AN EVALUATION OF THE EFFECTIVENESS OF SELECTED TECHNOLOGY EDUCATION LEARNING ACTIVITIES AT NEW RICHMOND MIDDLE SCHOOL

By

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ABSTRACT

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The purpose of this study was to evaluate two technology education learning activities by determining their alignment with national standards and by assessing student achievement and satisfaction upon completion of the activities.

It was determined that the learning activities had a modest relationship with national science and technology standards. The students achieved the aligned objectives with a significant level of understanding. Results of the satisfaction survey showed that almost all of the students were very satisfied with their experiences. However, there was

no significant correlation between student gain from the pre-test to the post-test and student satisfaction.

The results uncovered the merits of the learning activities as well as suggested several ways to make them even more effective. More specifically, the results suggest the methodology used to engage the students in learning was effective. However, they could be improved by incorporating more of the national science and technology standards into the objectives and the learning activities. This would enrich the learning activities in ways that increase engagement and possibly enhance student satisfaction.

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CHAPTER I: INTRODUCTION

Background

For genuine learning to occur, students need to perceive their learning activities as relevant and meaningful. The role and function of the teacher is to introduce and guide student progress on activities and assignments (Brophy, 1990). Learning activities support the technology education curriculum and the curriculum needs to fall under the auspices of the technology education standards. It is a commonly held belief that "hands on" activities help drive true learning in technology education. As the world becomes more technologically advanced, one's teachings and activities must also advance to meet the needs of students and society (Sanders, 1999).

Principals usually evaluate teachers several times during the school year; however, feedback does not truly assess the effectiveness of the curriculum or activities but merely the effectiveness of the teacher at a particular point in time. A more thorough evaluation needs to be done to truly evaluate the effectiveness of the teaching. Furthermore, the professional literature encourages all teachers to evaluate their current curricula in response to the recommendations made in the national standards for science and technology education.

Teachers are very busy with all of the demands of educating but should periodically take time to evaluate their teaching activities. Given the importance of the teacher's role in the teaching and learning process and the role of learning activities in that process, it stands to reason that learning activities would be the focus of sustained scholarly analysis and research (Brophy, 1990 p. 5). It is important for teachers to align the middle school philosophy, recommended curriculum, and content standards when building a foundation for their curriculum and instruction (Bouvier, 1999).

The literature review suggests that learning activities, which contribute to the attainment of technology education standards, can be an effective method of teaching (Brophy, 1990). Studies have also shown that student satisfaction with learning activities is an important factor in learning activity effectiveness. Therefore, high quality learning activities should address the salient themes embedded in the national science and technology standards and also provide high levels of student satisfaction. The technology education learning activities at New Richmond Middle School need to be evaluated to determine their effectiveness.

Statement of the Problem

The instructor needed to evaluate the effectiveness of selected technology education learning activities at New Richmond Middle School. In the spirit of action research, this study was conducted to determine if selected technology education learning activities at New Richmond Middle School were meeting the pre-determined objectives. This study also attempted to determine if the selected learning activities result in high levels of student satisfaction and whether the selected learning activities addressed salient themes in the national science and technology standards

Purpose of the Study

The purpose of this study was to evaluate the effectiveness of two technology education learning activities at New Richmond Middle School. The evaluation consisted of determining the level of correlation between gain scores as measured by the difference between pre and post-test scores and satisfaction scores, as measured by a survey instrument.

Research Questions:

1. To what extent did New Richmond middle school's eighth grade manufacturing learning activity address salient themes embedded in national science and technology education standards?
2. To what extent did students at New Richmond middle school achieve the objectives, which were derived from selected standards, of the eighth grade manufacturing learning activity?
3. To what extent were students satisfied with their experiences during the eighth grade manufacturing learning activity at New Richmond middle school?
4. To what extent is there a relationship between student performance on the manufacturing tests and student satisfaction with the manufacturing activity?
5. To what extent did the seventh grade research and development learning activity at New Richmond middle school address salient themes embedded in national science and technology education standards?
6. To what extent did students at New Richmond middle school achieve the objectives, which were derived from selected standards, of the seventh grade research and development learning activity?

7. To what extent were students satisfied with their experiences during the seventh grade research and development learning activity at New Richmond middle school?

8. To what extent is there a relationship between student performance on the design and problem solving tests and student satisfaction with the research and development activity?

Rationale for the Study:

This research will make the technology education program at New Richmond stronger by guiding the instructor in further development of high quality learning activities. These activities will address salient themes embedded in national science and technology education standards, while providing high learner satisfaction. Furthermore, this information would be useful for present and future administrators, parents, and teachers at New Richmond Middle School. Lastly, this study should bring a higher degree of program validity to the department.

This research can also be used as a model to validate the usefulness of technology education learning activities in other programs. More specifically, other middle school technology education instructors may want to use this information to make decisions about their learning activities. This may result in technology education instructors revising or developing learning activities that address salient themes embedded in national science and technology education standards.

Definition of Terms:

Learning Activity - anything that students are expected to do, beyond getting input through reading or listening, in order to learn, practice, apply, evaluate, or in some other way respond to curricular content (Brophy, 1990 p. 5).

