INTEGRATION OF TECHNOLOGY EDUCATION

INTO ELEMENTARY SCHOOL

The Usefulness of Manipulatives on the Level of Understanding of a Simple Machines Unit in The Fourth Grade Elementary Curriculum

by
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ABSTRACT

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INTEGRATION OF TECHNOLOGY EDUCATION INTO ELEMENTARY SCHOOL

The Usefulness of Manipulatives on the Level of Understanding of a Simple Machines

Unit in The Fourth Grade Elementary Curriculum

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The Mission of Technology Education in today’s schools can be summed up in two words, technological literacy. Students involved in technology education can experience many things including; technological systems, open-ended problems, real world experiences, working in a team environment, and science and technology relationships. The science community strive to understand the natural world around us, while technology strives to undestand the human made world. The quest to undestand the world outside of school makes these two subjects natural partners.

The purpose of the research was to analyze the usefulness of technology education integration through the use of manipulatives on one unit of study in the fourth/fifth grade science classes at River Heights Elementary School. The researcher used an observational, equivalent group design to measure the usefulness of manipulatives on the curriculum.

Data was collected in several ways. First, all students were administered a short written test prior to the lab and after the lab. Also data was collected through the use of video records and a journal of observations. The method of instruction follwed the themes of model, coach and fade. In this method of instruction the experiment was first modeled to the students at both a conceptual and tactile level. The modeling was followed by guided instruction and coaching the students as they completed their tasks. The final phase was one in which the instructor faded into the background and let the students explore and discover ideas on their own.

By analyzing the results from the evaluations and the interviews the instructor could see the overall usefulness of the manipulatives on this unit. Not only could the children build the simple machines, they could also see the effectiveness and mechanics of their design. The students had the advantage of the cognitive unit on simple machines as well as psychomotor activities to reinforce the lesson.

The findings of this study have implications for the development integration efforts and future research related to integration. Based on evidence in this study, students can apply science and technology in solving problems through the use of manipulatives. The research provides evidence that the use of manipulative aided students in the understanding of the systems associated with simple machines. Also, students where excited and interested in learning with the use of manipulative.

Based upon the findings several conclusions have been developed first, this study should used as a guide or example to substantiate the need for further study. Secondly, the use of manipulatives should be implemented as a useful, age appropriate tool in teaching a unit on simple machines. In addition, the model, coach and fade method of instruction works well when teaching the concepts of input, process, output on a simple machines unit. Lastly, the purchase of manipulatives like the TacTics used in this study is an effective use of school funds.

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CHAPTER ONE

Introduction to the Study

All educators strive to prepare students to excel in the 21st century. The teachers of the 21st century have a very difficult challenge in front of them, not only must they be able to successfully implement different teaching strategies and use new instructional technologies, they have to be able to integrate technology education into the students curriculum (Dockstader, J. 1999).

In the past some educators have simply introduced a unit on keyboarding or provided electronic encyclopedias and dictionaries and thought they were integrating technology. To truly integrate technology education you do not simply shove an activity in here or a unit there. In order for technology education integration to be successful the use of technology must not be a stand-alone activity, but rather a tool that is used through out the curriculum in order to enhance the learning that takes place in the existing curriculum (Wright, M., & Foster, P. 1999).

There has always been and always will be a lag time between the subject matter taught and the realities of life when the student completes their education. A few decades ago the estimated lag time of 10 to 15 years was not considered to be critical. The rate of technological change at that time was not as rapid as today, therefore, people had time to acclimate themselves to the changes they encountered. The lag time in education today must be greatly reduced. In order to provide curriculum that reflects today's needs schools must constantly be updating and changing their curriculum. An extremely critical element in making these changes is teacher awareness of the technological society (Minton, Minton, 1987).

Another important fact is that children like technology education. It should not be implemented solely on the basis that they like it, but all educators will agree that students perform better on activities that they enjoy doing. Today children are living in an age of high technology that provides not only the necessities, but also play and recreation. As a result, children are highly aware of the technology and hardware used today. Ironically, at the same time a child can show a high level of interest in technology and he or she can have a low level of technical understanding. For example, they may have a great interest in airplanes, but have no idea how they fly (Minton, Minton, 1987). If educators can capitalize on this high interest level, there could be a great deal of valuable and enjoyable education. To return to the example of airplanes, students already are interested, so a teacher could use airplanes to teach students about many technologies such as, composites, radar, aerodynamics, control systems, and different careers in aviation.

The purpose of technology education in today's schools can be summed up in two words, technological literacy. Students involved in technology education will experience the following:

1. designing, developing, and utilizing technological systems
2. open-ended, problem-based design activities
3. applying technological knowledge and process to real world experiences using up-to-date resources
4. working individually as well an in a team to solve problems (Fortier, J., Albrecht, B., Grady, S., Miller, K., & Strarkman, K. 1998).

The systems approach to curriculum design has been used in technology education since the early eighties. There are four primary areas that make up technology education today, they are communication, manufacturing, transportation and construction (Wright, 1986). A technology education program at the middle or high school level should include all four of these systems. Also, if technology education is integrated into elementary curriculum it to should include all four of the systems.

Communication technology is the study of the communication process. Some aspects discussed include: the communications model, equipment, historical developments, impacts, and future uses. Different types of communications are discussed, such as optical, physical, and atmospheric systems.

Construction technology is the study of the construction industry. Topics such as residential and commercial construction are discussed. Construction technology systems also look at different construction methods and materials.

Manufacturing technology is the study of the manufacturing industry. Topics covered in this area include types of ownership, management styles, processes, material science, quality control, and design. There is great importance placed on manufacturing as a business in the manufacturing technology systems.

The last area studied in a technology education program is the transportation technology system. In these systems the different ways we travel will be studied. The topics covered include terrestrial, marine, atmospheric, and space travel. In a technology education program all of these areas are studied and there are some elements that are universal to all. In all areas the concepts of problems solving, critical thinking, career exploration, and teamwork will be reinforced. In addition to these concepts the life skills of quality, craftsmanship, cooperation, and dedication are reinforced.

Technology education is the ideal subject for a unifying integration of different subject areas. Technology has a cyclical relationship with science. The science community and classes strive to understand nature and the world around us, while technology strives to design a human solution. The science community strives to understand and the technology community takes that understanding and applies it to make our lives better. Mathematics and language become a vital tool that is used universally by both science and technology (Fortier et al. 1998).

What is the meaning of technology education integration? Defining what it is not maybe helpful. It is not simply spending a lot of money on technological equipment. Technology education concepts can not be effectively integrated into the curriculum without teacher training and in-servicing. It is not substituting 30 minutes of reading for 30 minutes of computer time. It is not a set of expensive prepackaged activities that have nothing to do with the subject matter being taught in the class. Nor, is it teacher created programs that cover special interest and/or technical expertise but do not fit into the content area curriculum. Defining what integration is and is not is the first step in deciding how and if technology education integration is right for your school or class (Dockstader, Jan. 1999).

Defining what technology education integration is would also be helpful. Technology education integration is using technological equipment and concepts effectively and efficiently in the general content areas to allow students to learn how to apply technology in meaningful ways. Technological devices and concepts take on new meaning when they are integrated into the curriculum. Integration is incorporating technology in a way that increases and enhances the student's learning while also increasing their engagement in the learning process. Technology education integration is the use of technological equipment or concepts in a way that mirrors what the industrial/business world is using technology for. Another key concept to understanding the definition of integration is that curriculum must drive the technology usage, not having the technology drive the curriculum. Finally, technology education integration is organizing the goals of the curriculum and technology into a cohesive and coordinated plan (Dockstader, Jan. 1999).

Elementary Technology Education does not need to be a subject by itself like it is at the middle and high schools levels, but rather it needs to be a theme or a strand that runs though the student's educational experience. Technology education activities give a great deal of relevance to the educational process. Students find themselves involved in hands-on situations that orient them to the human-made world around them.

