DOCUMENT RESUME

ED 456 040 SE 065 153

AUTHOR	Griesser, Sara Anne
TITLE	A Study of the Problem Solving Abilities of Seventh Grade Students Who Receive Anchored Problem Solving Instruction.
PUB DATE	2001-07-00
NOTE	71p.; Master of Arts, Johnson Bible College.
PUB TYPE	Dissertations/Theses - Masters Theses (042)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Educational Change; *Educational Technology; Grade 7; *Mathematics Instruction; Middle Schools; *Problem Solving; Relevance (Education); Teaching Methods; Videodisks; *Word Problems (Mathematics)

ABSTRACT

Current mathematics education emphasizes the importance of a problem solving mindset in the classroom. Students need to know how they are going to use what they are learning in real life. The purpose of this study was to determine the effect of anchored problem solving instruction on middle school students' mathematical abilities. The researcher utilized the Jasper Woodsbury videodisc series created by the Cognition and Technology Group at Vanderbilt University. The researcher also utilized traditional instructional methods. The research investigated the following areas: traditional word problem solving ability, problem formulation, and the transfer of problem solving ability to novel situations. On day one, both groups watched the first anchor video, Journey to Cedar Creek. After viewing the video, both groups took a pre-test. On days two through three, each experimental class spent one 70-minute time period solving the complex problem presented by Jasper in The Journey to Cedar Creek. On day four, the experimental groups presented their final solution to the entire class. The students then viewed the solution offered on the videodisc provided by The Cognition and Technology Group. On days two through four, the control class was instructed in unrelated-context problems of the type commonly used in mathematics textbooks using traditional teaching methods. On day five, students took a post-test (#1) consisting of unrelated-context traditional word problems. Students also took a replica of the pre-test (post-test #2). On day six, after viewing the second anchor video, "Rescue at Boone's Meadow," the students participated in a near-transfer post instruction task (post-test #3). According to the data analysis, it was evident that traditional mathematics instruction produces significantly higher scores on unrelated-context math problem tests. On the other hand, the data also point out that there is no significant difference between either the problem formulation abilities or the problem solving transfer abilities in students who receive either anchored instruction or traditional instruction. (Contains 32 references.) (Author/ASK)

A STUDY OF THE PROBLEM SOLVING ABILITIES

OF SEVENTH GRADE STUDENTS WHO RECEIVE

ANCHORED PROBLEM SOLVING INSTRUCTION

An Action Research Project

Presented to the

Department of Teacher Education

Johnson Bible College

In Partial Fulfillment

of the Requirement for the Degree

Master of Arts in

Holistic Education

by

Sara Anne Griesser

July 2001

APPROVAL PAGE

This Research Paper by Sara Anne Griesser is accepted in its present form by the Department of Teacher Education at Johnson Bible College as satisfying the action research project requirements for the degree of Master of Arts in Holistic Education.

Chairperson, Examining Committee

Member, Examining Committee

Member, Examining Committee

Member, Examining Committee

Member, Examining Committee

Member, Examining Committee

July 17, 2001
Date

ABSTRACT

Current mathematics education emphasizes the importance of a problem solving mindset in the classroom. Students need to know how they are going to use what they are learning in real life. The purpose of this study was to determine the effect of anchored problem solving instruction on middle school students' mathematical abilities.

The researcher utilized the *Jasper Woodsbury* videodisc series created by the Cognition and Technology Group at Vanderbilt University. The researcher also utilized traditional instructional methods. The research investigated the following areas: traditional word problem solving ability, problem formulation, and the transfer of problem solving ability to novel situations.

On day one, both groups watched the first anchor video, *Journey to Cedar Creek.* After viewing the video, both groups took a pre-test. On days two through three, each experimental class spent one 70-minute time period solving the complex problem presented by *Jasper* in *The Journey to Cedar Creek.* On day four, the experimental groups presented their final solution to the entire class. The students then viewed the solution offered on the videodisc provided by The Cognition and Technology Group. On days two through four, the control class was instructed in unrelated-context problems of the type commonly used in mathematics textbooks using traditional teaching methods.

On day five, students took a post-test (#1) consisting of unrelated-context traditional word problems. Students also took a replica of the pre-test (post-test #2). On day six, after viewing the second anchor video, *Rescue at Boone's Meadow,* the students participated in a near-transfer post instruction task (post-test #3).

According to the data analysis it was evident that traditional mathematics instruction produces significantly higher scores on unrelated-context math problem tests. On the other hand, the data also points out that there is no significant difference between either the problem formulation abilities or the problem solving transfer abilities in students who receive either anchored instruction or traditional instruction.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made for the valuable suggestions and help given to me by Dr. Charles Syster and Dr. John Ketchen.

This research project was made possible by the cooperation and assistance of the Learning and Technology Center at Vanderbilt University, especially Allison Moore. Thank you for loaning the Jasper Video series to the researcher for the purposes of this action research project.

I also express my gratitude for the patience of my husband, Kevin, throughout the writing of this research paper.

I would also like to thank the seventh graders who are the subjects of this research paper for their willing and eager participation. Thank you also to my mentoring teacher, Jane French, for her support throughout this research project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

Concern and Purpose of the study

Current mathematics education emphasizes the importance of a problem solving mindset in the classroom. Current educational practice calls solving word problems at the end of the homework exercise "problem solving." Realistically, mathematics in life becomes a series of searching for all possible solutions and choosing the best answer. This cannot be replicated by a two-sentence problem in which the student must only choose the correct operation to perform on the numbers they perceive. Students need to know how they are going to use what they are learning in real life. This motivates students to learn what otherwise might simply become rote memorization.

Anchored problem solving instruction strives to create an authentic atmosphere where students not only perceive the usefulness of the mathematics they are learning, but are also stimulated to use the skills they learn in novel ways. The anchor becomes the catalyst that creates a desire within the student to learn. This study attempts to examine the effects of "anchoring" problem solving in a real life scenario on the problem solving abilities of students.

Statement of the Problem

Is there any difference in the performance/ability between students who receive anchored instruction and those who receive traditional methods of instruction in the following areas: traditional problem solving ability, problem formulation, and the transfer of problem solving ability to novel situations?

Definition of Terms

Anchored problem solving Anchored problem solving is the method of instruction in which teachers attempt to help students become actively engaged in learning by situating, or anchoring, instruction in interesting and realistic problem solving environments. For the purpose of this study, anchored problem solving will be the environment created in the experimental classroom, in which students view a video "anchor" and solve problems contained within the context of that video story. For further explanation of anchored instruction see the literature review contained with this research.

Traditional problem solving For the purpose of this study, traditional problem solving is the method of instruction in which teachers rely upon the word problems at the end of the homework sections in most textbooks as the primary method of teaching problem solving skills. These word problems do not have a context in which the problem is set. Instruction is characterized by lecture, teacher demonstration on an overhead projector, and worksheet practice.

Word problems For the purpose of this study, a word problem is a mathematical problem in which an operation is expanded to one or two sentences. Word problems do not have a relevant context. Example: "Each of 25 students contributed $3 towards a gift for their teacher. How much did the students contribute in all?"

Transfer Transfer occurs when students are able to apply skills learned in one situation to a totally novel (not related) situation.

Problem Formulation Problem formulation is the ability to understand a complex problem and categorize the sub-problems necessary to solve the overall problem. One must be able to identify the sub-problems and the factual information which applies to each.

Limitations of the Study

This study does not accurately reflect the entire population of 7th grade math students. This study is limited to 7th grade math students studying Course 2 mathematics in one *affluent, high ranking school.*

The researcher is also the instructor for the anchored problem solving. This may or may not affect the results of the method of instruction.

Due to the curriculum requirements of Knox County regarding math skills to be covered and mastered in the seventh grade classroom, the research will be limited to only one week's worth of time used for research.

Due to time constraints beyond the researcher's control in the classroom situation, analysis of the near-transfer post-instruction task will be performed in a written format as opposed to a verbal format. This may or may not impact the responses of the students.

Delimitations of the study

The researcher will do several things to narrow the scope of the study. Classes were randomly assigned in order to create equivalency in ability among the classes. All students in this study are working in the Course 2 textbook, which is the seventh grade math book. Therefore, no accelerated students with additional exposure to problem solving will be included in the data.

Assumptions

The classes were randomly assigned from a larger group of average level seventh grade math students. Therefore, it will be assumed that any significant difference between the mean scores of the experimental and control groups are due to the type of instruction, not because of ability.

Hypotheses

1. There is no difference between the *traditional problem solving ability* of students who received anchored instruction and students who received traditional instruction as measured by an *unrelated-context problem test* at the .05 significance level.

2. There is no difference between the *problem formulation ability* of students who received anchored instruction and students who received traditional instruction as measured by a *problem formulation test* at the .05 significance level.

3. There is no difference between the *performance on problem solving transfer tasks* of students who received anchored instruction and students who received traditional instruction as measured by a *near-transfer post-instruction task* at the .05 significance level.