National Technology Education Standards - statements that tell educators what knowledge and skills students should acquire within a given grade range.

Objectives – Statements of the main purpose, idea, or goal of a learning activity.

Student satisfaction - a numeric description, from zero to five, for how satisfied students are with a specific aspect of a given learning activity.

Salient theme – the main ideas within specific objectives that are in common with the key ideas found in particular national standards.

Alignment/correlation – an attempt to show some type of association or grouping between national standards and learning objectives.

Limitations of the Study

1. The results of this study are valid only for the New Richmond Middle School. This study was limited to students at New Richmond Middle School in a group activity setting, during a nine-week fourth quarter class, of the 2003-2004 school year. It is possible that a different activity in a different setting for a different length of time would result in different findings.

2. The scope of this evaluation is very narrow. The students at another school with another instructor may provide different results on surveys or pre-tests and post-tests. A more limited application may be made to other schools with similar situations.

3. The results of the student survey or pre-test may include guessing. There is a probability that some of the responses did not accurately reflect the student's level of understanding or satisfaction.

CHAPTER II: LITERATURE REVIEW

The purpose of this study was to assess the effectiveness of two technology education learning activities at New Richmond Middle School. The following narrative will provide information about the background and history of technology education, the national standards for the study of technology, learning activity design principles, and student satisfaction.

Introduction

"Teachers must tap their imagination and creative talent to translate abstract and complex technological concepts into meaningful learning activities that can implemented with limited resources" (Welty, 1993, p.2). This quotation begins to unfold the meaning of what it takes to develop quality learning activities in a technology education classroom. In an attempt to gain insight into the role of learning activities in the technology education classroom, a great deal of literary resources were located and reviewed. These resources provided a wealth of information about what exactly constitutes a quality learning activity. The resources also provided the history of learning activities as they relate to technology education.

New Richmond Middle School

The National Middle School Association (NMSA) states that there are three earmarks of an exploratory middle school program. First, an exploratory program enables students to discover their particular abilities, talents, interests, values, and preferences. Second, courses and activities are taught so as to reveal opportunities for contributing to society. Finally, exploratory experiences acquaint students with enriching, healthy leisure-time pursuits, such as lifetime physical activities, involvement in the arts, and social service (Brazee 2000)

The middle school technology education department consists of one instructor who has almost every student in the middle school during the year. This department is part of a larger group called the "encore" area, which consists of band, choir, family consumer education, art, physical education, and Spanish. The sixth grade course called "Materials and Processes" introduces students to many of the different materials and processes industry uses. In the seventh grade course, the underlying theme is design and problem solving. In the eighth grade course, students design and mass-produce a product, which they can sell or purchase. The facilities at New Richmond Middle School consist of a manufacturing lab, which utilizes mainly woodworking equipment. A separate classroom is used for lecture and discussion.

Learning Activities

The idea of what makes a good learning activity is something that eludes many educators but will be identified in this section of the paper. The relevancy, history, and background of technology education learning activities will be laid out to provide readers with ample knowledge to understand the subject matter.

Learning activities could be described as "hands on activities" which are simply a method of teaching that incorporates the hand with the mind. In general, learning activities are a means of bringing forth the content of the curriculum while providing students with a motivational, interesting, and meaningful process of gaining information. Learning activities begin with the teacher providing pertinent information about a given topic. Students are then provided with information about the topic in the form of directions or drawings or both. This is often followed by a teacher demonstration, which mimics the student activity. They are usually required to complete activities at this point and when finished are evaluated by using one of several methods. A checklist or rating scale is the most common method of evaluation.

Most Technology Educators use learning activities of some kind during their instruction. The issue is that most of these activities have not been evaluated for their effectiveness. One of the related problems with learning activities in technology education is that many times the activity does not promote progress toward standards, the goals of the classroom, or the goals of the department. This could be because the activity was built around a specific piece of equipment or designed to fit software that the instructor wanted to use rather than based on sound objectives of the class.

Another problem found with inadequate learning activities is falsely branching off into an area that is not sound curriculum content or the activity misrepresents the basis of the content. This problem can tend to "disrupt or even distort the presentation of knowledge content"(Brophy, 1990,p.2).

A third problem in the selection and design of learning activities is a disproportionate amount of time dedicated to an activity in relationship to the size or level of the concept being taught. An example of this might be spending five weeks on an activity that deals with solar energy when solar energy is a relatively small percentage of our state's power supply.

The fourth and final significant problem with inadequate learning activities is spending a disproportionate amount of money on an activity in comparison to the length of the activity and how large of a role it plays in the content. An example of this could be purchasing a computer-controlled mill for $9,000.00 and using it for only a small segment in one class.

For more than one hundred years, activities have been an integral piece of the pie for technology education, industrial arts, and manual arts (Bennet, 1926-1937). If technology education had learning without activities then it would be another core area struggling to make concepts relevant to students. This idea of a learning activity is not new. Although a great deal of confusion about the name of this discipline and what should be taught has always surrounded technology education, one constant has always been that incorporating some type of activity of the hands along with the mind is a necessity to the field. This dates back to the late 1800's when "professionals desiring to introduce a manual element to the school waged a battle with the classical educators and won" (Wright, 1981, p.231). Discipline leaders such as Dewey, Bonser and Woodward have been speaking about the "hands on" approach for over one hundred years. These people and other great philosophers like them were the founders and leaders of the technology education discipline.