Educators for the 21st century must also realize that technology does not mean just computers. There are many different tools, devices, and systems we use everyday that are considered technology (Dockstader, J. 1999). Technology must be viewed as anything that extends the human potential or make our lives more comfortable. When integrating technology education into the elementary levels, we must look at the different systems of technology, not just computers.

Problem Statement

The purpose of the research was to analyze the usefulness of technology education integration through the use of manipulatives on one unit of study in the fourth/fifth grade science classes at River Heights Elementary School. To look at the entire scope of technology integration at the elementary level would be a project too large to manage or undertake. Rather than looking at a comprehensive technology integration, this study focused on one curricular area currently taught at the elementary level. The focus of this study was simple machines. Simple machines is a unit taught by all fourth grade teachers as it is a state standard for the fourth grade level in Wisconsin.

Many elementary schools and teachers are concerned about the use of technology education at the elementary level. This research looked at the overall usefulness of technology integration on one unit of instruction and, therefore, answered some of the questions about the usefulness of integration. The final purpose of the research was to provide an example for teachers, administrators and other education professionals to guide them in the development of a program for the integration of technology education within their classrooms or schools.

It was the hope of the researcher that the fourth grade students at River Heights Elementary School who received the new approach to the simple machines unit, which included the use of manipulatives and the technology education approach, would demonstrate a high degree on understanding and internalization.

Objectives

This study has accomplished the following objectives:

1. To determining the usefulness of the integrated technology education concept of input-process-output has on a simple machines unit of instruction.
2. To determine if the technology education approach with the use of manipulatives is a useful method of instruction for students in the fourth or fifth grade.
3. To determine a practical way to integrate manipulatives into an existing elementary unit of instruction.

Justification

The use of technological systems in day-to-day life is becoming increasingly important in society. Today technology is used for work, recreation and education. Wherever you turn, there is another example of technology at work. People use technology so much on a daily basis that it is taken for granted. Technology has worked its way into every aspect of society, and for this reason it should be used throughout the curriculum in schools. The use of technology education should not be reserved for the post-secondary and secondary levels, but rather it should be integrated into the elementary levels as well (Hughie, Young, & Beynon, 1991).

To prepare students for the rapid changes to come, education must provide experiences that are relevant not only for today but for the future. That means that the curriculum taught in schools can not reflect the technology of the past, but rather it must be proactive and insightful in order to meet the needs of the technologically rich environment the students will experience in the future. Nell Eurich, writing on the topic of education and the future, states:

> The future arrives with increasing velocity, and we have come to expect startling announcements of new development daily. Obviously, the future will not offer us an environment basically similar to the present, with only slight modifications. It will be radically different for anything we have known. The role of educators as custodians of the past must, therefore, be cast in a different light. Their past-orientation for future purposes requires fundamental change (Minton, Minton, 1987, pg 91-92).

There is no doubt that technology will play a critically important role in every student's future life, no matter what path they pursue. By learning to apply technological devices and systems students will be better prepared to handle the challenges that face them in their education, and more importantly they will be better prepared for their adult life. If students feel comfortable with technology and technological change, they accept it and feel empowered and challenged to use it (Jarvis, 1993). The call for technology integration in education is not a new plea. The National Science Board Commission's (1982) report entitled "Today's Problems, Tomorrow's Crisis" is one example of a report warning us of the importance of technology integration. This report states that we are preparing a generation of Americans that are ill prepared for life in the technological society of today and the future (Wright, 1986). Curriculum and methods of teaching must change so that the elementary students of today will become the technologically literate problem solvers that our society will need in the future.

Summarization of the Justifications

- In today's society technology is used for work, recreation and education.
- Technology integration is needed to prepare students for the rapid change of things to come.
- Integration will help shorten the lag time between education and the society.
- Integration at the elementary level will better prepare students for their further education.
- Students like technology, and if they enjoy education their learning will be more productive.
- Principles, elementary teachers and other technology educators will find this research useful as they struggle with integration of technology education at their school or district.

Definition of Terms

1. Concept - Important ideas. Concepts have a lasting quality. Once learned, concepts have a usefulness that can be transferred and applied in new and different situations.
2. Technology - The generation of knowledge and processes to develop systems that solve problems and extend human capabilities.
3. Technological Literacy - An ability to initiate and conduct activities associated with technological processes, systems, problems, opportunities, history, future, impact, ethics, and consequences of technology.
4. Simple machines - The basic mechanical systems. Gears, wheels and axles, incline planes, and levers make up the simple machines.
5. Mechanical advantage - The ratio of the output force produced by a machine to the applied input force
6. Manipulative - to influence, manage, use, or control to one's advantage by artful or indirect means
7. Force - The capacity to do work or cause physical change; energy, strength, or active power
8. Work - The transfer of energy from one physical system to another, especially the transfer of energy to a body by the application of a force that moves the body in the direction of the force. It is calculated as the product of the force and the distance through which the body moves.
9. Trade off - An exchange of one thing in return for another
10. Circumference - The boundary line of a circle

11. Educational Technology - Devices and systems used to deliver education; generally communication technology equipment and the associated processes. Educational technology is the method by which education (subject matter) is delivered. In the case of technology education, technology is the content of the field and a method of delivery.
12. General Education. - General education is general in several clearly identifiable ways: it is not directly related to a student’s formal technical, vocational, or professional preparation; is part of every student’s course of study, regardless of his or her area of emphasis; it is intended to impart common knowledge, intellectual concepts, and attitudes that every educated person should posses.
13. School to Work Transition - A program of experiences designed to provide enhanced career exploration, rigorous school-based learning, hands-on work experience, and partnerships between business and education.
14. Technology Education - A program of studies that leads to technological literacy.
15. Vocational Education - A program of studies that leads to the preparation of workers with skills for specific occupations. This is usually a post-secondary function.

CHAPTER TWO

Review of Literature

During the 1970s and 1980s, students in most classrooms were taught based on the absorption theory, which viewed children as passive learners who store knowledge as a result of memorization, drill, practice and reinforcement. Using this method, students were not encouraged to think about or solve problems for themselves, but merely to recite a previously learned fact or theory. Today, researchers and educators disagree with that approach and believe children construct their own knowledge as they interact with their environment. (Cohen, D. 1991).

In most classrooms across the country education has changed from the boring pencil and paper chore it used to be, and has become a fun and exciting activity that many children now look forward to. The same concepts are being taught, but somehow it has become a pleasure rather than a chore. What has made the difference? The answer is the use of manipulatives and a hand-on technology rich approach to learning.

Findings are confusing among the few integration research studies related to manipulatives. It is difficult to identify patterns among them. Some of the studies that used samples larger than one hundred students and time frames longer than a school year found significant differences between the integration of manipulatives and the control groups. However, other studies of comparable size and duration found no significant differences. Studies using smaller samples and shorter treatment periods also had conflicting results. (Among other studies, see Anderson, 1992; Brusic, 1991; Clayton, 1989; Dugger and Johnson, 1992; Dugger and Meier, 1994; Graves and Allen, 1989; Scarborough and White, 1994.)

Educators recognize that concrete materials are important teaching aids that enhance student learning. These materials are commonly called manipulatives. They are physical, real world objects, which can be used to teach abstract ideas, concepts, principles and skills to students.

The challenge of teaching any subject is to find activities that have the richness to challenge all the students. Manipulatives are a wonderful resource for this. A critical component of the use of manipulatives is making sure that students make the connection between the conceptual work done with manipulatives and the knowledge that such work is supposed to support (NCTM 1989). To make sure that such connections are made it is helpful to think of using manipulatives in the context of transfer of learning.

Although the names of the stages may vary, advocates of the use of manipulatives suggest that students should progress through several stages. In this study they will be called concrete, bridging, and symbolic.

At the concrete stage, situations are attacked strictly using manipulatives. To promote transfer from this stage to later stages, it is critical that a close match be made between the way in which manipulatives are used and the expected outcomes at the symbolic stage. Failure to make this match not only may fail to promote learning, it may inhibit learning (Bohan 1971).