Chapter 2

REVIEW OF RELATED LITERATURE

Current Reform Efforts

The National Council of Teachers of Mathematics (NCTM), the National Research Council and many other educators have called for a radical change in mathematics education (Higgins, p. 5). The problem in the classrooms lies in the overemphasis on arithmetic computations at the loss of understanding mathematical concepts. The general consensus is that mathematics consists of more than calculations, "Most researchers and mathematics educators agree that there is more to mathematics than computational proficiency" (Higgins, p. 5). Several reports over the past few decades have been published summarizing this catastrophe in mathematics education. The following are among the national reports published: *An Agenda for Action, 1980; A Nation At Risk, 1983; A Report on the Crisis in Mathematics and Science Education, 1984* (Edwards, p. 1). The NCTM has also published documents which set forth standards for mathematics education: *Curriculum and Evaluation Standards for School Mathematics, 1989 and Professional Standards for Teaching Mathematics, 1991* (Edwards, p. 1).

In the above mentioned publication, *Curriculum and Evaluation Standards for School Mathematics*, the NCTM states that problem solving should take center stage in all mathematics curriculum (Oughton, p. 85). The following is a list of items the NCTM identifies that should be emphasized in the 5-8 grade mathematics curriculum:

- Pursuing open-ended problems and extended problem-solving projects;
- Investigating and formulating questions from problem situations;
- Representing situations verbally, numerically, graphically, geometrically, or symbolically;

- Discussing, writing, reading, and listening to mathematical ideas;
- Inductively and deductively connecting mathematics to other subjects and to the world outside the classroom;
- Connecting topics within mathematics;
- Applying mathematics;
- Developing an understanding of geometric objects and relationships;
- Actively involving students individually and in groups in exploring and conjecturing;
- Using appropriate technology for computation and exploration (a. Oughton, p. 86).

Problem solving has surfaced as the avenue that can accomplish all these goals. The NCTM again reiterates that problem solving is "the process by which students experience the power and usefulness of mathematics in the world around them" (a. Oughton, p. 86).

Obviously, the NCTM has included in the national curriculum specific standards addressing problem solving (Santos-Trigo, p. 632), but educators must discover how to implement the standards in the classroom. In the past, problem solving was taught using Polya's four-step model (Santos-Trigo, p. 633). But educators are now finding inadequacies of this model for equipping students with skill in solving novel and complicated problems. There have been many efforts recently to devise a curriculum or program that effectively implements the standards set forth by the NCTM (Edwards, p. 1). The *Connected Mathematics Project (CMP)* at Michigan State University is developing a middle school mathematics curriculum. This curriculum emphasizes solving problems by observing connections and patterns. The *Adventures of Jasper Woodbury* developed by the Cognition and Technology Group at Vanderbilt University emphasizes the importance of a meaningful context for problem solving. The adventures are a series of problem-solving videodiscs developed to provide this context. *Maneuvers With Mathematics,* a series of student lab books, was created at the University of Illinois at Chicago. This curriculum is intended to replace or supplement current mathematical curriculum by making use of thought-provoking, original problems. *Mathematics in Context,* a joint project of The University of Wisconsin – Madison and the Freudenthal Institute at Utrecht University, is a middle school mathematics curriculum that connects students' previous knowledge with new content, integrates other fields of study, and synthesizes procedural and conceptual knowledge. The *Quantitative Reasoning Project (QRP)* at San Diego State University is seeking to identify areas of the middle school curriculum that can be supplemented by direct instruction in quantitative reasoning. The *University of Chicago School Mathematics Project* has developed a six-year secondary mathematics curriculum that incorporates many of the standards set forth by the NCTM.

Situated Learning

Despite the current efforts towards reform in mathematics education, educators have discovered that most of the information presented in our schools becomes inert knowledge. Inert knowledge can be utilized when specifically addressed, but is not used spontaneously in new situations. Theorists such as Dewey have described knowledge as a tool. When people learn something within a useful context they are more likely to view the knowledge as a tool not a remote set of trivia. This concept is illustrated in the lives of apprentices who participate in their trade in order to learn it; to them, knowledge is useful (Brown, Collins, Duguid, p. 32). In the classroom situation, the role of the learner becomes that of a cognitive apprentice, "Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop, and use cognitive tools in authentic domain activity" (Brown, Collins, Duguid, p. 39). The term apprenticeship implies an environment in which activity and context become the stage for learning. Cognitive apprenticeships reach beyond the learning of the physical skills associated with traditional apprenticeships to include cognitive processes more commonly associated with the modern-day educational classroom.

Learning in authentic contexts, such as apprenticeships, has become a prominent educational method in recent years. The following is a summary presented by a commission created to implement the nation's educational goals:

> "We believe, after examining the findings of cognitive science, that the most effective way of learning skills is 'in context,' placing learning objectives within a real environment rather than insisting that students first learn in the abstract what they will be expected to apply" (a. Young, p. 44).

Educators and educational organizations have begun to create situated learning environments, a context in which learning occurs.

Young suggests that situated learning environments must meet the test of authenticity. They must include:

> "ill-structured complex goals, an opportunity for the detection of relevant versus irrelevant information, active/generative engagement in finding and defining problems as well as in solving them, involvement of the student's beliefs and values, and an opportunity to engage in collaborative interpersonal activities" (Young, p. 45).

Young summarizes four "critical tasks" for organizing a situated learning environment for instructional purposes. The first task is to choose the situation that will allow for the desired learning to take place. The second task is to provide the necessary scaffolding for the less advanced student, yet still allow the more advanced students to be challenged by the same situation. The third task is to provide supports for teachers in a situated learning environment. Finally, there must be some form of assessment possible within the instructional method. When choosing a situation to use for a situated learning environment, one must consider three factors: transfer possibilities of the situation to other ideas or skills, the ability of the situation to provide authentic meaning for learning, and the ability of the situation to provide "anchored instruction". Other research by McLarty and others has shown several guiding principles for curriculum development using anchored instruction and situated learning (McLarty et. al., p. 1).

The Learning Technology Center at Vanderbilt University

Most recently, the members of the Learning Technology Center at Vanderbilt University (LTC) have explored the usefulness of this concept in the classroom. Their research birthed the term *anchored instruction*: "The major goal of anchored instruction is to overcome the inert knowledge problem" (CTGV 1990, p. 3). The Learning Technology Center at Vanderbilt University provides an excellent example of the type of environment educators are trying to achieve in the classroom (Bransford, p. 44). This collaborative, multidisciplinary team is comprised of more than 70 researchers, designers, and educators. Members of the faculty from a diverse array of disciplines, research staff, administrative support, and technology experts all contribute to the team. Members of LTC publish individually, but when they publish collaboratively, they use the name "The Cognition and Technology Group at Vanderbilt (CTGV)".

The LTC has many quality projects to show for its collaborative efforts. The *Jasper Woodbury Problem-Solving Series* mentioned above is a series of 12 videodisc-based adventures that focus of problem solving. *Scientists in Action* is a research-based series that strives to engage students in the same inquiry that real scientists engage in. *Your Explorer Series (YES)* is a "multimedia literacy program for grades K-3 that is designed to help students develop important attitudes, concepts, and skills necessary for reading to learn and for lifelong learning" (Bransford, p. 45). The *Adult Literacy Program* teaches adults to read within relevant contexts using media technology. The

SMART Assessment Project stands for Special Multimedia Arenas for Refining Thinking. The goal of this program is to utilize multimedia technology to connect classrooms and teachers and create opportunities for authentic assessment. The LTC also offers preservice education programs to train K-12 grade teachers in innovative technology-based programs.

The Learning Technology Center has become an example of how a learning community should function. Using the LTC as an example of an environment suitable for situated learning, Barron et. al. have developed the following principles of a good social learning environment (Barron et. al., p. 49). First of all, the activities of the LTC are focused around projects, not teacher directed lessons. These projects almost always require the learning of new knowledge. The LTC would not function as highly without the diverse population and sharing of ideas and knowledge. This second quality, collaboration and distributed expertise, is what makes the LTC a multidisciplinary team. Most everyone at LTC is interested in what they are studying, but they also have deadlines for their work. The third quality is this combination of intrinsic and extrinsic motivation. The LTC is not doing all this work only for themselves. Much of their excitement and enthusiasm comes from the opportunity to share what they produce with interested members of the larger educational community – connectedness to a broad community of audiences. Throughout the process of creating new products, members of the LTC have constant opportunity for formative self-assessment. This simply means that they are able to compare their thinking with others. Computer software and other tools provide the necessary support to improve the efficiency of their work. Along with this technology is the wonderful benefit of experts in technology to assist them in utilizing new tools in their work.

Although the members of the LTC realize that it would not be feasible for classrooms to function in the same way as their group does, they also realize the learning benefits of the atmosphere that surrounds the center. They have attempted to include these elements in the philosophy behind anchored instruction.