When looking at the great educational philosophers of the past four hundred years, the roots of technology education can be traced through such people as Woodward, Comenius, Froebel, Locke, Dewey, Warner, and many others (Bennet, 1926). Specific themes spread through the ideas of these philosophers and seem to get stronger with time. Some of these themes run through the veins of technology education today and are honorable traits to be taught to others such as working with your hands, having a skill, developing the mind along with the hands, working with tools-processes-materials, and using problem solving skills.

Learning Activity Principles

Developing and implementing quality learning activities requires considerable time and knowledge. Most often this information is gathered from other instructors, books, professors, and journals. A great deal of variance was found between sources for what is to be considered the appropriate criteria. There was such a wide range of criteria that a decision had to be made to limit the scope of this research project. This decision was based on the criteria found most often in the related literature. The criteria found in literature for this study were appropriate level of difficulty, feasibility, cost effectiveness, multiple goals, motivational value, topic currency, highly experiential, and core curriculum connections (Brophy, 1990; Welty, 1993). Through a review of literature, the main criteria for quality learning activities in this study have been identified and will be outlined. The first principle of a quality learning activity included whether the objectives of the learning activity contributed to the attainment of the national standards of technology education and/or the national science standards. The second principle examined the extent the students achieved the objectives. The next principle inquired if the students were motivated and satisfied with the activity. The final principle compared the relationship between student performance and student satisfaction.

If a learning activity contributes to the attainment of the national technology education standards then it automatically meets some of the other criteria that were found to be relevant in the other literature. For this reason the criteria have been limited to the four previously mentioned. This is not to say that the national technology education standards and the national science standards are the only benchmarks for leaning activities. Neither the national technology education standards nor the national science standards mention anything about student satisfaction, student motivation, or any specific objectives that may be relevant to a specific geographical area. Hence, there is a need to survey students about some of this information.

National Standards

Benchmarks for Science Literacy is a report that was developed to aid in curriculum reform by telling educators what knowledge and skills students should acquire by the end of middle and high school so that they are better prepared upon leaving. In 1989, teams from school districts across the country developed a common set of benchmarks that were critiqued by hundreds of experts and educators. After three years, the final report included goals for different grade levels in technology and science education. *Benchmarks for Science Literacy* was developed as a tool for educators to use in curriculum reform and alignment. Chapter three of the *Benchmarks for Science Literacy* is called "The Nature of Technology" and within this chapter are grade six to eight technology education goals for middle school students to attain by the end of grade eight. This chapter might be extremely helpful in deciding the criteria for alignment of New Richmond Middle School's learning activities with the standards. "Benchmarks is a tool to be used by educators in designing a curriculum that makes sense to them and meets the standards for science literacy recommended in Science For All Americans" (AAAS, 1993, p.1).

The literature shows evidence of national technology education standards becoming necessary for technology educators to provide an improved rationale for their existence (Hook, 2001). The International Technology Education Association (ITEA), which is "the largest professional educational association, principal voice, and information clearinghouse devoted to enhancing technology education through experiences in our schools (K-12)" (ITEA, 2000), released in April of 2000 the *Standards for Technological Literacy*. A great deal of assistance on the standards has come from the National Aeronautics and Space Administration, and the National Science Foundation. This gives the standards a great deal more credibility than if they were simply written by technology educators. These standards will help provide organization, identity, recognition, and direction for technology educators. Now that these standards are out, technology education has the guidance that has always been missing from our field, but now these standards have the ability to change the current conditions and influence a paradigm shift for our future if we embrace and promote them" (Hook, 2001, p.1).

Satisfaction

Satisfaction is "a response, such as information, that fully meets doubts, objections or demands"(World Book Dictionary, 2000, p.1849). This definition for satisfaction requires the researcher to clearly define what constitutes satisfaction as it relates to the student surveys. The survey instrument that was given to seventh and eighth grade students at New Richmond middle school utilized a zero to five rating scale to record their level of satisfaction upon completion of the learning activity. Zero was the lowest level of satisfaction and five was the highest level of satisfaction. The survey instrument can be found in the Appendix E. Satisfaction is related to a "T" test score, which tells the amount of satisfaction for each question. These scores can be found in chapter five of this paper. For the purpose of this research paper, any satisfaction score of three, four, or five will be considered "satisfied" as it relates to how students felt about the technology education learning activity. An explanation of this raw data can be found in the results of the study.

CHAPTER III: METHODOLOGY

The purpose of this study was to assess the effectiveness of two technology education learning activities at New Richmond Middle School. The following narrative will provide information about the subjects of the study. This chapter will also contain information about the type of instrumentation that the researcher used in the study. Furthermore, this chapter will include information about the data, the collection process, and the analysis process. Finally, this chapter will review the limitations of this study.