At the bridging stage, objects and ideas are manipulated simultaneously. The function of this stage is to assure that students make the connection between what was done with manipulatives and the lesson. A solid base for this bridge was established by making the match between the concrete stage and its symbolic counterpart.

At the symbolic stage we begin to work with more abstract ideas. In most situations our goal is to get students to the symbolic stage--to the point where they can function with the concepts alone. In their initial work students may discover or be exposed to a variety of methods to accomplish a procedure. However, in most situations the job of the teacher is to guide students to the most efficient procedure available. The function of manipulatives in the curriculum is to help us teach in a meaningful way. Sometimes in our haste to use manipulatives, we lose sight of the fact that they are a means to an end, not an end in themselves.

Research and experience in teaching indicate that even when content has been mastered, students who are supplied with manipulatives will continue to use them. For example, Leutzinger (1979) found that when manipulatives were made available to students who knew their basics, they tended to revert to using the manipulatives to find answers. At some point students must be encouraged to put away the manipulatives and function at the symbolic stage alone.

Manipulatives help make abstract ideas concrete. A picture may be worth a thousand words, but while children learn to identify animals from picture books, they still probably don't have a sense about the animals' sizes, skin textures, or sounds. Even videos fall short. There's no substitute for firsthand experience. Along the same lines, manipulatives give students ways to construct physical models of abstract ideas.

While we want students to become comfortable and proficient with the main ideas. Ideas exist in children's minds, and manipulatives help them construct an understanding of ideas that they can then connect to vocabulary and concepts

Manipulatives build students' confidence by giving them a way to test and confirm their reasoning. If students have physical evidence of how their thinking works, their understanding is more complete.

Manipulatives are useful tools for solving problems. In searching for solutions, architects construct models of buildings, engineers build prototypes of equipment, and doctors use computers to predict the impact of medical procedures. In the same way, manipulative materials serve as concrete models for students to use to solve problems.

Manipulatives make learning interesting and enjoyable. Give students the choice of working on a page of problems or solving a problem with colorful and interestingly tools and machines, and there's no contest. Manipulatives intrigue and motivate while helping students learn.

Teachers are learning to direct their attention toward the facilitation of students' understanding and conceptualization rather than drill and practice of rote procedures. The use of manipulative materials in the classrooms supports this attempt. Incorporating the use of manipulative materials with an emphasis upon the thought process of students provides an opportunity for the teacher to assess and meet the needs of primary school students as they construct personal knowledge.

CHAPTER THREE

Methods and Procedures

Subjects

The subjects in this study were two summer school classes held at River Heights Elementary School located in Menomonie, Wisconsin. River Heights Elementary is a kindergarten through fifth grade school of approximately 450 students. There were 32 students involved in the study. Of the 32 students in the study 12 or 37 % were female and 20 or 63% were male. There were no randomization methods used to get the two groups of students for this study, they were simply the groups of students that the school had registered for this classroom. The school district stated that the assignment of students to individual classrooms is done randomly unless there was a request from the parents for their child to be in a particular classroom. I did not make any effort to select members for either group, I relied on the cluster method of sampling to select groups that already exist.

Instruments

The instruments used in the study was a series of oral and written questions asked of the students to determine the level of knowledge that each student had prior to receiving any lesson on the “Simple Machines” unit. In order to determine if the different method of instruction had an impact on the achievement, I needed to have the baseline information regarding the student’s knowledge of the subject.

The follow up questions were designed to evaluate the student’s feelings towards the new method of instruction using the manipulatives on simple machines. The follow up questions were used to assess the overall usefulness of the manipulatives and the technology education approach on the simple machine unit.

The instruments used directly reflect that State of Wisconsin's Fourth grade standards on simple machines. See appendix C for a copy of the state of Wisconsin's fourth grade standards. They also are in line with the Menomonie School Districts Educational Targets.

Procedures

The researcher used an observational, equivalent group design to measure the usefulness of manipulatives on the curriculum. While there were limitations within the methodology of the study, it can provide valuable guidance for future quasi-experiments in manipulative/technology curriculum integration.

Before any other planning could take place the researcher had to contact the coordinator of the summer school program and the teachers of the elementary science classes and ask them if they would be interested in participating in the study. The researcher explained the entire process to them, and what valuable information can be gained from the study. After two teachers agreed to participate the researcher had to get the approval of the school. This was accomplished by sending a cover letter and the research proposal to him so that he could get a better understanding of what the researcher would like to do. The last group that needed to approve the study was the parents of the children that are going to participate. The researcher sent a letter home that explained the study and provided them with a brief explanation of the study and gave them several ways to contact the researcher if they had any questions or concerns. This method of parental notification is in compliance with the school district policies. No parental notification was needed due to the fact that the curriculum was not changed, only the method of instruction was modified. Also no material or services were with held from any students.

Once all of the approvals were received the first step in the research was to administer the pre-lab questioning on simple machines to gauge their current level of understanding and document the results of both. This pre-lab questioning included the vocabulary and the concepts that a student must understand to gain technological literacy on the subject of simple machines. This pre-lab questioning forms the base level of understanding for the two groups participating in this study.

Once the pre-lab questioning was administered and the data collected, the next step was the treatment of each class. Both groups were taught simple machines with the use of manipulative. The manipulatives used were large lego-like building blocks that allowed the students to build the simple machines that they were studying. Not only could they build the simple machines but they were able measure the effectiveness of their design. For example, they can build a class one lever and then measure the mechanical advantage of their design. The students would have the advantage of the cognitive unit on simple machines as well as psychomotor activities to reinforce the lesson. The method of instruction used followed the themes of model, coach and fade. In this method of instruction the subject will first be modeled to the students at both a conceptual and psychomotor level. The modeling was be followed by guided instruction and coaching the students as they completed their tasks. The final phase was one in which the instructor faded into the background and let the students explore and discover on their own and only assisted when it is obvious that someone needs guidance.

After the classes had the same period of time on the simple machines unit, they were again re-questioned with a series of post-lab questions, which assessed the same topics as the pre-lab questions. The post-lab questions were exactly the same for both groups. From these post-lab and interview questions the overall usefulness of the manipulative/technology method of instruction can be analyzed. By comparing the results from the pre-lab and post-lab questioning sessions the instructor determined the overall usefulness of the manipulatives on this unit.

Assumptions of the Study

Several assumptions were made while doing this research paper; they are listed below:

1. It was assumed that the results of this research are generalizable to similar activities at the elementary level in the Menomonie School District.
2. It was assumed that both classes have approximately the same qualifications.
3. It was assumed the classes studied are representative of all Menomonie fourth grade classrooms.

Limitations

For this study several limitations will need to be considered when looking at the over all results of the research. The limitations are listed below:

1. The study was limited to the findings collected from the integration of only one unit of instruction.
2. The students involved in this study were not randomly selected; they were selected by the cluster method.

3. This research looked at only two fourth/fifth grade classes within the Menomonie Area School District.

4. This research did not look at the differences in teaching styles and the quality of the teacher.

Context for the Study

In this study the teachers were not part of an interdisciplinary team at the school. It would be useful to conduct a parallel study to this one in which the teacher is an integral member of the interdisciplinary team that shares all students among team members.

Although it was beyond the scope of this study, it was difficult to determine whether or not students understood the science and technology concepts taught. The researcher recommends that a test be developed to evaluate students on the extent to which they understand the science and technology concepts in similar activities.

In this study, students had to actually participate in an informal interview process to gauge the level of knowledge that they pocessed at the start of the project. It is recommended that demographic, socioeconomic, intellectual ability, and academic achievement data is collected in furture studies. Such a study would attempt to develop an index of data and might allow future researchers to avoid the need to actually have students complete a pretest.