Anchored Instruction and the *Jasper Series*

All LTC projects are created under the framework of "anchored instruction". The fundamental principle behind anchored instruction is providing an anchor or macrocontext in which to situate the learning of real-life problems. Rather than recreate an apprenticeship, the environments in which the CTGV have chosen are complex problems called macrocontexts. Due to the complex nature of the macrocontexts, students and teachers are able to spend large amounts of time on the problem as well as examine the problem from many different perspectives. These environments are conducive to cooperative learning and teacher scaffolding (McLarty, pp. 1-17). The following features make anchors ideal for use in the classroom.

1. They are quite complex and this complexity affords opportunities for students to be engaged in the problem-solving process for extended periods of time. Video-based stories make this complexity manageable.
2. They provide an excellent context for collaborative learning because individuals invariably notice different aspects of problems; hence this collaborative noticing pays off.
3. Anchors have multiple solutions. This feature affords opportunities for students to engage in lively dialogue about their chosen solutions. Because there is not a single right answer, students can begin to engage in the evaluation of ideas and take intellectual responsibility for their choices as they defend them to their peers.
4. As noted earlier, anchors provide models of approaches to problems that increase the quality of student-generated projects.

5. Engaging anchors can be shown to other members of the community (business leaders, principals, superintendents, politicians), who can try to solve them and, ideally, receive help from "experts" who are students from the schools (Hedley, p. 53).

The research efforts of the LTC surrounding anchored instruction produced the *Jasper Series* – a set of 12 video-based adventures that focus on mathematical problem finding and solving (Kumar, Sherwood, p. 254). Each episode contains a 15-20 minute video adventure that ends in an unresolved problem. All the information needed to solve the problem is contained within the adventure video. The adventures are arranged in four sets of three according to topics: Complex Trip Planning, Statistics and Business Plans, Geometry, and Algebra. The *Jasper Series* was designed to support learning activities that line up with the standards set forth by the NCTM. These standards include such things as an emphasis on complex, open-ended problems, communication, connection between math and the real world, and the usage of more technology. In the *Curriculum and evaluation standards for school mathematics* the NCTM states:

> "...the mathematics curriculum should engage students in some problems that demand extended effort to solve. Some might be group projects that require students to use available technology and to engage in cooperative problem solving and discussion. For grades 5-8 an important criterion of problems is that they be interesting to students" (a. CTGV 1992a, p. 68).

As opposed to the traditional word problems found in most mathematics text books today, the *Jasper Series* accomplishes the goals set forth by the NCTM and many more (CTGV 1992b, p. 296).

The CTGV designed the *Jasper Series* around several specific principles (CTGV 1992a, p. 69). First of all, the series is presented in a video-based format. Because of the difficulty of allowing each student to experience an apprenticeship, the CTGV utilizes technology to introduce a real-life situation into the classroom. This allows students to view a problem from the perspective of an expert and use the information as tools. The visual format is dynamic and stimulating, and contains more complex situations than text (Kozma, p. 191). Also, this complex problem is more easily communicated in video format to those who have difficulty reading. The CTGV has chosen to present the problems using videodisc technology. The CTGV chose videodisc technology over videotape due to the random-access capacities. Students are able to retrieve additional necessary information immediately.

Secondly, the CTGV chose to use a narrative format to present information. Stories help to create the meaningful context necessary for anchored instruction. Stories are well understood by middle school students, and provide a natural way to create a mental model of the problem setting. Narratives portray realistic problems rather than a lecture on video, as most educational video materials have been in the past.

Another design principle of the *Jasper Series* is a generative learning format in which the stories end and the students must generate the problems to be solved. The CTGV chose to do this instead of guide students through an already determined solution for a few reasons. First of all, finding your own solution is motivating and will engage students in complex problem solving. Secondly, students will become active participants in the learning process. Even though there is a solution included on each videodisc, it is emphasized that there are many correct solutions.

An important feature of the *Jasper Series* is embedded data design. All the information needed to solve the problem is included throughout the video. The mathematical problems are not already set up for the viewer, with numbers scattered throughout the video. Students must actually search for relevant information after they have generated the problems to be solved themselves. Students find this similar to a good mystery in which all the information (clues) were provided along the way, and in looking back one can see their importance.

The *Jasper Series* contains problems with high complexity as each adventure involves a problem of at least 14 steps. These type of problems provide an atmosphere that students are not used to, one in which the answer is not obvious. The solution is found only after sustained amounts of time are spent on the problem.

There are three videos in the *Jasper Series* that reinforce the same mathematical idea. By exposure to several videos, each with a different context, but all with the same type of problem, transfer of learning is encouraged. Students can analyze the difference between the videos and what skills they used in common to solve the problems in the different videos.

The final principle utilized in the development of the *Jasper Series* are provisions for links across the curriculum. Each episode provides multiple opportunities to introduce other topics. For example, the episodes on trip planning contain links to geography, navigation, aeronautics, and even ecological issues.

Another unique characteristic of anchored instruction is the purposeful authenticity. The data and setting included in the video are real to life. The problems within the context are also authentic. Children are asked to solve problems that could very naturally be a part of everyday life, "When should I leave to arrive at my destination, and what do I need to do to get there?" (CTGV 1990, p. 7). This is in direct opposition to the word/story problems included in most mathematics textbooks.

This realistic nature helps students to construct important beliefs about the use of mathematics (CTGV 1991a, p. 17). Many of today's mathematics students hold many misconceptions about mathematics including the following:

> "(a) problems are something that are presented by the teachers rather than discovered by good learners, (b) that good learners almost instantly know the answer to all problems…and (c) that if they can't solve a problem in five minutes then they can never solve it" (CTGV 1991a, p. 17).

Users of the *Jasper Series* report great success with low-achieving students contributing to the problem solving process. The fact that the solution is not immediately attainable gives these students more time to contribute. Also, students may feel that the adventures are real problems and not fake, easy "stuff".

Throughout the use of the *Jasper Series*, three distinct teaching styles have emerged (CTGV 1992a, p. 73-79). In the first model, teachers tend to feel that students need to master the basics first. The *Jasper Series* is then used as an opportunity to practice these skills acquired by teacher lecture and worksheet reinforcement. Often times the teacher in this model walks students through the adventure, asking them only to provide the numbers and do the calculations. Obviously, this model misses out on many of the generative learning benefits of the series.

The second model, structured problem solving, differs from the basics first model in that students are not required to master the skills necessary before solving the adventure. But, the structured problem solving model does not begin with the students generating their own subproblems. Instead, the teacher, in order to minimize mistakes, creates a series of worksheets that will walk the students through the adventure. The strong point of this model is that students only work on correct plans, but in exchange they do not participate in problem generation and self-monitoring.

The final model of teaching the *Jasper Series* makes full use of the benefits of the intended structure of the series. Students engage in problem generation without any prespecified paths. Cooperative group learning makes this model feasible, as students tend to keep each other from going too far off track. Teachers often provide some assistance, or scaffolding, to students when using this model.

The *Jasper Series* allows not only anchored instruction, but also many other recommended teaching techniques and learning goals. Transfer of problem solving skills is one of these learning goals (Young 1993, p. 53). The *Jasper Series* also exposes learners to ill-structured problems that enhance critical thinking (Leader, Middleton, p. 417). The series is also very motivating and interesting to students, which encourages participation from all students. More research has been gathered on other benefits of the *Jasper Series*, such as the effects on attitudes and beliefs about mathematics.

Many precautions have been taken in the development and testing of the *Jasper Series* to ensure that it is feasible for classroom teachers to implement (Halpern, p. 36-39). Front-line teachers have been involved in the development of the series. Real schools with average students and financial constraints have been the testing ground. The CTGV is making steps towards training teachers in the use of their materials. Work is being done on utilizing the series to achieve more specific curricular goals. Further developments by the CTGV have produced analogous problems that are included with the videodiscs to help cultivate transfer. The CTGV is also working on authentic assessment materials that test the skills taught in the series within the context of the actual classroom. One such alternate form of assessment that has been created is a telecast talk-show that classrooms who are involved in using the series can view.

Other efforts are being made to improve upon the series. Technology has been developed by which the videodisc can be controlled by a computer (Barron et. al. 1993, p. 479). This can be used to access video and organize it to associate with additional data. Students can navigate this software to access the information they need to solve the problem. Students can also use this software to create their own multimedia productions. Supplemental software has also been developed including a spreadsheet to aid students in their problem solving and provide a place to record their data (Barron et. al. 1993, p. 71). The Cognition and Technology Group at Vanderbilt continues to field test the series, and is currently working on making the series available on CD-ROM. Allison Moore, member of the Learning Technology Center, expects this new series to be available in January 2001.

