would record that information

on the board. New vocabulary words that the readers will encounter will then be taught. Next, the students would take turns reading from the textbook out loud. After the reading was completed, the instructor would refer to the board to verify what previous knowledge was correct and what knowledge needed clarifying. The students would discuss the reading and ask any questions they might have. The instructor would then put the students into cooperative groups and assign each person in the group a role, such as timer, reader, recorder, etc. Groups would be assigned to a station that would be equipped with a piece of plywood board that has four different materials, foil, waxed paper, wool, and felt, two Hot Wheel cars, a ruler, a sheet of paper to record their hypothesis, the procedure they choose to do, why they choose that procedure, and the results of the experiment. They would be instructed that they must classify the four materials into two groups and label the groups as more friction or less friction. Next, they would be shown how they start the race using the Hot Wheel cars and the ruler so that each car leaves the marked starting point at the same time. Then they would be told to predict the ranking of each material as to how fast the car would travel down the material. Last, they will be asked to discuss what happened in their experiment and to write

their results and why they think they got the results they did. After 15 minutes of experimenting, the students will return to their desks, and the reporter will share the group's results and discuss with the class whether the results seem reasonable and why or why not. Each student will be given a copy of the experiment form with all the information from the experiment to be kept in a folder for later review.

Statement of the Problem

In one small, rural, western Wisconsin school, students have not been achieving on the state tests as well as administration and faculty would like. Because of this, the district is looking at their curriculum and testing procedures to see where improvements can be made. In the area of science, the Elementary School supplemented the curriculum they had been using with multiple hands-on activities to be used with the text and also with additional technology. This was done in the 1996 - 1997 school year. The district has not done any assessment on how the supplemental activities and the use of the technology have affected the students' growth in the area of science. The purpose of this study is to determine and identify which method of teaching science, using a textbook with worksheets or using a textbook with hands-on

activities, is more beneficial to third grade students in this rural, western, Wisconsin Elementary School. A test will be given at the end of the unit to determine achievement of both groups of students. The study will be done during the fourth quarter of the 1999 - 2000 school year. Two different third grade classes will be taught; one class will be taught using the textbook and worksheets, while the other class will be taught using the textbook with an experiment or demonstration following.

Hypothesis

There will be a difference in science achievement between the two third grade classrooms studied when one group is taught using the textbook with worksheets and the other group is taught using the textbook with hands-on activities.

Definition of Terms

For the purpose of this study, the following terms will be defined in this manner.

Textbook instruction with worksheets - instruction that will consist of reading the textbook in a whole group manner with a worksheet assigned to be done individually. The worksheet will be directly related to the topic from the reading material. This is sometimes considered the traditional way of teaching science.

Textbook instruction with hands-on activities - instruction that will consist of reading the textbook in a whole group manner with an activity (often times an experiment that will require the students to use skills such as classifying, comparing, identifying, describing, predicting, hypothesizing, inferring, sequencing, and summarizing). Students will be asked to work in a cooperative group for the activity with each of them taking on a role such as recorder, timer, etc. The activity will be directly related to the topic from the reading material.

Assumptions of the Research

The following are the assumptions for this research. There are varying degrees of ability in each of the classrooms. The learning ability of both groups is somewhat equal. One group will remain in their homeroom for the science instruction, while the second group will leave their homeroom to receive the science instruction in another classroom.

Limitations of the Research

This research is limited to two sections of third grade students enrolled in the rural, Western Wisconsin Elementary School District for the fourth quarter of the 1999 - 2000 school year. This study will only include achievements in the area of science. The instructor comes

to this research with a bias towards hands-on learning. She will be aware of this bias and present the lessons in as much the same manner as possible. The subjects were not randomly selected but it is believed that each group has approximately the same learning ability.

CHAPTER 2

Review of Literature

Introduction

This chapter will complete a literature review on the following topics: the need for a change in the way science is being taught in our schools, the method and advantages of implementing hands-on learning with the traditional textbook and worksheet method and the method and advantages of traditional textbook and worksheet. Some of the public feels there is a need for changes in education. According to Wawracz (1997) "There seems to be a view of public education lately that suggests we are in a time of turmoil and academic decline and that there is no end in sight."(p.3) Much has been written in this area and on today's market there are a number of revised elementary science curriculums that have incorporated the use of the hands-on activities. This might indicate that there is a real need for the change and that the need is being addressed.