It was possible for students to observe the solutions of other students and integrate what the teacher taught them with their own ideas and their observations. It would be interesting, but difficult, to conduct a similar study in which the students work independently so that the effects of observing other solutions could be assessed. This might be accomplished in a lab school or clinical setting.

In spite of the foregoing attempt to explain the results of this experiment, the most fundamental constraint to this study was the lack of probability sampling and the small sample size. Researchers should develop working partnerships with the public schools in order to pursue research interests through long-term planning. Such a relationship would ensure that future studies are able to identify a number of sites and are able to use random assignment of groups in experiments with complicated treatments such as curriculum integration.

CHAPTER FOUR

Results and Discussions

Data Analysis

The data analysis of the study was qualitative in nature and based on interpretations and inductive analysis. The study was guided by the stated research objectives. It involved direct group observations and employed a search for patterns within the data.

This study focused mainly upon the small-group social interaction and its effect at the individual level. Therefore data collection procedures were aimed at capturing pupils' social interaction and actions in small-group settings. Data was collected by means of observations recorded in a field diary and videotaped recordings of group social interaction. The field diary and videotapes represent the primary data sources. Videotaping was aimed at wide angle to capture the entire classroom and the social and interpersonal reactions that happened throughout the unit. The field notes were written on all of the groups.

The researcher assumed the role of participant observer. During the study the researcher also acted as a tutor. This procedure enabled the researcher to be "inside" the study, true to the nature of qualitative research.

Demographics

The first variables analyzed in the observational equivalent group design were the demographics of each of the two classes. These demographics were collected from the cooperating teachers. These variables were simple descriptive statistics that are illustrated in Figures A through F. The data from these tables will be used to form simple relationships between the classes in the areas of gender and grade level

FIGURE A. Class One Gender

	CLASS 1 GENDER
MALE	FEMALE
9	7

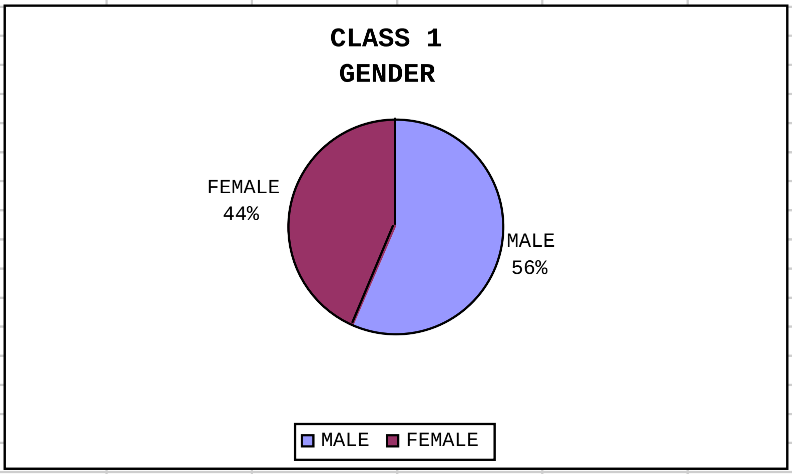


FIGURE B. Class Two Gender

	CLASS 2 GENDER
MALE	FEMALE
10	6

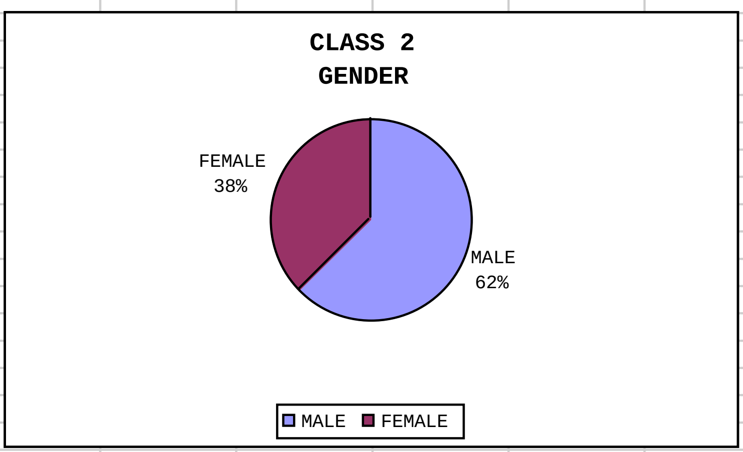


FIGURE C. Class One and Two Gender

	CLASS 1 and 2 GENDER
MALE	FEMALE
19	12

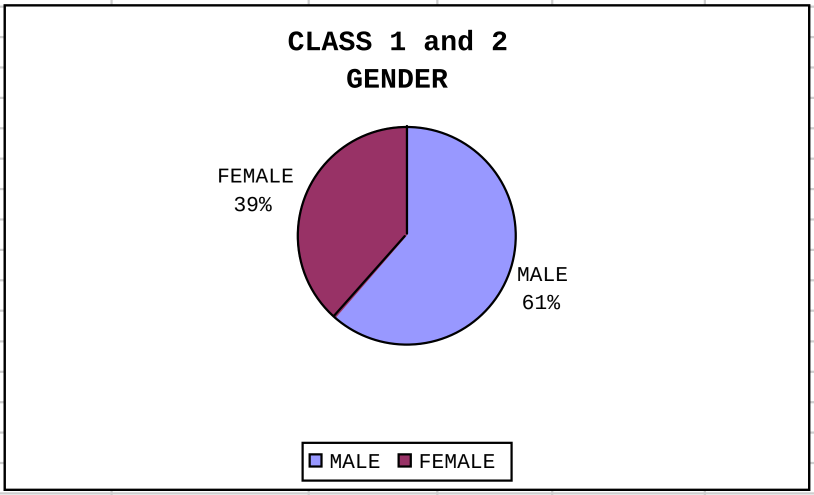
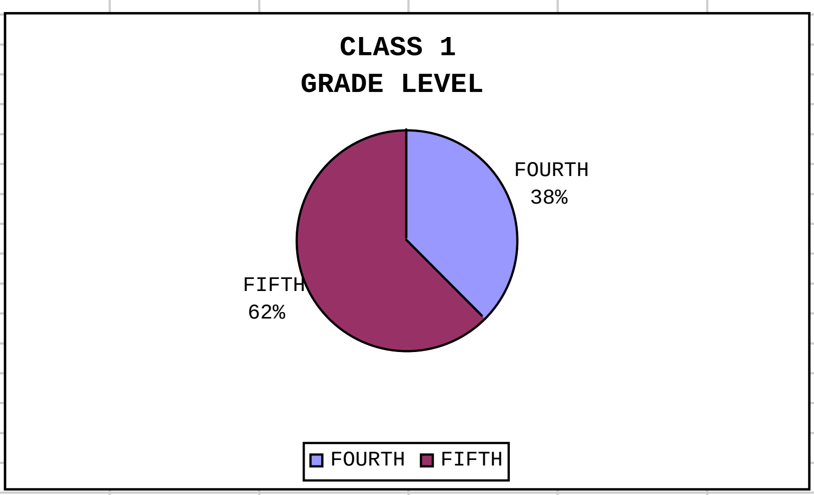