Current Research

Several different research projects have been conducted to evaluate different aspects of the *Jasper Series* (Kumar, Sherwood, p. 255). The first series tested how well high-achieving sixth grade students could perform on the adventures. Even though these students were successful in traditional mathematics classrooms, they had difficulty with the Jasper problems. The second set of studies tested learning and transfer in students who received instruction using the *Jasper Series* versus those who received traditional classroom word problem instruction. The results showed a higher rate of transfer to new, complex problems by those who had received instruction using the *Jasper Series*. The third set of studies was also the first major field test of the *Jasper Series* and was conducted during the 1990-1991 school year. With the support of corporate sponsors, the CTGV implemented the program in 16 schools in nine states. Four specific areas were examined: the changes in students' abilities to solve problems, the effects of different approaches to the series, assessment of outcomes, and ways to support teachers who are utilizing the materials (CTGV 1992b, 300-315). Testing showed that experience with Jasper problems produced an increase in the ability to solve complex problems, an improvement in attitudes towards mathematics, and equivalent standardized test scores to those who did not receive instruction using the *Jasper Series*. The fourth set of research studies emphasized the underlying mathematical ideas of the Jasper problems, in hopes of improving transfer to new problem situations. Using new technology developed to accompany the series, students showed improved transfer abilities.

Research by Van Haneghan et. al. tested achievement on unrelated-context word problems, problem generation and near-transfer tasks (Halpern, p. 31). The control group received traditional instruction in unrelated-context word problems and the experimental group received instruction using the *Jasper Series*. Both groups showed equal achievement on the unrelated-context word problems. The experimental students showed significant gains on the problem formulation tests. Also, experimental students showed much higher transfer ability than the control students. Other research has been conducted to examine the effects of "tuning" students' attention to the material before the use of the *Jasper Series* (Arthurs, pp. 345-363). A project by Sterner and Wedman attempted to discover the reasons behind poor performance on complex, multi-step problems (Sterner, Wedman, p. 2). Moore and Schwartz tested two kinds of invariance and their role in proportional reasoning (Moore, Schwartz, p. 1). Both these studies utilized the *Jasper Series* within their experimental design.

Other research has been done by organizations other than the Learning Technology Center at Vanderbilt that addresses the same instructional issues as the *Jasper Series*. The Mission to Mars Curriculum was developed to help stimulate problem generation (Czarnik, Hickney, p.2). A study by Czarnik and Hickney investigated the types of problems generated after instruction using the Mission to Mars curriculum. Two research projects by Shyu at Tamkang University in Taipei, Taiwan investigate the use of anchored instruction (Shyu, p. 119; Shih, Shyu, Chen, p. 453). One experiment closely resembles those done by the CTGV, and tests the effects of video-based anchored instruction on elementary students' attitudes and problem solving skills. The second research study examined the effects of anchored instruction on near and far transfer tasks. Young and Barab utilized anchored instruction to test the goals adopted by students during instruction (Young, Barab, p. 119). They found that those who received anchored instruction identified problem-solving goals, while those who received traditional instruction identified passing tests and finishing assignments as goals.

The Cognition and Technology Group at Vanderbilt since its original release of anchored instruction materials in 1990 has undergone much criticism and scrutiny concerning the *Jasper Series*. Several educators have challenged the practicality of the series, to which the CTGV has responded with much work and encouragement. Researchers from the Cognition and Technology Group at Vanderbilt have found that students who score above average on standard mathematical achievement tests are initially extremely poor at problem identification and formulation in an anchored setting. Yet, after exposure and instruction in anchored problem solving, these students have become very good at complex problem formulation tasks (CTGV 1993, p. 52, 56).

Others, such as Tripp, criticize CTGV's use of terms such as situated cognition (Tripp, p. 75). While he does not think that the *Jasper Series* affords authentic situated learning, he still advocates what the *Jasper Series* can do in the educational setting.

Conclusion

Overall, the *Jasper Series* represents a collaborative effort to synthesize current findings in cognitive research with calls for improvement in mathematics education. According to widespread research, the *Jasper Series* has positive effects on middle school learners in areas of attitude, problem solving ability, problem formulation and problem transfer ability. Mathematics classrooms will continue to benefit as the CTGV advances in research and technological improvements.

Chapter 3

Methods and Procedures

Subjects

The research project took place in a middle school in Middle Eastern Tennessee. The school consistently ranks above the 90th percentile on standardized tests which places them as the top school in the county. The school's Parent, Teacher, Student Association (PTSA) is the top in the state for involvement and accomplishments. The surrounding community is extremely affluent, sitting in a suburb of a very large city in Eastern Tennessee. The students involved in the study represent 1/3 of the population of average-level seventh grade math students in the school. The students range in age from 12-14 years old.

	Girls	**Boys**	**Total**
Experimental Group	21	27	48
Control Group	18	7	25

FIGURE 1
Summary of students

Experimental process/Timeline

Students were randomly assigned to one of three mathematics classrooms within their pod – a self-contained group of 120-150 students in which all students have the same four teachers. Randomization was accomplished using *Making the Grade* software. The researcher entered all student data into the computer, and requested the computer to assign the 72 students to three random groups. All students were studying the Course 2 seventh grade level mathematics book. This particular seventh grade pod followed a rotating block schedule. This schedule allowed students to meet for each class three times a week for 70 minutes and once for 50 minutes. The following is a representation of when the researcher met with each group.

Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
I	-----	**III**	**II**	**I**
II	**I**	-----	**III**	**II**
III	**II**	**I**	-----	**III**

FIGURE 2

Daily class schedule

Experimental Group Classes I and II represented the experimental group.

Control Group Class III represented the control group.

Timeline

On day one both groups watched the anchor video number one, *Journey to Cedar Creek*, a 20 minute videodisc produced by the Cognition and Technology Group at Vanderbilt University. After viewing the video, both groups took a pre-test. This pre-test consists of two columns: column one listed the central sub-problems of the anchor video; column two listed the factual information presented in the video necessary to solve the sub-problems. Students were asked to determine what information from the right hand column is necessary to solve each problem listed in the left hand column.

On days two through three, each experimental class spent one 70 minute time period solving the complex problem presented by *Jasper* in *The Journey to Cedar*

Creek. Students were guided on day one as a whole class to identify the major sub-problems of the story. This engaged students in planning for problem solving. Students then participated in various activities as a whole class, in small groups and on an individual basis to solve the complex problem. The videodisc was available to students to refer to in order to gather additional information. The teacher provided additional scaffolding.

Group	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Experimental	- Video #1 viewing - Pre-test (Problem formulation test)	Class/Group/Individual work on complex problem solving		Presentation of final decision	- Repeat Pre-test (problem formulation test; post-test #2) - Unrelated-context word problem test (post-test #1)	Near-transfer post-instruction task (Video #2 viewing; post-test #3)
Control	- Video #1 viewing - Pre-test (problem formulation test)	Class/Group/Individual instruction on traditional word problems using teacher lecture, worksheets, and overhead explanations.			- Repeat Pre-test (problem formulation test; post-test #2) - Unrelated-context word problem test (post-test #1)	Near-transfer post-instruction task (Video #2 viewing; post-test #3)

FIGURE 3

Experimental process

On day four, the experimental groups presented their final solution to the entire class. The students were encouraged to ask questions about each other's answers. The discussion was based on the question: "Is there one correct answer to this problem?" The students then viewed the solution offered on the videodisc provided by The Cognition and Technology Group.

On days two through four, the control class was instructed in unrelated-context problems of the type commonly used in mathematics textbooks using traditional teaching methods. Instruction consisted of lecture, question and answer, worksheets, and teacher presentations on the overhead projector. The problems consisted of traditional problems addressing the following topics: computation with decimals, ratio, proportion, measurement of time and elapsed time. Half of the class time was devoted to developing the concepts or procedures to be learned. During the remaining class time, students worked independently or in small groups on worksheets. The materials used for instruction of the control group can be obtained in the Glencoe Mathematics Applications and Connections Course 1 student workbook pages 22, 25, 28, 48, and 57.

On day five, students took a post-test (#1) consisting of unrelated-context traditional word problems. This test took approximately 30-45 minutes. Students also took a replica of the pre-test (post-test #2). They matched the sub-problems with the factual information necessary to solve them.

On day six, students participated in a near-transfer post instruction task (post-test #3). All students viewed the second anchor video, *Rescue at Boone's Meadow*. After viewing the anchor, students wrote a written response to the question posed at the end of the video, "What do you need to do to solve this problem?" Responses were analyzed using a criterion rubric, which is explained under the tests section to follow.

Tests

Pre-Test The pre-test consists of two columns: column one (left side) contains the central problems posed within the Jasper video; column two (right side) contains the factual information presented in the video. Students were asked to match what information listed on the right is necessary to solve the sub-problems listed on the left. This test assesses how well students can organize information presented in the *Jasper* video for problem solving before instruction. This test was generated based on the information included in the instructional packet that accompanied the anchor video, *Journey to Cedar Creek*, which the researcher received from the Cognition and Technology Group at Vanderbilt University. A copy of the pre-test is included in Appendix A.

Post-Test #1 The first post-test consists of unrelated-context word problems similar to the type found in most mathematics textbooks. The problems are similar to the types of problems in which the students in the control group were instructed. This test allows comparison of the performance of the experimental students not instructed in solving these more routine problems to that of the control students who were. The questions in the first post-test covered information such as computation with decimals, ratio, proportion, measurement of time and elapsed time. This test was composed using test generation software from Glencoe Mathematics and Applications Course 1. A copy of Post Test #1 is included in Appendix B.