Subject Selection and Description

New Richmond is a community of approximately 6,000 people located in Western Wisconsin about 35 miles east of St. Paul, Minnesota. The community consists mainly of local business people, their employees, and commuters to the Twin Cities metro area. The New Richmond school district has a total population of 2,375 students with two elementary buildings, a middle school, and a high school. The middle school has approximately 575 students with 40 full time teachers. Technology education is a required class for sixth, seventh, and most eighth grade students. Middle school technology education is about "generating interest and enthusiasm for technology while teaching students the most important concepts" (Peirce, 1999,p.xvii).

The population for this study consisted of seventh and eighth grade students from New Richmond Middle School. The sample consisted of students enrolled in Technology Education during second, fourth, fifth, and sixth hours of fourth quarter. This was a convenient sample in which the selection of the subjects was neither random nor systematic. The seventh grade students were enrolled in a class titled, "How In The

World." During this class, they were exposed to power and energy concepts as well as the research and development process. The eighth grade students were enrolled in a course titled "Industry". They were exposed to many aspects of industry and manufacturing.

All students in seventh grade received technology education during a nine-week course in either first, second, third, or fourth quarter. Technology education was offered in a rotation along with art, Spanish, and health. A total of forty-nine seventh grade technology education students from the middle school comprised the sample for the second portion of the study. Students from two sections were a part of the seventh grade data. There were twenty-five students in the fifth hour section of which fourteen were male and eleven were female. There were twenty-four students in the sixth hour section of which twelve were male and twelve were female. The distribution of students demographically was generally equal. Approximately forty-nine students were tested and surveyed to ensure a large enough sample from which to pull data for the recommended thirty subjects.

A total of thirty-six eighth grade technology education students from the middle school comprised the sample for this portion of the study. Students from two sections were a part of the eighth grade data. The two sections were not only different in the number of students in each section but the student dynamics were also greatly different, which the researcher felt was important background information about the subjects. The twenty -four students in the fourth hour were students who were not in band, choir, orchestra, or Spanish. On the flip side, the twelve students in the second hour section were in at least one of choir, orchestra, or Spanish. Approximately forty students were tested and surveyed to ensure a large enough sample from which to pull data for the recommended thirty subjects. Thirty is the optimum number for a correlation study.

Instrumentation

In order to assess student achievement gain, a middle level technology education evaluation instrument was used. Questions on the test were written to address objectives, which were written to address salient themes imbedded within the national technology education and science standards. This was used as both the pre-test and post-test. The second instrument to be used was a simple survey to assess the level of student satisfaction upon completion of a learning activity. A rating scale from zero (the lowest) to five (the highest) was used to determine this information. The questions were similar to; On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with certain aspects of the learning activity you just completed?

Data Collection Procedures

The pre-test was administered to forty-eight seventh grade students at New Richmond middle school during the first week of the nine-week quarter. The test questions supported the objectives, which address salient themes embedded in national science and technology education standards. The twenty-two-point test consisted of four "true/false" questions and three short answer/fill in the blank questions. The forty-eight sets of pre-test instruments were manually scored.

Following the administration of the pre-test, a treatment was given to the forty-eight subjects. The administered treatment consisted of a learning activity in which students were involved in designing a project. This work was done individually. Students were required to draw their designs starting with simple sketches and following with more detailed working drawings. The majority of the students' time was spent building and refining the project, although adequate time was allowed for making the designs. Information about research and designing was also given to the students in the form of video, overhead transparencies, Power Point presentations, and readings/questions from a textbook.

The post-test, which was the same test as the pre-test, was administered to the seventh grade students at New Richmond middle school during week nine of the quarter. The test questions supported the objectives, which address salient themes embedded in national science and technology education standards. The twenty-two-point test consisted of four "true/false" questions, and three fill in the blank questions.

The pre-test was administered to thirty-seven eighth grade students at New Richmond Middle School during the first week of the nine-week quarter. The test questions supported the objectives, which address salient themes embedded in national science and technology education standards. The fifty-two-point test consisted of five "true/false" questions and nineteen short answer/fill in the blank questions. The thirty - seven sets of pre-test instruments were manually scored.

Following the administration of the pre-test, a treatment was given to the thirty-seven subjects. The administered treatment consisted of a learning activity in which students were involved in manufacturing a project. Students worked in small groups ranging in size from two to five students. Some of the groups were required to design a simple jig or fixture to aid in the manufacturing of the product. The majority of the students' time was spent manufacturing the project. Information about manufacturing was also given to the students in the form of video, overhead transparencies, and readings/questions from a textbook.

The post-test, which was the same test as the pre-test, was administered to the eighth grade students at New Richmond Middle School during week nine of the quarter. The test questions supported the objectives, which address salient themes embedded in national science and technology education standards. The fifty-two-point test consisted of five "true/false" questions, and nineteen fill in the blank questions.

Data Analysis

The forty-eight sets of post-test instruments for seventh grade students and the thirty-seven sets of post-test instruments for eighth grade students were manually scored. Student gain was then calculated by taking the difference between the pre-test and post-test score of each student.

Results from the survey regarding student satisfaction of the learning activity were also compiled. During the last week of the quarter students were asked to answer four questions about their level of satisfaction with the learning activity they had completed (see Appendix C). The surveys were collected and scored. Statistical significance between student gain and student satisfaction were then examined using the "Pearson's r" test. The results of the significance test can be found in chapter four of this paper.