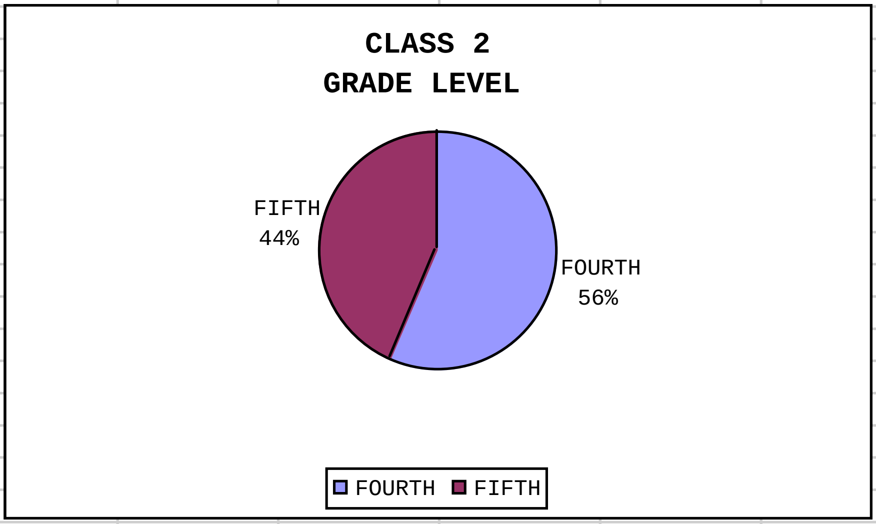
FIGURE D. Class One Grade Level

	CLASS 1 GRADE LEVEL
FOURTH	FIFTH
6	10



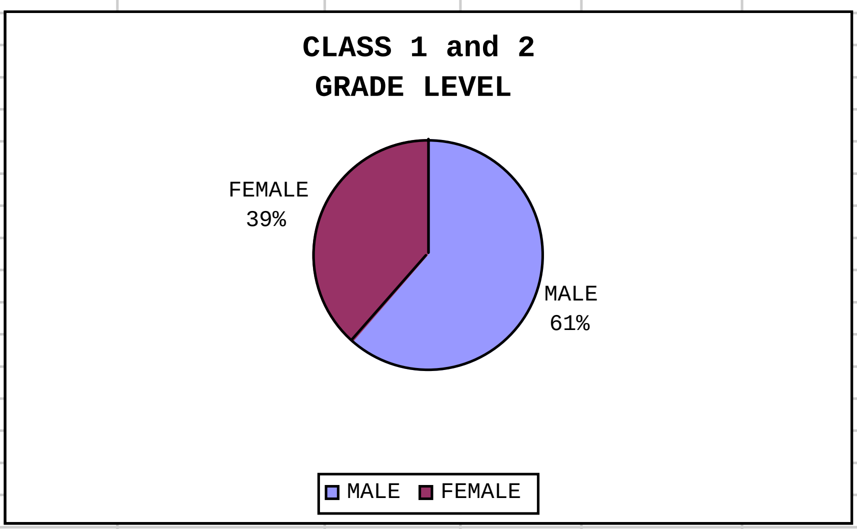
<u>FIGURE E</u>. Class Two Grade Level

	CLASS 2
	GRADE LEVEL
FOURTH	FIFTH
9	7



<u>FIGURE F</u>. Class One and Two Grade Level

	CLASS 1 and 2
	GRADE ELVEL
MALE	FEMALE
19	12



Knowledge of Simple Machines

The next part of the data analysis was to look at the results from the pre-lab and the post-lab questions that both classes completed. From this data the research could support the generalization between that the use of manipulatives will increase the student's understanding of technological subjects and concepts such as simple machines. This data was presented in the form of a bar graph. In addition to the correctional data of pre-lab and post-lab research was able to determine a descriptive statistic to measure the overall effect that the labs had on the students understanding and internalization of the basic concepts of simple machines and trade offs.

Prior to any instruction or lab activities a five-question pretest was administered. This test was simply a true or false evaluation to measure the knowledge level that the students possessed on simple machines. These same five questions were asked again at the end of the simple machines unit. The results of these five questions that where asked are shown in table 1,2 and figures G,H, and I.

TABLE 1. Pre Lab Survey Results

Responses	True	False	Percentage Correct
Question #1	20	12	62.5%
Question #2	18	14	62.25%
Question #3	17	15	46.875%
Question #4	22	10	31.25%
Question #5	19	10	40.625%

32 Valid Responses

FIGURE G. Pre Lab Survey Results

Pre-Lab				
Q - 1	Q - 2	Q - 3	Q - 4	Q - 5
62.5	62.5	46.875	31.25	40.625

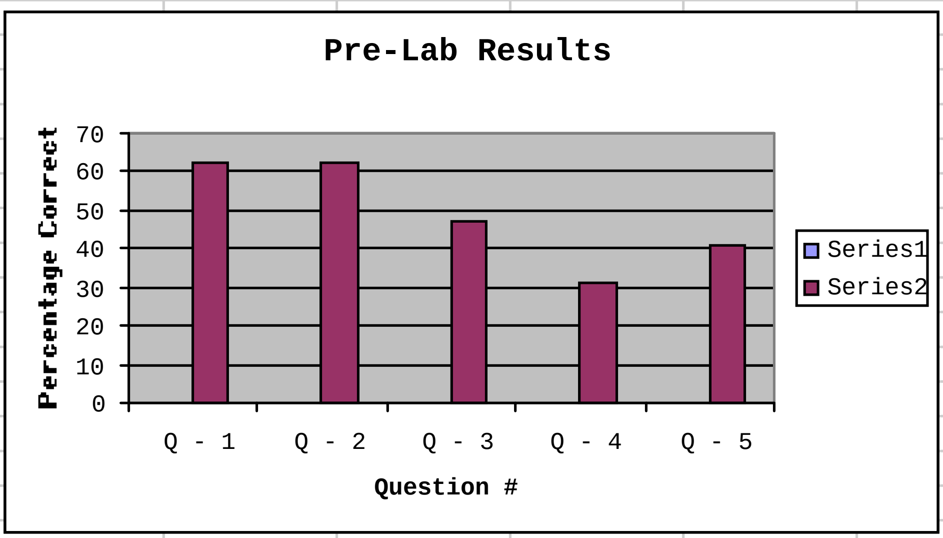


TABLE 2. Post Lab Results

Responses	True	False	Percentage Correct
Question #1	29	3	90.625%
Question #2	30	2	93.75%
Question #3	5	27	84.375%
Question #4	3	29	90.625%
Question #5	0	32	100%