Post-Test #2 The second post-test is the exact same test as the pre-test. This test serves to assess how well students can organize information in the *Jasper* video for problem solving after instruction. A copy of Post Test #2 is included in Appendix C.

Post-test #3 The third and final post-test was a near-transfer post-instruction task. Students in both the control and experimental groups viewed a second anchor video, *Rescue at Boone's Meadow.* They were then asked to answer the question posed at the end of the video, "What do you need to do to solve this problem?" Written responses were analyzed according to a criterion rubric. The rubric consists of five levels. This rubric is specific to the anchor video, with examples of what the students must write. This will allow for a subjective analysis. Both the Post Test #3 and the rubric for assessing Post Test #3 are included in Appendix D.

Data Collection

Individual scores from each student were gathered for each of the above mentioned measures.

Variables

Independent variable The independent variable is the anchored instruction using *The Journey to Cedar Creek* by The Cognition and Technology Group at Vanderbilt University and the process of situated cognition.

Dependent variables The dependent variable is the scores on the pre-test and post-tests one, two, and three.

Control for the experimental factor Control for the experimental factor is possible because of the contained nature of the instruction. The testing took place immediately prior to application of the independent variable and immediately following application. The testing of the control group occurred simultaneously with the experimental group.

Data Analysis

A t-test was performed using the pre-test scores on the problem formulation test. There was no significant difference of .05 between the pre-test scores on the problem formulation test of the experimental and control groups, therefore a t-test was conducted to determine if there was a statistically significant difference of .05 in the scores on the *problem formulation post-test #2* between the experimental and control groups.

If there would have been a statistically significant difference of .05 between the scores of the experimental and control groups on the pre-test as measured by the t-test, then an analysis of co-variance would have been conducted. The scores on the *problem formulation pre-test* and the scores on the *problem formulation post-test #2* were used to determine if there was a statistically significant difference of .05 between the experimental and control groups.

A t-test was conducted to determine if there was a statistically significant difference of .05 in the scores on the *unrelated-context word problem post-test* between the control and experimental groups.

A t-test was conducted to determine if there was a statistically significant difference of .05 in the scores on the *near-transfer post-instruction task* between the control and experimental groups.

Chapter 4

RESULTS

Comparison of performance on unrelated-context problem test

Null Hypothesis #1: There is no difference between the *traditional problem solving ability* of students who received anchored instruction and students who received traditional instruction as measured by an *unrelated-context problem test* at the .05 significance level.

After the control and experimental groups received instruction and a post-test was administered, the researcher collected and compared the data. An analysis of the data showed the mean for the experimental group, those who received anchored problem solving instruction with the Jasper videodisc series, was 83.6170 (See Table 1 below). The analysis of the data showed the mean for the control group, those who received traditional instruction, was 90.8333. The two-tailed t-test for Equality of Means was .018. Since this data indicated statistical significance at the .05 level, the hypothesis was rejected.

Table 1

Performance on unrelated-context word problem test

Groups	N	Means	Mean Difference	Std Error Of Means	t-ratio	Sig. 2-tailed
Anchored Instruction	47	83.6170	-7.2163	1.88537	-2.430	.018*
Traditional Instruction	24	90.8333				

*Significant at < .05 level

Comparison of problem formulation abilities

Null Hypothesis #2: There is no difference between the *problem formulation ability* of students who received anchored instruction and students who received traditional instruction as measured by a *problem formulation test* at the .05 significance level.

After the control and experimental groups received instruction and a post-test was administered, the researcher collected and compared the data. An analysis of the data showed the mean for the experimental group, those who received anchored problem solving instruction with the Jasper videodisc series, was 94.6809 (See Table 2 below). The analysis of the data showed the mean for the control group, those who received traditional instruction, was 93.3333. The two-tailed t-test for Equality of Means was .652. Since this data indicated no statistical significance at the .05 level, the hypothesis was retained.

Table 2

Comparison of problem formulation abilities

Groups	N	Means	Mean Difference	Std Error Of Means	t-ratio	Sig. 2-tailed
Anchored Instruction	47	94.6809				
			1.3475	1.68936	.453	.652*
Traditional Instruction	24	93.3333				

*Not Significant at .05 level

Comparison of performance on a problem solving transfer task

Null Hypothesis #3: There is no difference between the *performance on problem solving transfer tasks* of students who received anchored instruction and students who received traditional instruction as measured by a *near-transfer post-instruction task* at the .05 significance level.

After the control and experimental groups received instruction and a post-test was administered, the researcher collected and compared the data. An analysis of the data showed the mean for the experimental group, those who received anchored problem solving instruction with the Jasper videodisc series, was 3.2766 (See Table 3 below). The analysis of the data showed the mean for the control group, those who received traditional instruction, was 2.9167. The two-tailed t-test for Equality of Means was .302. Since this data indicated no statistical significance at the .05 level, the hypothesis was retained.

Table 3

Comparison of performance on a problem solving transfer task

Groups	N	Means	Mean Difference	Std Error Of Means	t-ratio	Sig. 2-tailed
Anchored Instruction	47	3.2766	.3599	.20107	1.040	.302*
Traditional Instruction	24	2.9167				

*Not Significant at .05 level

Chapter 5

SUMMARY, CONCLUSION, RECOMMENDATIONS

Summary

The purpose of this study was to determine the effect of anchored problem solving instruction on middle school students' mathematical abilities. The researcher utilized the *Jasper Woodsbury* videodisc series created by the Cognition and Technology Group at Vanderbilt University. The researcher also utilized traditional instructional methods. The research investigated the following areas: traditional problem solving ability, problem formulation, and the transfer of problem solving ability to novel situations.

Three null hypotheses were stated:

1. There is no difference between the *traditional problem solving ability* of students who received anchored instruction and students who received traditional instruction as measured by an *unrelated-context problem test* at the .05 significance level.

2. There is no difference between the *problem formulation ability* of students who received anchored instruction and students who received traditional instruction as measured by a *problem formulation test* at the .05 significance level.

3. There is no difference between the *performance on problem solving transfer tasks* of students who received anchored instruction and students who received traditional instruction as measured by a *near-transfer post-instruction task* at the .05 significance level.

On day one, both groups watched the first anchor video, *Journey to Cedar Creek.* After viewing the video, both groups took a pre-test. On days two through three, each experimental class spent one 70-minute time period solving the complex problem presented by *Jasper* in *The Journey to Cedar Creek.* On day four, the experimental groups presented their final solution to the entire class. The students then viewed the solution offered on the videodisc provided by The Cognition and Technology Group. On days two through four, the control class was instructed in unrelated-context problems of the type commonly used in mathematics textbooks using traditional teaching methods.

On day five, students took a post-test (#1) consisting of unrelated-context traditional word problems. Students also took a replica of the pre-test (post-test #2). On day six, after viewing the second anchor video, *Rescue at Boone's Meadow,* the students participated in a near-transfer post instruction task (post-test #3).

Conclusions

After reviewing the statistical analysis, the researcher concluded that two of the null hypotheses should be retained and one of the hypotheses should be rejected. Those to be retained were numbers two and three. The one to be rejected was number one. In the rejected hypothesis the two-tailed t-test showed significance at the .05 level. Looking at the data analysis it becomes evident that traditional mathematics instruction produces higher scores on unrelated-context math problem tests. On the other hand, the data also points out that there is no significant difference between either the problem formulation abilities or the problem solving transfer abilities in students who receive either anchored instruction or traditional instruction.

Even though there was not a statistically significant difference in the scores on the problem formulation test and the problem solving transfer task, the group who received anchored instruction evidenced a slightly higher mean. As seen in tables two and three, the group who received anchored instruction had a mean score of 94.6809 on the problem formulation test, while the group who received traditional instruction had a mean score of 93.3333. In the problem solving transfer task, the group who received anchored instruction had a mean score of 3.2766, while the group received traditional instruction had a mean score of 2.9167. This difference was not significant in the two-tailed t-test. However, the researcher made personal observations during the action research that may aid in developing an explanation for the consistently higher scores of the group who received anchored instruction.

It appeared to the researcher that the group who received anchored instruction were motivated by the videodisc format. The *Jasper Woodbury* series, due to its visual and audio format and real-life applicability, captured the attention of the seventh grade math students. As the students worked in groups, they experienced what it is like to solve real life problems. Even though this was a limited experience with only one videodisc from the series, those who received anchored instruction showed slightly better skill in solving complex problems.

On the other hand, the students who received traditional instruction grudgingly participated in the daily assignments. Though the scores on the unrelated-context word problem test show significantly higher scores of this traditional group, their general attitudes would be ranked much lower. Their slightly lower scores on the other two posttests reflect their limited exposure to complex problem solving tasks.