Limitations

This study was conducted in the spirit of action research. This is to say that the researcher was actively teaching and the research conducted pertained directly to the work. While the research was ongoing, reflection was taking place as well. Reflecting on the work being done should help the researcher to make valuable changes to the program under study. Action research is a limiting factor for this study because the results may not be useful for populations outside of this group.

The information gathered utilized a convenient sample. The results of this sample can be applied to the rest of the seventh and eighth grade students in at New Richmond Middle School with modest reservations. This is because there is not any evidence to suggest that the subjects studied are any different than those enrolled in other courses in the Encore rotation.

CHAPTER IV: RESULTS

The purpose of this study was to evaluate two technology education learning activities by comparing student gain on pre-tests and post-tests with a student satisfaction survey. The following narrative will provide information about student achievement from pre-test to post-test, student satisfaction with the learning activities, and salient themes found in learning activity objectives and national standards.

Respondents

Students were given a pre-test during the first week of class, followed by a treatment in the form of an activity, and concluded by a post-test. Following the activity they were asked to fill out a satisfaction survey. Upon tabulation and calculation of the data, it was determined that there was no significant correlation between student gain from pre-test and post-test data and student satisfaction. This was true for the seventh grade as well as the eighth grade students. Although the gain score for both seventh and eighth grade students was significant and the average satisfaction score for both grades of students was also quite high, the correlation between student gain and satisfaction was close to zero.

Seventh Grade

The satisfaction or "T" scores for the seventh grade students were extremely high. The satisfaction survey, which can be seen in Appendix D, utilized a zero to five rating scale for the three questions. The mean "T" score for the forty-seven students in seventh grade was 4.1064 with a standard deviation of .83147.

Gain scores for the seventh grade students were very high as well. The seventh grade test had a total of twenty-two points. The mean score on the pre-test was 7.15 with a standard deviation of 3.413. The mean score on the post-test was 17.28 with a standard deviation of 4.397. The difference in this data produced a number of 10.13 for a mean gain score.

Alignment between the learning activity objectives and the national science and technology education standards was modest. Three seventh grade learning activity objectives showed salient themes with the national science standards while four of the objectives had salient themes with the national technology education standards. This information can be found in the Appendix E.

Eighth Grade

The satisfaction or "T" scores for the eighth grade students were extremely high. The satisfaction survey, which can be seen in Appendix D, utilized a zero to five rating scale for the four questions. The mean "T" score for the thirty-six students in eighth grade was 4.1759 with a standard deviation of .81059.

Gain scores for the eighth grade students were very high as well. The eighth grade test had a total of fifty-two points. The mean score on the pre-test was 8.69 with a standard deviation of 5.030. The mean score on the post-test was 43.64 with a standard deviation of 9.556. The difference in this data produced a number of 34.94 for a mean gain score.

Alignment between the learning activity objectives and the national science and technology education standards was modest. Zero eighth grade learning activity objectives showed salient themes with the national science standards while four of the objectives had salient themes with the national technology education standards. This information can be found in the Appendix E.

The information provided in the following tables refers to the academic performance of seventh and eighth grade students at New Richmond Middle School on individual test questions as well as performance on activities. This information also attempted to show a correlation of the questions to the objectives as well as how the objectives related to the national science and technology standards.

Item Analysis

Seventh Grade

Definition for Design. The National Standards for Technology Education call for all middle school students to understand that "Design is a creative planning process that leads to useful products and systems" (ITEA 2000 p.95). Coincidently, one of the objectives for the seventh grade technology education students at New Richmond Middle School was "On a written exam, students will be able to define design." Upon completion of the unit students were asked to identify if a statement about design was true or false. (see table 1)

Table 1

Seventh Grade Responses to Question Four

Test Question	Correct	Wrong	n
T or F A design is a plan for making something.	36 (77%)	11(23%)	47

Most of the students (77%) recognized design as "a plan for making something." One quarter of the students did not identify the given definition as a true statement.

Steps of the Design Process. The National Standards for Technology Education (2000) call for all middle school students to understand that, "The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution (s), making the item, evaluating it, and presenting the results" (ITEA, 2000 p.102). Furthermore, the National Research Council (1996) recommends "Students should review and describe any completed piece of work and identify the stages of problem identification, solution design, implementation, and evaluation" (NRC 1996 p.13). Consequently, one of the objectives for the seventh grade students at New Richmond Middle School was, On a written exam, "students will be able to list and summarize the steps of the design process." Upon completion of the unit students were asked to list the steps in the design process, then explain one of them. (see table 2)

Table 2

Seventh Grade Responses to Question Seven

Test Question	6 or more correct	3 or more wrong	n
List the steps in the design process, then choose one step and explain what is done during that step. (8 points)	29 (62%)	18(38%)	47

A majority of the students (62%) received at least six out of the eight points possible for listing the steps of the design process and explaining one of them. A little over one-third of the students answered three or more of the possible eight points incorrectly.

Application of Design Process. The National Standards for Technology Education (2000) call for all middle school students to understand that "Design is a creative planning process that leads to useful products and systems" (ITEA, 2000 p.95). Furthermore, the American Association for the Advancement of Science (AAAS 1993) recommends "Engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems" (AAAS 1993 p.4). Therefore, one of the objectives for the seventh grade students at New Richmond Middle School was, "During an activity, students will be able to use the design process to solve real problems."