32 Valid Responses

FIGURE H. Post Lab Survey Results

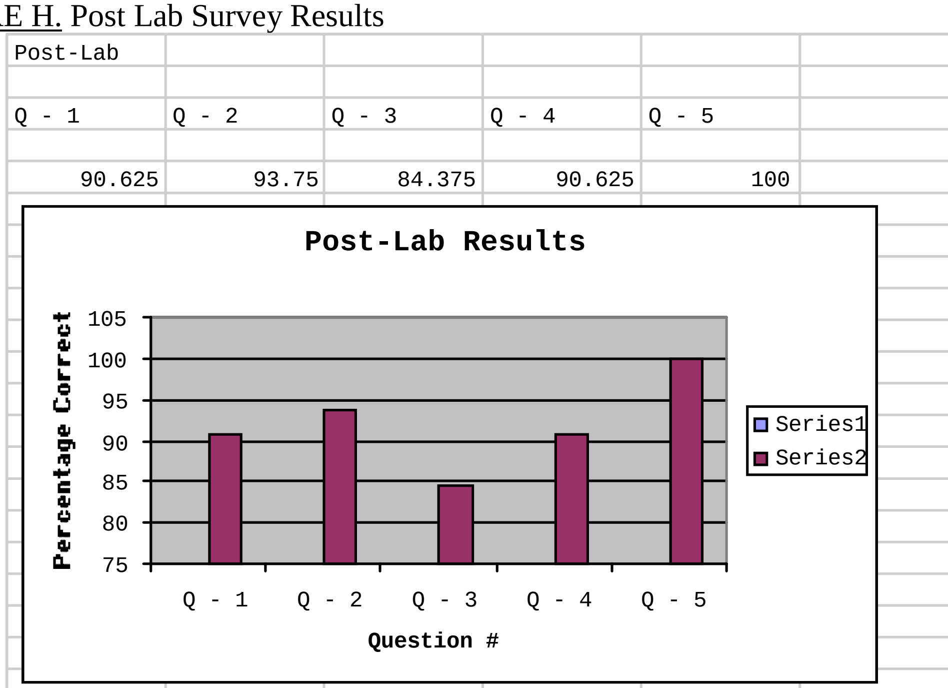


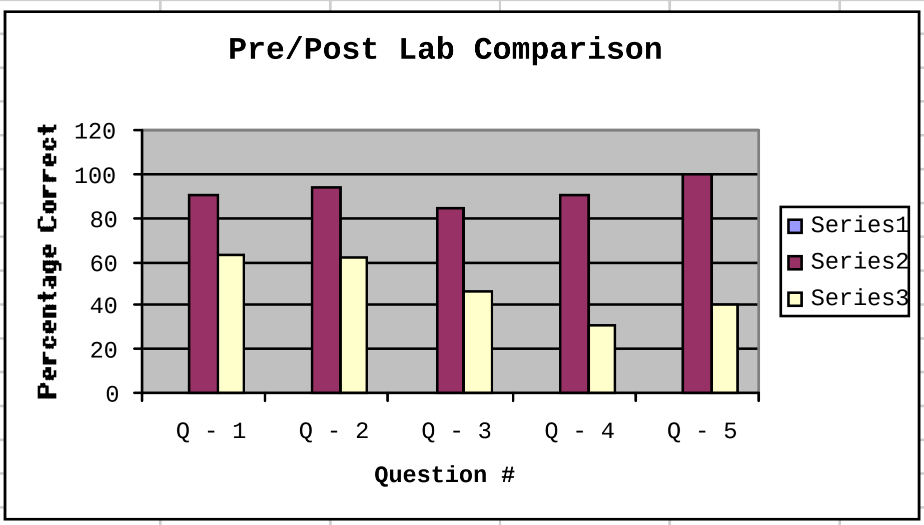
TABLE 3. Summary of pre-lab post-lab evaluation

Responses	Pre Lab % Correct	Post Lab % Correct	Percentage of Increase
Question #1	62.25%	90.625%	45.58%
Question #2	62.25%	93.75%	50.6%
Question #3	46.875%	84.375%	80%
Question #4	31.25%	90.625%	190%
Question #5	40.625%	100%	146%

32 Valid Responses

FIGURE I. Pre/Post Lab Survey Results

Post-Lab					
Q - 1	Q - 2	Q - 3	Q - 4	Q - 5	
90.625	93.75	84.375	90.625	100	
62.5	62.25	46.875	31.25	40.625	



The purpose of the pretest posttest evaluation was to determine the overall impact that the methods of instruction used had on the students basic understanding of the content. These question where to reflex the objectives of the research. As illustrated in table 3 there was a drastic increase in the percentage of students selecting a correct answer on the evaluation tool. The results from this evaluation tool by themselves do not completely validate the method of instruction as being superior to traditional methods. However, when they are combined with the responses from the interviews of the participants they do form a substantial argument in favor of the use of manipulatives and the model, coach and fade method of instruction.

The following are sample of the results and interpretations of questions asked orally of the students and documented in a data log. The questions are designed to directly measure the objectives of this research.

The Usefulness of the Integrated Technology Education Concepts (Objective 1)

Example 1

Researcher asks: “Does building a simple machine like this help you understand how they work”?

Student 1 says: “Yes”

Researcher asks: “Can you tell me why you understand it better if you get to build it like this”?

Student 1 says: “Well you have to really know how it works or you don’t know what to build.”

Example 2

Researcher asks: “Does building a simple machine like this help you understand how they work”?

Student 2 says: “Yeah I Guess”

Researcher asks: Can you tell me why you understand it better if you get to build it like this”?

Student 2 says: “getting to see the parts and then getting to play with them makes it much easier to understand”

Example 3

Researcher asks: “Does building a simple machine like this help you understand how they work?”

Student 3 says: “I don’t know”

Researcher asks: Would you learn more by actually building simple machines out of these TacTics or by listening to a teacher lecture about them?”

Student 3 says: “I guess I learn more by doing it”

Over the course of the unit the researcher asked most of the participants these question in an effort to establish a basis for objective #1. After review of the video record of this lab it became very clear that the students all felt actually getting to build and work with the simple machines made it easier for them to understand the principles of the unit. Without exception all students felt that the use of manipulatives made it easier for them to understand what was going on. Though not addressed in the form of a interview question, it was very obvious that the students were enjoying themselves. They seemed to be truly interested and excited about what they were learning. Every day at the end of the hour they were asking if they get to use the TacTics again tommarrow, and when they came in the next day they first thing they would ask is if they get to use the TacTics today. It is obvious to all educators that students learn better when they are enjoying themselves. The students truly seemed to enjoy themselves while participating in this lab.

Age Level and the Use of Manipulative with Technology Education (Objective 2)

Example 1

Researcher asks: “Do you think that using things like these Tactics would help most kids your age learn?”

Student 1 says: “Yeah”

Researcher asks: “ You don’t think they are too simple for someone your age?”

Student 1 says: “Oh no, they’re cool”

Example 2

Researcher asks: “Do you think that using things like these Tactics would help most kids your age learn?”

Student 2 says: “if you like to build things, they will help you”

Researcher asks: “ You don’t think they are too simple for someone your age?”

Student 2 says: “No, not really”

Example 3

Researcher asks: “Do you think that using things like these Tactics would help most kids your age learn?”

Student 3 says: “probably”

Researcher asks: “ You don’t think they are too simple for someone your age?”

Student 3 says: “No, I would play with these even when I am older”

From these and other similar responses the researcher concluded that the use of TacTics or similar manipulatives are an age appropriate teaching tool. In addition to the interview responses, the pre/post-test instrument substantiated the use of these TacTics with this age level of student. Not only do they seem age appropriate, the students seemed so engaged that they went beyond the objects of the lesson and explored and created on their own.

<u>A Practical Way to Integrate Manipulatives into Your Class (Objective 3)</u>

<u>Example 1</u>

Researcher asks: “Did it work well for you to have me first lecture and demonstrate simple machines followed by having you build something with TacTics?”

Student 1 says: “Yeah, it was ok, but I would have rather just built the stuff.”

<u>Example 2</u>

Researcher asks: “Did it work well for you to have me first lecture and demonstrate simple machines followed by having you build something with TacTics?”

Student 2 says: “Yeah”

Researcher asks: Do you think that you understood everything after just the lecture and the demonstration?”

Student 2 says: “No, not really”

<u>Example 3</u>

Researcher asks: “Did it work well for you to have me first lecture and demonstrate simple machines followed by having you build something with TacTics?”

Student 3 says: “It was ok”

Researcher asks: “What could I (the teacher) have done different?

Student 3 says: “I would have liked to make more things”

From these and other similar responses the researcher concluded that the teaching method used was an effective and useful method of instruction. Asking the students to evaluate the teaching strategy used may have been beyond their comprehension. They understood that they were learning but they could not relate that back to the teaching method. They simply knew that they were having fun while they were learning the content. They could not relate the teaching method to the overall success of the lab. To evaluate this area of the research it would be necessary to ask other professionals in the field of education.

CHAPTER FIVE

Summary, Findings, and Conclusion

Summary

The purpose of the research was to analyze the usefulness of technology education integration through the use of manipulatives on one unit of study in the fourth/fifth grade science classes at River Heights Elementary School. The researcher used an observational, equivalent group design to measure the usefulness of manipulatives on the curriculum. The pre-lab questioning formed the base level of understanding for the two groups participating in this study. Once the pre-lab questioning was administered and the data collected, the next step was to administer the treatment in each class. Both groups were taught simple machines with the use of manipulatives. The method of instruction used followed the themes of model, coach and fade. In this method of instruction the experiment was first be modeled to the students at both a conceptual and tactile level. The modeling was be followed by guided instruction and coaching the students as they complete their tasks. The final phase is one in which the instructor fades into the background and lets the students explore and discover ideas on their own.

The manipulatives used were large lego like building blocks that allowed the students to build the simple machines that they were studying. Not only could they build the simple machines but they were able measure the effectiveness of their design. The students would have the advantage of the cognitive instruction on simple machines as well as psychomotor activities to reinforce the lesson. By comparing the results from the pre-lab and post-lab questioning sessions and the video record the instructor could gauge the overall usefulness of the manipulatives on this unit.