The question arises as to what is most valuable for middle school mathematics students to learn? Should educators emphasize strict mathematical skills, such as those that are traditionally tested on standardized tests? Or should educators emphasize the problem solving skills that students will someday utilize in everyday situations? Educators must answer this question before they can determine the method of instruction that produces the most favorable results. It is the researcher's opinion that all middle school mathematics students should be exposed and trained in the problem solving skills covered in such programs as the *Jasper Woodbury* series created by Vanderbilt University. It is also the researcher's opinion that these problem-solving skills enhance the students' ability to view the world systematically, to be creative in discovering alternative solutions, and to develop an appreciation for complex thinking, even though they do not particularly improve scores on traditional math tests.

In the final analysis, the research clearly shows that the best way to prepare students for unrelated-context math problem tests is through traditional methods of instruction. On the other hand, the research suggests that either method of instruction will produce similar results in problem formulation or problem solving abilities of middle school mathematics students.

Recommendations

The researcher recommends the following for further research:

1. Replications of this study should be performed in other classrooms with other subjects and comparisons should be made with the results of this study.
2. This study should be performed over a longer amount of time with a larger group of subjects incorporating increased exposure to multiple videodiscs.
3. This study should be repeated with other grade levels, including upper elementary and middle school levels.

4. This study should be repeated at a developmental level that is totally unfamiliar with the mathematical concepts covered in the videodisc used.
5. This study should be repeated in an educational environment that fosters problem-solving skills.

Even though the research shows that the best way to prepare students for traditional problem solving tasks is by using traditional instructional methods, the researcher highly recommends the *Jasper Woodbury* videodisc series created by the Cognition and Technology Group of Vanderbilt University for use in the mathematics classroom for the following additional purposes. The videos created excitement and enthusiasm among seventh grade mathematics students. Students enjoyed being able to "see" the problem instead of only being able to read it. Students also appreciated learning that some problems take longer than a few minutes to solve. Students were given the opportunity to work together and utilize one another's strengths. The researcher recommends that all educators, even those who are restricted by skills-based curriculum, incorporate this video series into the schedule for the year.

BIBLIOGRAPHY

BOOKS

Halpern, D.F. (Ed.) (1992). Enhancing Thinking Skills in the Sciences and Mathematics. Hillsdale, N.J.: Lawrence Erlbaum Associates: Citing Van Haneghan, J.P., Barron, L., Young, M.F., Williams, S.M., Vye, N.J., and Bransford, J.D. The Jasper Series: An experiment with new ways to enhance mathematical thinking.

Hedley, C., Antonacci, P., and Rabinowitz, M. (Eds.) (1995). Thinking and Literacy: The mind at work. Hillsdale, N.J.: Lawrence Erlbaum Associates: Citing Barron, B.J.S., Vye, N., Zech, L., Schwartz, D., Bransford, J., Goldman, S., Pellegrino, J., Morris, J., Garrison, S., and Kantor, R. Creating Contexts for community based problem solving: The Jasper Series.

a. Hedley, C., Antonacci, P., and Rabinowitz, M. (Eds.) (1995). Thinking and Literacy: The mind at work. Hillsdale, N.J.: Lawrence Erlbaum Associates: Citing Barron, B.J.S., Vye, N., Zech, L., Schwartz, D., Bransford, J., Goldman, S., Pellegrino, J., Morris, J., Garrison, S., and Kantor, R. Creating Contexts for community based problem solving: The Jasper Series: Citing Cognition and Technology Group at Vanderbilt (1994). From Visual word problems to learning communities: Changing conceptions of cognitive research. In K. McGilly 9Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 157-200). Cambridge, MA: MIT Press/Bradford Books.

McGilly, K. (Ed.) (1994). Classroom lessons: Integrating cognitive theory and classroom practice. Cambridge, MA: MIT Press/Bradford Books: Citing Cognition and Technology Group at Vanderbilt. From visual word problems to learning communities: Changing conceptions of cognitive research, 157-200.

PERIODICALS

Arthurs, E. (Ph.D), DeFranco, T (Ph.D), Young, M. (Ph.D). (1999). An Examination of the Impact of Tuning Students' Attention to Information in a Mathematics Problem on their Problem Solving Performance. Journal of Educational Computing Research, 20 (4) 345-363.

Barron, L., Bransford, J., Campbell, O., Ferron, B., Goin, L., Goldman, E., Goldman, S., Hasselbring, T., Peelegrino, J., Rewey, K., Sherwood, R., Vye, N., Warren, S., Williams, S. (1992). The Jasper Experiment: An Exploration of Issues in Learning and Instructional Design. Educational Technology Research and Development, 40 (1) 65-80.

Barron, L., Bransford, J., Goin, L., Goldman, E., Goldman, S., Hasselbring, T., Peelegrino, J., Rewey, K., Sherwood, R., Vye, N. (1993). The Jasper experiment: using video to furnish real-world problem-solving contexts. Arithmetic Teacher, 40 (8) 474-479.

Bransford, J. (1994). The Learning Technology Center at Vanderbilt University. Educational Media and Technology Yearbook, 20, 44-48.

Brown, J.S., Collins, A., and Duguid, P. (1989). Situated Cognition and the Culture of Learning. Educational Researcher, 18 (1) 32-41.

Cognition and Technology Group at Vanderbilt (1990). Anchored Instruction and its Relationship to Situated Cognition. Educational Researcher, 19 (6) 2-10.

Cognition and Technology Group at Vanderbilt (1991a). Some Thoughts about Constructivism and Instructional Design. Educational Technology, 31 (9) 16-18.

Cognition and Technology Group at Vanderbilt (1991b). Technology and the design of generative learning environments. Educational Technology, 31 (5) 34-40.

Cognition and Technology Group at Vanderbilt (1992a). The Jasper Experiment: An exploration of issues in learning and instructional design. Educational Technology Research and Development, 40 (1) 65-80.

a. Cognition and Technology Group at Vanderbilt (1992a). The Jasper Experiment: An exploration of issues in learning and instructional design. Educational Technology Research and Development, 40 (1) 65-80: Citing National Council of Teachers of Mathematics (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: Author.

Cognition and Technology Group at Vanderbilt. (1992b). The Jasper Series as an Example of Anchored Instruction: Theory, Program Description, and Assessment Data. Educational Psychologist, 24 (3) 291-315.

Cognition and Technology Group at Vanderbilt (1993). Anchored Instruction and its Relationship to Situated Cognition. Educational Technology, 33 (3) 52-70.

Dick, W. (1991). An Instructional Designer's view of constructivism. Educational Technology, 31(5) 41-44.

Gay, S.A. (1999). Is Problem Solving in Middle School Mathematics "Normal"?. Middle School Journal, 31 (September) 41-47.

Higgins, K.M. (1997). The Effects of year-long instruction in mathematical problem solving on middle school students' attitudes, beliefs, and abilities. The Journal of Experimental Education, 66 (1) 5-29.

Kozma, R. (1991). Learning With Media. Review of Educational Research, 61, 179-211.

Kumar, D., Sherwood, R. (1997). Hypermedia in Science and Mathematics: Applications in Teacher Education, Problem Solving and Student Testing. Journal of Educational Computing Research, 17 (3) 249-262.

Oughton, J.M. (1995). Computers and Problem Solving for Sixth-Grade Mathematics Students. Journal of Computing in Childhood Education, 6 (1) 81-118.

a. Oughton, J.M. (1995). Computers and Problem Solving for Sixth-Grade Mathematics Students. Journal of Computing in Childhood Education, 6 (1) 81-118: Citing National Council of Teachers of Mathematics (1989). Curriculum and Evaluation Standards for School Mathematics. Reston, VA: Author.

Perkins, D.N. (1991). What Constructivism demands of the learner. Educational Technology, 31 (9) 19-21.

Santos-Trigo, M. (1998). Instructional qualities of a successful mathematical problem-solving class. International Journal of Mathematical Education in Science and Technology, 29, 631-646.

Shyu, H.Y. (1999). Effects of Media Attributes in Anchored Instruction. Journal of Educational Computing Research, 21 (2) 119-139.

Tripp, S.D. (1993). Theories, Traditions, and Situated Learning. Educational Technology, 33 (3) 71-77.

Young, M.F. (1993). Instructional Design for Situated Learning. Educational Technology Research and Development, 41 (1) 43-58.

a. Young, M.F. (1993). Instructional Design for Situated Learning. Educational Technology Research and Development, 41 (1) 43-58: Citing SCANS (Secretary's Commission on Achieving Necessary Skills). (1991). What work requires of schools: A SCANS report for America 2000: Executive Summary. Washington, D.C.: U.S. Department of Labor.

Young, M.F., Barab, S.A. (1999). Perception of the Raison d'Etre in Anchored Instruction: An Ecological Psychology Perspective. Journal of Educational Computing Research, 20 (2) 119-141.

ERIC

Czarnik, J.C. Jr., Hickney, D.T. (1997). Problem Generation in the Mission to Mars Curriculum. (ED408196). U.S. Tennessee.

Edwards, T.G. (1994). Current Reform Efforts in Mathematics Education. (ED372969). U.S. Ohio.