The Need for Change

The problem is how to change and if the change will be for the better in the teaching of science. Who knows what's the best way to teach science? Shrestha (1996) feels that most competent teachers have a feel for the best way to teach. In a video called, "Science Standards," it is stated "To prepare students for the challenges of the 21st

century, scientists, educators, and other community members are formulating a new vision of science education, starting in the earliest grades. They are meeting to discuss what it means to be scientifically literate and what steps we need to take to help students achieve that literacy" (Famellette, 1996). The National Science Education Standards emphasize that skills are necessary, whether learned through worksheets or hands-on experiences, to become independent inquirers about the natural world. Because we need to enable students to become independent inquirers, it appears that a change in the way that science is taught might help.

Method and Advantages of Textbook with Worksheets

But is hands-on learning the direction teaching science should go? Some feel not. "More research in this area is needed so that other methods of instruction can be used in the classroom" (Kempter, 1981, p.15) is the feeling Kempter holds. "A study done by Boeck investigated the effects on ninth grade students' understanding of science. He used three groups in his experiment: (1) a group that read and discussed the science textbook; (2) a group that observed demonstrations; and (3) another group that read, discussed what had been read, and observed demonstrations. His analysis showed that there were no significant

differences in achievement" (Riley, 1964). This brings about the question; will the students show any significant differences in achievement if hands-on activities are added to their curriculum? There are advantages to teaching using the traditional method. Some advantages of a teacher lecturing to students from the textbook include things such as large amounts of material being taught in one setting, the teacher bringing in immediate information to students, thus by-passing unimportant details. Listening skills can also be developed if the student so desires. (Gilstrap & Martin, 1975). Advantages of memorizing from textbooks and worksheets including factual information may be important. However, as pointed out by Saul and Newman (1986), most eight-year-olds can recite the alphabet, but very few are able to rattle off the noble gases from the periodic table. They go on to say that even though the memorization of facts can be misused and abused, one should not completely ignore the idea of collecting and storing information. Facts can be important because they give form and precision to things we understand. Another part of the textbook method can include creating a KWL chart. This is a chart that lists what the children know (K), what they want to know (W), and (at the completion of the unit) what they learned (L). "This activity helps children relate prior

knowledge to new information" (McLaughlin, Hampton, Moxham, 1999, p.8). This is a technique many teachers use when teaching a variety of subjects, and it appears to work very well with helping children relate new information they are reading with what they already know. Another advantage with staying with the traditional method of teaching science is that often hands-on science is more difficult to organize and takes more time. (Saul, Newman, 1986). There are many supplies that are often needed, many messes to clean up, and classroom management needs to be organized or the experiment and time can get out of control. Another advantage to staying with the traditional method is that in the hands-on method, science does not necessarily counter naive misconceptions (Saul and Newman, 1986). If a group of students working together have a wrong concept, they may go about the activity working toward that incorrect concept. Because of this, it may be important that hands-on science never replaces informed conversation and reading.

Method and Advantages of Including Hands-on Learning

There are also advantages to teaching science using the Hands-on learning method. Learning science is something that students do. The students are engaged in the active doing process through inquiry and hands-on activities (Decker, 1999). In the book, Science Fare Asimov (1986)

feels that we should not think of science merely in terms of its content but realize it is possible to pile up the content indefinitely, and doing so, we can make that pile so difficult to grasp that only a gifted few can study long enough to master it all. Science, however, is so much more than that. It is a way of thinking. It is careful observation. It is collecting. It is experimenting. It is theorizing. It is predicting. It is a method of thinking--the scientific method--and it is the same at all levels. Agreeing with that is Mohrmann (1999, p.25) who said, "The scientific method takes place in an authentic environment that stimulates curiosity in a way textbook learning simply can't." Continuing to support that philosophy Calkins (1999, p.32) wrote, "As every science teacher knows, exploration and discovery lie at the heart of good science--and good education." Further support, "Engaging young children in real, hands-on experiences ...helps them to remember the elements and processes involved. As a result, they may want to learn even more." (McLaughlin, Hampton, & Moxham, 1999, p.31). The title alone of: "Science Is About Not Knowing, but Trying to Find Out" (Manganus, Rottkamp, & Koch, 1999) supports what the other researchers have claimed. In the opinion of several writers, there is a lot of support for hands-on; activity based experiments using

the scientific method. If we look at a survey done with K-5 science students, "the majority of the students depicted themselves studying science through an activity" (Barman, 1999, p.19). So it does appear that many schools are going back to, changing to, or adding in hands-on activities.