This study has accomplished the following objectives:

1. To determining the usefulness of the integrated technology education concept of input-process-output has on a simple machines unit of instruction.
2. To determine if the systems approach with the use of manipulatives is a useful method of instruction for students in the fourth or fifth grade.
3. To determine a practical way to integrate manipulatives into an existing elementary unit of instruction.

Findings

The findings of this study have implications for the development integration efforts and future research related to integration. Development of curriculum integration materials that facilitate technological problem solving and the application of science and technology should continue based on evidence in this study. Students will, in fact, try to apply science and technology in solving problems through the use of manipulatives. The data collection and analysis process resulted in the following findings:

- The research provides evidence that the use of manipulative aided students in the understanding of the systems associated with simple machines.
- The research provides a good example of the integration of manipulatives in an existing unit of study.
- Students where excited and interested in learning with the use of manipulative.

- The use of manipulatives is an age appropriate method of instruction for students in the fourth or fifth grade.
- Student where highly engaged and involved in the learning process
- The teaching method of model, coach and fade works well with this type of lab activity.

Conclusions

Based upon the findings of this study the following conclusions have been developed.

- This study should used as a guide or example to substantiate the need for further study.
- The use of manipulatives such as the TacTics used in this study should be implemented as a useful tool in teaching a unit on simple machines.
- The model, coach and fade method in instruction works well when teaching a unit on simple machines.
- The use of manipulatives are age appropriate for the fourth and fifth grade levels.
- The purchase of manipulatives like the TacTics used in this study is an effective use of school funds.
- The use of manipulatives helped students comprehend the concept of input, process, output.

Recommendations

It is the researcher recommendation that this study be used as a guide or example to substantiate the need for further study. The scope and effects of the integration of manipulatives and technology concepts into the elementary curriculum are vast and beyond the reaches of this study. The research did provide an example of the effects that the technology and use of manipulatives can have in an existing unit of study. This a very narrow focus and in order to evaluate the overall usefulness that the manipulatives can have on an entire educational system or target population a much more comprehensive study is needed. The research provided an example that can use in an effort to provide quality educational opportunities to the children of their classrooms. The analysis of the findings resulted in the following recommendations:

- Conduct a parallel study to this one in which the teacher is an integral member of the interdisciplinary team that shares all students among team members.
- Develop a test to evaluate students on the extent to which they understand the science and technology concepts in similar activities
- Demographic, socioeconomic, intellectual ability, and academic achievement data be collected in a follow up study.
- Conduct a similar study in which the students work independently so that the effects of observing other solutions could be assessed.

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APPENDIXES

(Appendix A)

TacTic manipulatives unit on simple machines

River Heights Elementary School

Menomonie Wisconsin

INTRODUCTION:

A machine is a tool used to make the work easier. Simple machines are simple tools used to make the work easier. Compound machines have two or more simple machines working together to make the work easier.

In science, work is defined as force acting on an object to move it across a distance. Pushing, pulling, and lifting are common forms of work. Furniture movers do work when they move boxes. Gardeners do work when they pull weeds. Children do work when they go up and down on a seesaw. Machines make their work easier. The furniture movers use a ramp to slide boxes into a truck. The gardeners use a hand shovel to help break through the weeds. The children use a seesaw to go up and down. The ramp, the shovel, and the see-saw are simple machines. Each one makes work easier to do by providing some trade-off between the force applied and the distance over which the force is applied.

OVERVIEW:

Students participating in this project will investigate simple machines and their usefulness in everyday life.

OUTCOMES:

* Students will be able to identify each simple machine.
* Students will identify the give and takes that happen with simple machines.
* Students will understand the following terms: force, effort, and work.
* Students will be able to demonstrate their knowledge of simple machines by demonstrating, and/or creating a simple or complex machine.

SCOPE AND SEQUENCE:

Day One:

Topic: Wheel, axles and incline planes

The wheel and axle is another simple machine. The axle is a rod that goes through the wheel. This lets the wheel turn. It is easy to move things from place to place with wheels and axles.

Inclined Plane - A plane is a flat surface. For example, a smooth board is a plane. Now, if the plane is lying flat on the ground, it isn't likely to help you do work. However, when that plane is inclined, or slanted, it can help you move objects across distances. And, that's work! A common inclined plane is a ramp. Lifting a heavy box onto a loading dock is much easier if you slide the box up a ramp--a simple machine.

Lab Activity: Lab #1 Wheel and Axle TacTics create dolly

Time required: 50 Minutes

Day Two:

Topic: Pulleys and gears

This simple machine is made up of a wheel and a rope. The rope fits on the groove of the wheel. One part of the rope is attached to the load. When you pull on one side of the pulley, the wheel turns and the load will move. Pulleys let you move loads up, down, or sideways. Pulleys are good for moving objects to hard to reach places. It also makes the work of moving heavy loads a lot easier.

A gear is a kind of Simple Machine, which comes in a variety of sizes, with the teeth straight or curved and inclined at a variety of angles. They are connected together in various ways to transmit motion and force in machines.

When working with gears different numbers of teeth will have different effects on the work that the gears do.

Lab Activity: Lab #2 Gears and Pulley's - Speed it up / Slow it down

Time required: 50 Minutes

Day Three:

Topic: Gear and Pulleys lab

Lab Activity: Lab #3 Crane Design

Time required: 50 Minutes

Day Four:

Topic: Design and Build a simple machine and explain it to the class.

Now that the students have a basic understanding of simple machines it is time for them to put their knowledge to work. They are to design (invent) a simple machine to complete a task. The task could be entirely left up to the creativity of the children or it could be a guided idea from the instructor.

Lab Activity: Lab #3 Crane Design

Time required: 50 Minutes

(Appendix B)

Lesson #1

Simple Machines

Wheel, axles and incline planes

The wheel and axle is another simple machine. The axle is a rod that goes through the wheel. This lets the wheel turn. It is easy to move things from place to place with wheels and axles.

Inclined Plane, a plane is a flat surface. For example, a smooth board is a plane. Now, if the plane is lying flat on the ground, it isn't likely to help you do work. However, when that plane is inclined, or slanted, it can help you move objects across distances. And, that's work! A common inclined plane is a ramp. Lifting a heavy box onto a loading dock is much easier if you slide the box up a ramp--a simple machine.

Objectives

Students will be able to:

1.Identify the simple machines (wheel and axle, inclined plane) and give examples of how each can be used.

2.Work in groups to complete the lab TACTIC LAB 1

3.Predict and determine how simple machines such as wheels and axles will effect the work to be done.

4. Design and build a working model, using wheels and axles and an incline plane to move the create to the top of the table.

5. Students will be able to identify the three simple machines (gears and pulleys) and give examples how each can be used to lessen the effort needed to do work.

Estimated Time

-One 50 minute period

Outcomes

- Students will be able to demonstrate an understanding of the trade offs that happen in different wheel and axle or incline plane systems.

Assessment

-Students will share the results of their activity through a follow up discussion with the class.

-Students will be verbally questioned to gauge their understanding of the concept of give and take or compromises.

Resources

-Internet connection

-Paper, pencils, string, and misc. classroom supplies

-TakTic SciTek One kits (one kit for every three or four students)

TACTIC LAB #1 Create Dolly

INTRODUCTION:

A machine is a tool used to make the work easier. Simple machines are simple tools used to make the work easier. Compound machines have two or more simple machines working together to make the work easier.

In science, work is defined as force acting on an object to move it across a distance. Pushing, pulling, and lifting are common forms of work. Furniture movers do work when they move boxes. Gardeners do work when they pull weeds. Children do work when they go up and down on a seesaw. Machines make their work easier. The furniture movers use a ramp to slide boxes into a truck. The gardeners use a hand shovel to help break through the weeds. The children use a seesaw to go up and down. The ramp, the shovel, and the seesaw are simple machines. Each one makes work easier to do by providing some trade-off between the force applied and the distance over which the force is applied.