Upon completion of the unit students were graded on their drawings and their finished project. (see table 3) Grading rubrics were created for the drawings as well as the final project. These can be found in Appendix A, B, C, and D respectively.

Table 3

Seventh Grade Activity Scores

Class Period	Drawing 1	Drawing 2	Drawing 3	Project
Hour 5 Class Ave	10 (100%)	22.5 (90%)	43 (86%)	35.2 (88%)
Hour 6 Class Ave	10 (100%)	23.3 (93%)	45 (90%)	32 (80%)
Hour 5 & 6 Ave	10 (100%)	22.9 (91.5%)	44 (88%)	33.6 (84%)
Total Possible Points	10	25	50	40

All of the students (100%) in fifth and sixth hour received a score of ten on their thumbnail sketch drawing. This drawing was only graded on two criteria, as shown in Appendix A. Virtually all of the students (91.5%) received a score of 22 or higher on their second drawing with the average score being 22.9. The second drawing was graded on five criteria as indicated in Appendix B. Most of the students (88%) in fifth and sixth hour received a score of 43 or higher on their third drawing with an average score of 44 out of a possible 50. Most of the students (80%) scored 32 or higher out of a possible 40 on their final project. The final project was graded on eight criteria as shown in Appendix D.

Types of Drawings. The National Standards for Technology Education (2000) call for all middle school students to "Make two-dimensional and three-dimensional representations of the designed solution. Two-dimensional examples include sketches, drawings, and computer-assisted designs (CAD)" (ITEA, 2000 p.95). Additionally, the National Research Council (1996) states that "Students must consider constraints -- such as cost, time, trade-offs, and materials needed – and communicate ideas with drawings and simple models" (NRC 1996 p.13). Coincidently, one of the objectives for the seventh grade students at New Richmond Middle School was, "During an activity, students will be able to create three drawings (thumbnail sketches, design sketches, working drawings and simple models."

Upon completion of the unit students were asked to identify if a statement about the three types of drawings was true or false. (see table 4) Students were also asked to write down examples of drawing tools. (see table 5) Additionally, students were asked to write down the types of drawings and describe one of them. (see table 6)

Table 4

Seventh Grade Responses to Question Two

Test Question	Correct	Wrong	n
T or F A thumbnail sketch is larger and more detailed than a design sketch.	37 (79%)	10(21%)	47

Table 5

Seventh Grade Responses to Question Five

Test Question	3 or more correct	2 or more wrong	n
List four examples of traditional drawing tools. (4 points)	45 (96%)	2(4%)	47

Table 6

Seventh Grade Responses to Question Six

Test Question	5 or more correct	2 or more wrong	n
List the three types of drawings we used to develop our CO-2 cars. (3 points) Choose one of these drawing types and describe it. (3 points)	25 (53%)	22(47%)	47

Table four shows that most of the students (79%) knew that a thumbnail sketch is not larger and more detailed than a design sketch. A small number of students (10%) did not answer the question correctly.

As table five shows, virtually all of the seventh grade students (96%) were able to list three or four examples of drawing tools. Only two (4%) of the students answered two or more wrong on this question.

A majority of students (53%) earned at least five out of six points by listing and describing the three types of drawings used in their design process. Some of the students (47%) answered two or more wrong out of a possible six points on the same question.

Eighth Grade

Manufacturing Definition. The National Standards for Technology Education (2000) call for all middle school students to learn that "Manufacturing systems produce products in quantity" (ITEA, 2000 p.183). Coincidently, one of the objectives for the eighth grade students at New Richmond Middle School was, "On a written exam, students will be able to define manufacturing." Upon completion of the unit, students were asked to provide a written definition for manufacturing. (see table 7)

Table 7

Eighth Grade Responses to Question Eighteen

Test Question	Correct	Wrong	n
Define manufacturing	36 (100%)	0(0%)	36

All of the students (100%) wrote a correct definition for manufacturing on the exam.

Categories of Materials. The National Standards for Technology Education (2000) call for all students to understand that "Materials have different qualities and may be classified as natural, synthetic, or mixed." (ITEA, 2000 p.189). Coincidently, one of the objectives for the eighth grade students at New Richmond Middle School was, "On a written exam, students will be able to list and provide examples of the three main categories of raw materials used for manufacturing." Upon completion of the unit, students were asked to list categories of materials and give an example of each. (see table 8)

Table 8

Eighth Grade Responses to Question Six

Test Question	5 or more correct	2 or more wrong	n
List three types of raw material and give 1 example of each. (6 pts)	25 (69%)	11(31%)	36

A majority of students (69%) earned at least five out of six points by listing and describing the three types raw materials. Some of the students (31%) answered two or more wrong out of a possible six points on the same question.