Leader, L.F., Middleton, J.A. From Ability to Action: Designing Instruction for Critical Thinking Dispositions. (ED436170). U.S. Arizona.

McLarty, K. et al. (1989). Implementing Anchored Instruction: Guiding Principles for Curriculum Development. (ED315736). U.S. Texas.

Moore, J.L., Schwartz, D.L. (1994). Visual Manipulatives for Proportional Reasoning. (ED376200). U.S. Tennessee.

Shih, Y.F., Shyu, H.Y., Chen R.S. Effects of Knowledge Abstraction with Anchored Instruction on Learning Transfer. (ED409877). Taiwan.

Sterner, P., Wedman, J. The Influence of Prior Experience and Process Utilization in Solving Complex Problems. (ED400275). U.S. Missouri.

SOFTWARE/TECHNOLOGY

Jay Klein Producation, Inc. (1991-1999) Making the Grade, Version 8.1g.

Cognition and Technology Group at Vanderbilt. The Jasper Series: *Journey to Cedar Creek* and *Rescue at Boone's Meadow.*

APPENDICES

APPENDIX A

Pre-Test for Journey to Cedar Creek

Student Identification: ____________

QUESTIONS		ANSWERS	
1. ___	How far is it from Cedar Creek to Jasper's home?	*A.*	*Fuel consumption of the cruiser at 5 gallons/hour*
2. ___	How far is it from Cedar Creek to Willie's?	*B.*	*Mile marker at Jasper's dock: 132.6*
3. ___	What is the speed of the cruiser when converted from miles per minute to miles per hour?	*C.*	*Pump shows:* *Total sale - $6.50* *Total gallons sold – 5 gal.* *Discount - $.04 per gallon*
4. ___	How much time is left before sunset?	*D.*	*Before filling up at the fuel dock at Sal's, Jasper determines the tank is approximately half full. Sal adds 6 gallons.*
5. ___	Is there enough time for Jasper to get to Willie's before it closes?	*E.*	*Mile marker at Willie's – 140.3*
6. ___	How much fuel will Jasper need to get home?	*F.*	*Going downstream the cruiser travels at a rate of 1 mile in 7 minutes and 30 seconds.*
7. ___	How much fuel is in the cruiser when Jasper leaves Cedar Creek?	*G.*	*Time of sunset – 7:52 p.m.*
8. ___	How much money will Jasper need to buy fuel on the way home?	*H.*	*Money Jasper began with: $20.00* *Money spent at Willie's for repairs: $8.25*
9. ___	How much money did Jasper spend on fuel at Larry's?	*I.*	*Cost of fuel at Willie's: 1.10 per gallon*
10. ___	How much money does Jasper have in his wallet when he leaves Cedar Creek?	*J.*	*Willie's Boat Repair closing time: 5:00 p.m.*

Pre-Test for Journey to Cedar Creek

Student Identification: Answer Key

QUESTIONS			ANSWERS
1. B	How far is it from Cedar Creek to Jasper's home?	A.	*Fuel consumption of the cruiser at 5 gallons/hour*
2. E	How far is it from Cedar Creek to Willie's?	B.	*Mile marker at Jasper's dock: 132.6*
3. F	What is the speed of the cruiser when converted from miles per minute to miles per hour?	C.	*Pump shows: Total sale - $6.50 Total gallons sold – 5 gal. Discount - $.04 per gallon*
4. G	How much time is left before sunset?	D.	*Before filling up at the fuel dock at Sal's, Jasper determines the tank is approximately half full. Sal adds 6 gallons.*
5. J	Is there enough time for Jasper to get to Willie's before it closes?	E.	*Mile marker at Willie's – 140.3*
6. A	How much fuel will Jasper need to get home?	F.	*Going downstream the cruiser travels at a rate of 1 mile in 7 minutes and 30 seconds.*
7. D	How much fuel is in the cruiser when Jasper leaves Cedar Creek?	G.	*Time of sunset – 7:52 p.m.*
8. I	How much money will Jasper need to buy fuel on the way home?	H.	*Money Jasper began with: $20.00 Money spent at Willie's for repairs: $8.25*
9. C	How much money did Jasper spend on fuel at Larry's?	I.	*Cost of fuel at Willie's: 1.10 per gallon*
10. H	How much money does Jasper have in his wallet when he leaves Cedar Creek?	J.	*Willie's Boat Repair closing time: 5:00 p.m.*

APPENDIX B

Post Test 1

Student Identification: ____________________

1. 6.28 + 3.47 + 5.48 =

   [A] 15.23 [B] 1,523

   [C] 5.08 [D] 0.001523

   [1] ____

2. Subtract: 10.51 − 1.34

   [2] ____________________

3.
$$\begin{array}{r} 181 \\ \times\ 0.015 \\ \hline \end{array}$$

   [A] 2.715 [B] 27.15

   [C] 0.2715 [D] 271.5

   [3] ____

4. Multiply: 0.14 × 0.5

   [A] 0.9 [B] 0.09

   [C] 0.07 [D] 0.7

   [4] ____

5. 69.6 ÷ 12 =

   [A] 0.58 [B] 5.8

   [C] 4.8 [D] 48

   [5] ____

6. Divide: 0.528 ÷ 0.16

   [A] 33 [B] 3.3

   [C] 0.33 [D] 0.0033

   [6] ____

7.
$$\begin{array}{rrrr} & 5\text{ h} & 14\text{ min} & 12\text{ s} \\ + & 3\text{ h} & 6\text{ min} & 39\text{ s} \\ \hline \end{array}$$

   [7] ____________________

8.
$$\begin{array}{rrrr} & 22\text{ h} & 16\text{ min} & \\ - & 13\text{ h} & 10\text{ min} & 54\text{ s} \\ \hline \end{array}$$

   [8] ____________________

9. Tramain drove 350 miles in 7 hours. Which rate expresses the number of miles per hour?

   [A] 60 miles per hour

   [B] 350 miles per hour

   [C] 2,450 miles per hour

   [D] 50 miles per hour

   [9] ____

10. Which rate is the same as the ratio 110 words in 2 minutes?

    [A] 110 words per minute

    [B] 220 words per minute

    [C] 11 words per minute

    [D] 55 words per minute

    [10] ____

POST TEST 1

STUDENT IDENTIFICATION: ____________________

[1] A

[2] 9.17

[3] A

[4] C

[5] B

[6] B

[7] 8 h 20 min 51 s

[8] 9 h 5 min 6 s

[9] D

[10] D

APPENDIX C

Post Test #2 for Journey to Cedar Creek

Student Identification: ___________

QUESTIONS

1. ___ How far is it from Cedar Creek to Jasper's home?

2. ___ How far is it from Cedar Creek to Willie's?

3. ___ What is the speed of the cruiser when converted from miles per minute to miles per hour?

4. ___ How much time is left before sunset?

5. ___ Is there enough time for Jasper to get to Willie's before it closes?

6. ___ How much fuel will Jasper need to get home?

7. ___ How much fuel is in the cruiser when Jasper leaves Cedar Creek?

8. ___ How much money will Jasper need to buy fuel on the way home?

9. ___ How much money did Jasper spend on fuel at Larry's?

10. ___ How much money does Jasper have in his wallet when he leaves Cedar Creek?

ANSWERS

A. *Fuel consumption of the cruiser at 5 gallons/hour*

B. *Mile marker at Jasper's dock: 132.6*

C. *Pump shows:*
Total sale - $6.50
Total gallons sold – 5 gal.
Discount - $.04 per gallon

D. *Before filling up at the fuel dock at Sal's, Jasper determines the tank is approximately half full. Sal adds 6 gallons.*

E. *Mile marker at Willie's – 140.3*

F. *Going downstream the cruiser travels at a rate of 1 mile in 7 minutes and 30 seconds.*

G. *Time of sunset – 7:52 p.m.*

H. *Money Jasper began with: $20.00*
Money spent at Willie's for repairs: $8.25

I. *Cost of fuel at Willie's: 1.10 per gallon*

J. *Willie's Boat Repair closing time: 5:00 p.m.*

Pre-Test for Journey to Cedar Creek

Student Identification: Answer Key

QUESTIONS			ANSWERS
1. B	How far is it from Cedar Creek to Jasper's home?	*A.*	*Fuel consumption of the cruiser at 5 gallons/hour*
2. E	How far is it from Cedar Creek to Willie's?	*B.*	*Mile marker at Jasper's dock: 132.6*
3. F	What is the speed of the cruiser when converted from miles per minute to miles per hour?	*C.*	*Pump shows:* *Total sale - $6.50* *Total gallons sold – 5 gal.* *Discount - $.04 per gallon*
4. G	How much time is left before sunset?	*D.*	*Before filling up at the fuel dock at Sal's, Jasper determines the tank is approximately half full. Sal adds 6 gallons.*
5. J	Is there enough time for Jasper to get to Willie's before it closes?	*E.*	*Mile marker at Willie's – 140.3*
6. A	How much fuel will Jasper need to get home?	*F.*	*Going downstream the cruiser travels at a rate of 1 mile in 7 minutes and 30 seconds.*
7. D	How much fuel is in the cruiser when Jasper leaves Cedar Creek?	*G.*	*Time of sunset – 7:52 p.m.*
8. I	How much money will Jasper need to buy fuel on the way home?	*H.*	*Money Jasper began with: $20.00* *Money spent at Willie's for repairs: $8.25*
9. C	How much money did Jasper spend on fuel at Larry's?	*I.*	*Cost of fuel at Willie's: 1.10 per gallon*
10. H	How much money does Jasper have in his wallet when he leaves Cedar Creek?	*J.*	*Willie's Boat Repair closing time: 5:00 p.m.*

APPENDIX D

Post Test #3 Rescue at Boone's Meadow

Student Identification: ____________

What do you need to do in order to solve this problem:

**"FIND THE QUICKEST WAY TO RESCUE THE EAGLE.
HOW LONG WILL IT TAKE?"**

Please use the space below to answer the question.