Vocabulary terms:

-Friction

-Mechanical Advantage (give and take) (trade-offs)

-Work

-Force

••

Today we are going to start looking at two simple machines, the wheel and axle and the incline plane.

The wheel and axle is a simple machine. The axle is a rod that goes through the wheel. This lets the wheel turn. It is easy to move things from place to place with wheels and axles.

Inclined Plane, a plane is a flat surface. For example, a smooth board is a plane. Now, if the plane is lying flat on the ground, it isn't likely to help you do work. However, when that plane is inclined, or slanted, it can help you move objects across distances. And, that's work! A common inclined plane is a ramp. Lifting a heavy box onto a loading dock is much easier if you slide the box up a ramp--a simple machine.

Now its time to build a device that uses a wheel and axle.

The device that they will build is a simple cart that could be used to move heavy objects like the crate full of TacTics. Show the example and demonstrate how to put things together.

-They may also simple roll the crate on the blue rods and uses them as wheels)

Follow Up Questions:

Discuss the and gauge the students understanding of the following topics:

-How does and incline planes make it easier to move a heavy object up a distance?

-What is gained by using an incline plane and what is lost?

-How does a wheel and axle make it easier to move the crate across the room?

Lesson #2

Simple Machines

Gears and Pulleys

Pulley: This simple machine is made up of a wheel and a rope. The rope fits on the groove of the wheel. One part of the rope is attached to the load. When you pull on one side of the pulley, the wheel turns and the load will move. Pulleys let you move loads up, down, or sideways. Pulleys are good for moving objects to hard to reach places. It also makes the work of moving heavy loads a lot easier.

Gears: This simple machine, which comes in a variety of sizes, with the teeth straight or curved and inclined at a variety of angles. They are connected together in various ways to transmit motion and force in machines.

Objectives

Students will be able to:

1.Identify the simple machines (Gears and Pulleys) and give

examples of how each can be used.

2.Work in groups to complete the lab TACTIC LAB 2

3.Predict and determine how simple machines such as gears and pulleys will effect the work to be done.

4. Design and build a working model, using gears and pulleys to show how gears and pulleys can speed things up or slow them down or make it easier or harder to move an object .

5. Students will be able to identify the three simple machines (gears and pulleys) and give examples how each can be used to lessen the effort needed to do work.

Estimated Time

-One 50 minute period

Outcomes

-Students will be able to demonstrate an understanding of the trade-offs that happen in different gear or pulley systems.

Assessment

-Students will share the results of their activity through a follow up discussion with the class.

-Students will be verbally questioned to gauge their understanding of the concept of give and take or compromises.

Resources

-Internet connection

-Paper, pencils, string, and misc. classroom supplies

-TakTic SciTek One kits (one kit for every three or four students)

TACTIC LAB #2 Speed it up / Slow It down

INTRODUCTION:

A machine is a tool used to make the work easier. Simple machines are simple tools used to make the work easier. Compound machines have two or more simple machines working together to make the work easier.

In science, work is defined as force acting on an object to move it across a distance. Pushing, pulling, and lifting are common forms of work. Furniture movers do work when they move boxes. Gardeners do work when they pull weeds. Children do work when they go up and down on a seesaw. Machines make their work easier. The furniture movers use a ramp to slide boxes into a truck. The gardeners use a hand shovel to help break through the weeds. The children use a seesaw to go up and down. The ramp, the shovel, and the seesaw are simple machines. Each one makes work easier to do by providing some trade-off between the force applied and the distance over which the force is applied.

Vocabulary terms:

-Ratio

-Gear

-Pulley

-Block and Tackle

- Circumference

- Revolution

- Input

- Output

••

Today we are going to start looking at Gear and Pulley Systems

Now its time to build a device that uses a Gear and Pulley systems.

The device that they will build is a simple gear or and pulley mechanism that will either speed up or slow down the distance the a gear or pulley will travel along its circumference.

Follow Up Questions:

Discuss the and gauge the students understanding of the following topics:

-If you have a small gear as the input gear and a large gear as the output gear, for every revolution of the input will the output gear spin move or less revolution?

- If you have a large gear as the input gear and a small gear as the output gear, for every revolution of the input will the output gear spin move or less revolution?

-If there is a gain in speed in a gear system, what is lost?

-If there is a loss in speed in a gear system, what is gained?

Lesson #3-4

Simple Machines

Complex machines

A complex machine is a machine that is made up of two or more simple machines. Each simple machine within the complex machine has its own set of trade offs individually and the complex machine has a total set of trade offs by itself.

Objectives

As a final phase of the study of simple machines, students will demonstrate their knowledge by:

1.Identify the complex machines and give examples of how each can be used.

2.Work in groups to complete the lab TACTIC LAB 3

3.Predict and determine how simple machines such as wheels, axles, gears, pulleys and incline planes will effect the work to be done.

4. Design and build a working model, using wheels and axles and an incline plane to lift an object one foot off the floor.

Estimated Time

-Two 50 minute periods

Outcomes

-Demonstrate an awareness of the types of simple/complex machines and be able to classify common objects in relation to the simple machines involved.

Assessment

-Students will share the results of their activity through a follow up discussion

-Students will be verbally questioned to gauge their understanding of the concept of give and take or trade-offs.

Resources

-Paper, pencils, string and misc. classroom supplies

-TakTic SciTek One kits (one kit for every three or four students)

TACTIC LAB #3 The Crane

INTRODUCTION:

A machine is a tool used to make the work easier. Simple machines are simple tools used to make the work easier. Compound machines have two or more simple machines working together to make the work easier.

In science, work is defined as force acting on an object to move it across a distance. Pushing, pulling, and lifting are common forms of work. Furniture movers do work when they move boxes. Gardeners do work when they pull weeds. Children do work when they go up and down on a seesaw. Machines make their work easier. The furniture movers use a ramp to slide boxes into a truck. The gardeners use a hand shovel to help break through the weeds. The children use a seesaw to go up and down. The ramp, the shovel, and the seesaw are simple machines. Each one makes work easier to do by providing some trade-off between the force applied and the distance over which the force is applied.

Vocabulary terms:

-Complex machine

-Systems

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Today we are going to start working on a complex machine. The crane

The device that they will build is a Crane.

Follow Up Questions:

Discuss the and gauge the students understanding of the following topics:

- Explain how all the simple machines in your crane work individually.

- Explain the trade-offs of all the simple machines with in your crane.

- Explain how all the simple machines in your crane work together.

- Explain the trade-offs of you complex machine.

(Appendix C)

Wisconsin Model Academic Standards

Fourth Grade Science Standards

FOURTH GRADE

Performance Standards

By the end of **grade four**, students will:

PROPERTIES OF EARTH MATERIALS

D.4.1 Understand* that objects are made of more than one substance, by observing, describing and measuring the properties of earth materials, including properties of size, weight, shape, color, temperature, and the ability to react with other substances

D.4.2 Group* and/or classify objects and substances based on the properties of earth materials

D.4.3. Understand* that substances can exist in different states-solid, liquid, gas

D.4.4 Observe* and describe* changes* in form, temperature, color, speed, and direction of objects and construct* explanations* for the changes

D.4.5 Construct* simple models* of what is happening to materials and substances undergoing change*, using simple instruments or tools to aid observations and collect data

POSITION AND MOTION OF OBJECTS

D.4.6 Observe* and describe* physical events in objects at rest or in motion

D.4.7 Observe* and describe* physical events involving objects and develop record-keeping systems to follow these events by measuring and describing changes in their properties, including position relative to another object, motion over time, and position due to forces

LIGHT, HEAT, ELECTRICITY, AND MAGNETISM

D.4.8 Ask questions and make observations to discover* the differences between substances that can be touched (matter) and substances that cannot be touched (forms of energy, light, heat, electricity, sound, and magnetism)