Manufacturing Categories. The National Standards for Technology Education (2000) call for students to understand that "Manufacturing may be classified into types, such as customized production, batch production, and continuous production." (ITEA, 2000 p.189) Coincidentally, one of the objectives for the eighth grade students at New Richmond Middle School was, "On a written exam, students will be able to compare and contrast between continuous, intermittent, flexible, and custom manufacturing." Upon completion of the unit students were asked to identify if five statements about the three types of manufacturing were true or false. (see table 9) Students were also asked to provide written definitions for custom production, intermittent production, and mass production. (see table 10)

Table 9

Eighth Grade Responses to Questions 1-5

Test Question	Correct	Wrong	n
T or F Continuous manufacturing allows for the greatest "flexibility" in a manufacturing system.	35 (97%)	1(3%)	36
T or F Production costs are generally the lowest with custom manufacturing.	32 (89%)	4 (11%)	36
T or F Custom manufacturing requires a higher degree of worker skill.	36 (100%)	0 (0%)	36
T or F Equipment costs are highest with continuous manufacturing.	23 (64%)	13 (36%)	36
T or F The cost of a continuously manufactured product is generally lower than that of the same custom manufactured product.	31 (86%)	5 (14%)	36

As shown in table 9, virtually all of the students (97%) recognized that continuous manufacturing does not allow for much flexibility in a manufacturing system. All (100%) of the students understood that custom manufacturing requires a high degree of worker skill. Although only about two-thirds (64%) of the students understood that equipment costs are the highest with continuous manufacturing.

Table 10

Eighth Grade Responses to Questions 15,17 and 19

Test Question	Correct	Wrong	n
Define custom production.	34 (94%)	2(6%)	36
Define intermittent production.	33 (92%)	3(8%)	36
Define mass production.	33 (92%)	3(8%)	36

As shown in table 10, virtually all of the students (92-94%) were able to provide definitions for each of the three types of production. Only a small amount (6-8%) of the students could not provide an adequate definition for custom, intermittent, or mass production.

Types of Ownership. The National Standards for Technology Education (2000) call for students to understand that "Large corporations typically have their own marketing departments, whereas smaller companies with limited resources may contract with a marketing firm." (ITEA, 2000 p.190) Coincidently, one of the objectives for the eighth grade students at New Richmond Middle School was, on a written exam, students will be able to describe advantages and disadvantages of each of the three types of business ownership. Upon completion of the unit students were asked to provide written definitions for corporation and proprietorship. (see table 11)

Table 11

Eighth Grade Responses to Questions 13 and 16

Test Question	Correct	Wrong	n
Define corporation.	36 (100%)	0(0%)	36
Define proprietorship.	23 (64%)	13(36%)	36

Table 11 shows that all (100%) of the eighth grade students provided an accurate definition for a corporation while only about two-thirds (64%) of the students provided a correct definition for proprietorship.

CHAPTER V: DISCUSSION

Introduction

The purpose of this study was to evaluate two technology education learning activities by determining the level of correlation between national standards and the objectives of the learning activities, assessing student achievement during the activity, and surveying student satisfaction. The following narrative will address the research questions found in chapter I of this paper. The narrative will also provide information and insights about what may be done to improve the learning activities at New Richmond Middle School.

This final chapter is divided into three sections. The first section will summarize the population of the sample, the instruments used, the data collection procedures, the data analysis procedures and the limitations of the study. The second section will identify conclusions derived from the analysis of the data. The third section will discuss recommendations related to this study and recommendations for future studies.

The following research questions were used to determine what information needed to be gathered about the learning activities at New Richmond Middle School.

1. To what extent did New Richmond Middle School's learning activities address salient themes embedded in national science and technology education standards?
2. To what extent did students at New Richmond Middle School achieve the objectives, which were derived from selected standards, while engaged in the learning activities?

3. To what extent were students satisfied with their experiences during the learning activities at New Richmond Middle School?
4. To what extent is there a relationship between student performance on the tests and student satisfaction with the activities?

Methodology

The population for this study consisted of seventh and eighth grade technology education students from New Richmond Middle School. This was a convenient sample that included students who had technology education during second, fourth, fifth, and sixth hours of fourth quarter. A middle level technology education evaluation instrument was then used to assess student achievement gain. The second instrument to be used was a simple survey to assess the level of student satisfaction upon completion of a learning activity. Each of these instruments was then administered to the subjects at the appropriate time during the quarter. Results were gathered from tests and surveys, which provided information that showed students achieving the objectives and being highly satisfied. The information also showed almost zero correlation between student gain on the test and student satisfaction.

Conclusions

Upon tabulation and calculation of the data, it was determined that there was no significant correlation between student gain from pre-test and post-test data and student satisfaction. This was true for the seventh grade as well as the eighth grade students. Although the gain score for both seventh and eighth grade students was significant and the average satisfaction score for both grades of students was also quite high, the correlation between student gain and satisfaction was close to zero.

At first glance it seems quite logical that students with a high gain score would have a high satisfaction score and students with a low gain score would have a low satisfaction score. Interestingly, several students who were not very satisfied but had high gain scores threw off the correlation. Students who were very satisfied but had low gain scores also skewed the correlation. The data shows that a number of students in these two categories will indeed show an almost zero group correlation score.