Just because a teacher is actively involving students in experiments and activities, it does not mean they are "learning science." An article entitled, "How Do You Know Science Is Going On?" gave three case scenarios. In each scenario, the students were “doing” experiments in the intention of learning the scientific concept; however, this article argues that sometimes very little learning is going on. This is a very important aspect to pay attention to. "If learners cannot attribute to themselves they are doing science and be able to explain how and why something they are studying or doing is science, are they doing science? Couldn't they be just playing or imagining or something else? I contend we cannot attribute doing science to others if they do not attribute it to themselves" (Sullenger, 1999, p22). She went on to explain that the students must be able to give their own explanations and ask questions in an effort to figure out why something is the same or different, etc.

Summary

With all of this information in mind, we are left with the question, what is the best method to teach science? This research project will give some insight into that question. The results of this research may be a motivator, which could be used to enable teachers to teach science to their students using the best possible methods.

CHAPTER 3

Methodology

Introduction

This chapter will describe the subjects under study and how they were selected for inclusion in this study. In addition, the content, validity, and reliability of the instruments being used to collect information will be discussed. Data collection and analysis procedures will then be presented. The chapter will conclude with some of the methodological limitations.

Subjects

The children selected as the subjects for this study will come from two third grade classrooms. There will be 18 children in classroom A and 18 in classroom B. In classroom A, there will be ten boys and eight girls. These students will be taught using the textbook and worksheets. In classroom B, there will be nine boys and nine girls. This group will be taught using the textbook and hands-on activities. All students will receive the same amount of instructional time. All of the subjects will be between eight or nine years of age. Most of the students have been in the same school since the beginning of kindergarten.

Selection of Sample

The sample for this study will consist of thirty-six third grade students from a small rural school located in western Wisconsin. The students will be in two separate classrooms. The control classroom, will be the classroom using the traditional method of instructing science. The classroom receiving the treatment will be classroom B. The classes were randomly assigned to be classroom A and classroom B by the flip of a coin. All the students in each class will be participating in this survey and will be

instructed by the same teacher. Sometimes students will work especially hard when they know they are involved in a study. To lessen the chance of students working "harder than usual," the students will not be told of this study.

The majority of the students will come from two-parent homes. In about three-fourths of these homes, both parents worked outside of the home. The majority of the remaining families will be farmers. This sample was chosen because of its availability and because it was appropriate to the researcher's training and grade level taught.

Instrumentation

Both groups will be reading the textbook which is the 1987 Silver Burdett Company science textbook. Class A will be given the worksheets that accompany each lesson in the textbook. Class B will be given a hands-on activity which will directly relate to the material from the textbook. These activities will come from a variety of sources such as, Insights, Windows on Science, GEMS, FOSS, and AIMS. Other activities will come from Frank Schaffer Publications, Inc., Science and Children, and Carson-Dellosa Publications. Both classes will have a fifty-minute science period. Data will be collected through the use of a pretest to measure each student's incoming knowledge of simple machines and a posttest will be used to measure

each student's knowledge after the instruction on simple machines.

Data Collection

Data will be collected through the use of a pretest to measure each student's incoming knowledge of simple machines. A posttest will be used to measure each student's knowledge after the instruction on simple machines. The test will be read aloud and there will be no time limit on the test. Students may ask the teacher any appropriate questions during the test-taking time. The same teacher who did the instruction will correct the test. The test, which will be used, is the 1987 Silver Burdett Test from the unit on simple machines.

Data Analysis

The tests' validity and reliability are unknown at this time. Comparison of the two scores will be made along with a comparison of the two different groups' scores and any significant differences between the two groups' achievement will be noted. A one tailed t-test will be used to look at the differences between each group. Measures of mean and mode will be calculated along with the range of scores, and the standard deviation.