Rubric for Post Test #3 Rescue at Boone's Meadow

Level	General Qualifications	Specific Information
1	Identifies overall problem or makes no effort at all	• Select quickest route • No answer
2	Identifies overall problem and identifies two different rescue plans	• Mentions the possibility of different pilots and/or routes and/or vehicles
3	Identifies overall problem, the possibility of at least two different rescue plans, and mentions one of the two calculations needed to identify which plan is the most effective	• Mentions the possibility of different pilots and/or routes and/or vehicles • Mentions the need to test the feasibility of the rescue plan and/or to estimate the time of the rescue plan
4	Identifies overall problem, the possibility of at least two different rescue plans, mentions one of the two calculations needed to identify which plan is the most effective, and identifies at least three specific calculations	• Mentions the possibility of different pilots and/or routes and/or vehicles • Mentions the need to test the feasibility of the rescue plan and/or to estimate the time of the rescue plan • Mentions at least three of the following specific calculations: 1. Compare fuel needed to fuel available

		2. Compare landing area needed to available 3. Compare actual payload to maximum payload 4. Estimate distance(s) 5. Estimate speed(s)
5	Identifies overall problem, the possibility of at least two different rescue plans, mentions one of the two calculations needed to identify which plan is the most effective, identifies at least three specific calculations, and mentions any specific data from the videodisc	• Mentions the possibility of different pilots and/or routes and/or vehicles • Mentions the need to test the feasibility of the rescue plan and/or to estimate the time of the rescue plan • Mentions at least three of the following specific calculations: 1. Compare fuel needed to fuel available 2. Compare landing area needed to available 3. Compare actual payload to maximum payload 4. Estimate distance(s) 5. Estimate speed(s)

		• Mentions any specific data from the videodisc

APPENDIX E

Knox County Schools
Andrew Johnson Building

Dr. Charles Q. Lindsey, Superintendent

December 12, 2000

Ms. Sara A. Griesser
Johnson Bible College
7900 Johnson Drive, Box 588
Knoxville, Tennessee 37998

Dear Ms. Griesser:

You are granted permission to contact appropriate building-level administrators concerning the conduct of your proposed research study entitled, "A Study of the Problem Solving Abilities of Seventh Grade Students Who Receive Anchored Problem Solving Instruction." In the Knox County schools final approval of any research study is contingent upon acceptance by the principal(s) at the site(s) where the study will be conducted.

In all research studies names of individuals, groups, or schools may not appear in the text of the study unless *specific* permission has been granted through this office. The principal researcher is required to furnish this office with one copy of the completed research document.

Good luck with your study. Do not hesitate to contact me if you need further assistance or clarification.

Yours truly,

Samuel E. Bratton, Jr.

Samuel E. Bratton, Jr., Ed.D.
Coordinator of Research and Evaluation
Phone: (865) 594-1740
Fax: (865) 594-1709

Project No. 118

P.O. Box 2188 • 912 South Gay Street • Knoxville, Tennessee 37901-2188 • Telephone (865) 594-1800

APPENDIX F

Knox County Schools

Permission to Conduct Research

December 12, 2000

TO: Dr. Donald G. Rhodes, Principal, Farragut Middle School

Subject of Research: Mathematics problem solving
Name of Researcher: Ms. Sara A. Griesser
Position: Master's candidate, JBC
Supervisor/Associate (if applicable): Dr. Chris Templar

Ms. Sara A. Griesser has received permission to contact you concerning her research study entitled, "A Study of the Problem Solving Abilities of Seventh Grade Students Who Receive Anchored Problem Solving Instruction." Although this study has been approved at the central office level, it is our policy to allow the building-level administrator the right to accept or reject a given research project for his/her school or administrative unit. If you have questions or concerns about this project, telephone me at 594-1740. Thank you for your careful consideration of this study.

Samuel E. Bratton, Jr.

Samuel E. Bratton, Jr.
Coordinator of Research and Evaluation

Project No. 118

xc: Mr. Robert B. Gratz, Coordinator of Middle Schools
Ms. Sara A. Griesser

APPENDIX G

February 9, 2001

Dear Parent or Guardian,

My name is Sara Griesser, and I am an intern at Farragut Middle School. As part of my graduate education, I am completing an action research project in conjunction with Mrs. French's seventh grade math classes this year. I am attempting to compare the benefits of anchoring instruction in a real life situation with the traditional model of education most often used in our classrooms today.

Your child will participate in five days of normal classroom instruction in traditional mathematical problem solving. On day one and day five, they will complete a problem formulation assessment. On day five they will complete a traditional mathematical problem assessment. On day six they will complete a transfer problem assessment. The teacher education faculty of Johnson Bible College, Knox County's central office, Farragut Middle School's principal, Dr. Rhodes, and your child's classroom teacher, Mrs. French, have approved this activity. Each student's identity will remain completely anonymous, as no student, school, or town name will be included in any research publication.

I need your permission to include your child's test scores in this action research project. Please sign and return the permission slip below. If you have any questions, feel free to contact me at Farragut Middle School. Thank you for your willing participation.

Sara Griesser
Sara Griesser
Student Intern

Jane French
Jane French
Classroom Teacher

Donald Rhodes
Dr. Rhodes
FMS Principal

I agree to allow the test scores of my child, ______________________________,
to be included in Sara Griesser's action research project as part of Mrs. French's mathematics classroom at Farragut Middle School.

______________________________ ______________________

Parent/Guardian Date

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

SE065353

ERIC®

Reproduction Release

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: A Study of the Problem Solving Abilities of Seventh Grade Math Students Who Receive Anchored Problem Solving Instruction	
Author(s): Sara Griesser	
Corporate Source: Johnson Bible College	Publication Date:

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, Resources in Education (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign in the indicated space following.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY SAMPLE TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY SAMPLE TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY SAMPLE TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
Level 1	Level 2A	Level 2B
☑	☐	☐
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g. electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproducti and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche, or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Signature: Sara Griesser	Printed Name/Position/Title: Sara Griesser	
Organization/Address: 3793 Burlington Pike Burlington, KY 41005	Telephone: (859) 586-6225	Fax:
	E-mail Address: kcgriesser@aol.com	Date: 7/16/01

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
4483-A Forbes Boulevard
Lanham, Maryland 20706
Telephone: 301-552-4200
Toll Free: 800-799-3742
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com

EFF-088 (Rev. 9/97)

February 9, 2001

Dear Parent or Guardian,

My name is Sara Griesser, and I am an intern in Mrs. French's seventh grade math class this year. As part of my graduate education, I must complete an action research project. The action research project I have chosen will involve your children while they are in Mrs. French's classroom.

Your children will be privileged to participate in "anchored problem solving instruction". Your child will view a video on the first day of instruction that sets up a complex real-life problem. Through a series of research and computation, the students and their teammates will solve the problem.

Previous research has shown that there is great benefit to "anchoring" a problem in a real life situation. Students not only are motivated by the more interesting content of the problem, but they also are exposed to ways in which mathematics is used in everyday life.

Your child will participate in the following activities:

Day One	Viewing of the anchor video, initial group work, and preliminary assessment
Days Two & Three	Group work on the problems presented in the anchor video
Day Four	Presentation to the class of their solution
Day Five	Mathematical problem solving assessment and problem formulation assessment
Day Six	Assessment of transfer

The teacher education faculty of Johnson Bible College, Knox County's central office, Farragut Middle School's principal, Dr. Rhodes, and your child's classroom teacher, Mrs. French, have approved this activity. Each student's identity will remain completely anonymous, as no student, school, or town name will be included in any research publication.

I need your permission to include your child's test scores in this action research project. Please sign and return the permission slip below. If you have any questions, feel free to contact me at Farragut Middle School. Thank you for your willing participation.

Sara Griesser
Student Intern

Jane French
Classroom Teacher

Dr. Rhodes
FMS Principal

I agree to allow the test scores of my child, ______________________________,
to be included in Sara Griesser's action research project as part of Mrs. French's mathematics classroom at Farragut Middle School.

______________________________ ______________________
Parent/Guardian Date