Limitations of Study

The data from this study will be collected from only two of the three third grade classrooms in the school population. This study includes only achievements in the area of science in the unit on simple machines. The results may not be generalized for any other subject area. The subjects are limited to those who are actually enrolled in third grade in a small rural school located in western Wisconsin for the fourth quarter of the 1999 - 2000 school year.

Chapter 4

Results and Discussion

Introduction

This chapter will present the results of this study, a comparison of Traditional Textbook Science Instruction with Hands-On Activities to Traditional Textbook Science Instruction with Worksheets. The primary purpose of this study was to determine and identify which method of teaching science, using a textbook with worksheets or using a textbook with hands-on activities is more beneficial to third grade students in a rural, western, Wisconsin Elementary School. The science achievement differences in a unit on simple machines between the two third grade classrooms would be used to determine if one method was more beneficial than the other method.

Demographic Data

The subjects in this study were from two of the three classes in the third grade level in a rural, western Wisconsin elementary school. The number of students in each class was equal. There were 10 boys and 8 girls in classroom A, the group taught using the textbook with the worksheets, and there were 9 boys and 9 girls in classroom B, the group taught using the textbook with the hands-on activities.

Of the 36 students tested at the beginning of the study, the same 36 students were tested at the end of the

study. 19 of the subjects were male and 17 of the subjects were female.

Pretest

Prior to the treatment, both groups of students were given a pretest on simple machines to measure their prior knowledge of the subject matter. Between both groups, the range of scores went from a low of 10 correct answers out of a possible 41, to a high score of 26 correct. The mean of group A, those using the worksheets, was 39.02 and the mean of group B, those using Hands-on activities was 45.69. The standard deviation of group A was 16.84 and the standard deviation of group B was 11.12. A p-value of $<.05$ was used for the level of significance. The results of the analysis on the pretest measures provided no evidence of statistically significant differences between groups A and B. As a result of these findings, the two groups were considered statistically equivalent prior to starting treatment.

Posttest

Following the treatment in this study, a posttest test covering the same material as the pretest was administered to all 36 students to measure achievements acquired from their study. The range of scores went from a low of 13 correct out of a possible 41, and three students scored 41

correct. Both groups of students showed improvement in their scores from the pretest to the posttest. Group A, those using the worksheets, had a lower mean of 82 compared to the mean of group B which was 94. However, the standard deviation between the two groups differed extraordinarily. The standard deviation for group A was 15.3 compared to the standard deviation for group B of 5.4. This shows that the group with the hands-on activities were tightly clustered around the mean which was again a very high score of 94. This was no true for the group using the worksheets, group B. Their results showed a wider spread of scores after the treatment.

Summary

The data found after running a t-test revealed the mean on the posttest for the hands-on group of 93.98% with a standard deviation of 5.44 which yielded a t value of 3.21 and a p>.0021 clearly shows a significant difference at the .05 level of significance between the two groups.

Chapter 5

Conclusions and Recommendations

Introduction

This chapter will include the conclusions from this study. This chapter will also give recommendations for further research.

Conclusions

Any conclusions of this study must be limited due to the small sample size. It can be concluded from this study that there was a significant difference in the achievement of students who were taught science by using a textbook and worksheets in comparison to the students who had greater achievement by being taught using a textbook and hands-on activities.

It should be noted that the group taught with hands-on activities all clustered around a very high mean score of 94% while in contrast to the group taught with the worksheets. Their scores spread out much farther from their mean. Although the material presented to both groups was similar, the results of the posttest reveal a significant difference between the two groups.

The results from this study differ from some of the research found for this study. However, most of the current research on this study supports the use of hands-on learning with the textbook.

Recommendations for Further Research

The following topics may be areas designed for further study.

1. The desire of the student to learn using a hands-on method rather than with worksheets and its impact on their learning.
2. The positive and negative effects of learning using the hands-on method for students who are learning disabled or who have A.D.D.
3. Modifying the posttest to include higher level thinking skill questions to allow the student to demonstrate their ability to apply what they’ve learned.

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