There was a correlation of about zero between student gain from pre-test to post-test and student satisfaction. One variable that may have influenced student satisfaction or dissatisfaction was gender bias. Research shows that girls are not as interested in technology education as their male counter parts (Waite, 2003). Furthermore, some of the other possible reasons for students to be in the low satisfaction and high gain category would be that they were highly satisfied with the activity but did not necessarily do well on the test. The reverse is also true. An excellent student academically may have done very well on the test yet did not enjoy the activity at all. Several other explanations for this phenomenon can be theorized. However, higher levels of student satisfaction would be extremely difficult to achieve given the diverse nature of the population being served, the complexity of the learning activities in question, and the need to facilitate genuine exploration.

Recommendations

Further research in this area could surely be done. The following are suggestions the researcher has for the completed study and also any further research that may be done related to this area.

Although most students seem to be satisfied with the learning activities, a good deal more could be done to provide a more rich learning experience. One suggestion is to include more salient themes between the objectives and the national standards. The activities are rich enough in content but need to be supplemented by showing the connection between more of the objectives with equally more national standards. Providing students with a richer activity may help to increase the satisfaction level of students who may not otherwise be interested in technology education.

Another opportunity for improvement comes in the way of the evaluation instruments. Even though students obtained significant gain from pre-test to post-test, the instrument itself should be modified to better test students' knowledge of the targeted objectives. This could be as simple as changing from a true and false layout to a multiple choice format. It could also mean changing from a standard written test arrangement to using a rubric to evaluate a project.

Another finding from this research is that the researcher's method for providing students with information seems to be yielding good results. As a result of this finding, the researcher will not make major changes to the method of implementation.

There were some inherent problems with the survey instrument (Appendix E) that may have contributed to some inaccuracies in the data. The instrument did not have any explanation for what each number meant. The researcher should have included an explanation for each number assigned to a satisfaction level. This would have allowed students to better describe their satisfaction.

The size and scale of the evaluation instrument were questionable. Some objectives could have used more test questions to ensure proper testing of the objectives. Some objectives did not have test questions that related to their content.

Based on these conclusions it is recommended that further improvements and modifications be made to improve the quality of the learning activities at New Richmond Middle School.

References

American Association for the Advancement of Science. (1993). Project 2061 Benchmarks. (Online) Available: http://www.project2061.org/tools/benchol/bolintro.htm

Bennet, C. A. (1926). History of manual and industrial education up to 1870. Peoria, IL: Bennet.

Bennet, C. A. (1937). History of manual and industrial education 1870 to 1917. Peoria, IL: Bennet.

Bouvier, David F; Corley, Charles (1999). Assessing Technology Education in Massachusetts. *Tech Directions*, v 59 no.1 Aug. pp. 28-29.

Brazee, Ed (2000). Exploratory Curriculum in the Middle School. ERIC Publications

Brophy, Jere; Alleman, Janet (1990). Activities as Instructional Tools: A Framework for Analysis and Evaluation. ED 319 733 Michigan State Univ., East Lansing. Inst. for Research on Teaching. Mar 90 42p

Fales, Kuetemeyer, Brusic. (1997). Technology Today and Tomorrow. New York, NY Glenco/McGraw-Hill, Inc.

Hook, Paul (2001). The Standards for Technological Literacy: A Needed Change for Technology Education. *The Technology Teacher*, May/June, pp.31-32.

International Technology Education Association. (2000). *Standards for Technological Literacy*. Reston, VA: Author.

National Committee on Science Education Standards and Assessment, National Research Council. National Science Education Standards. (1996). Retrieved July 1, 2004, from http://www.nap.edu/readingroom/books/nses/html/6d.html.

Sanders, Mark E (1999). Technology Education in the Middle Level School: Its Role and Purpose. *NASSP Bulletin*, pp34-44, 83.

Saskatchewan (1999) http://www.sasked.gov.sk.ca/k/pecs/ae/tl_overview/index.html

"Satisfaction." *World Book Dictionary.* Volume 1. 2000. Pp 1849.

Waite, William III (2003). Factors that Prevent Female Students from Enrolling in Technology Education Courses at Richfield Senior High School. University of Wisconsin Stout Online Thesis Collection. Taken on July 7,2004 from http://ww.uwstout.edu/lib/thesis/2003/2003waitew.pdf

Welty, Kenneth (1993). Quality Features for Technology Education Learning Activities. A Paper Presented at the University of Wisconsin-Stout 40th Annual Technology Education Conference.

World Book Dictionary (2000). p.1849. World Book, Incorporated. Chicago, Illinois

Wright, R., & Barella, R. (1981). Summary and reflections. In R.Barella, & R.Wright (Eds.), *An interpretive history of industrial arts: The interrelationship of society, education, and industrial arts*. (pp. 227-231). Bloomington, IL: McKnight & McKnight.

Appendix A: Thumbnail Sketch Grading Rubric

Thumbnail Sketch Grade Sheet

Name______________________________

Hour______

At Least 10 Sketches:	1	2	3	4	5
Design will Fit into Block:	1	2	3	4	5

Total out of 10 ____________

Appendix B: Design Sketch Grading Rubric

Design Sketch Grade Sheet

Name______________________________

Hour______

Views Align:	1	2	3	4	5
View Location: (top, front)	1	2	3	4	5
CO-2 Hole Drawn:	1	2	3	4	5
Axel Holes Drawn:	1	2	3	4	5
Proportional:	1	2	3	4	5

Total out of 25 ___________

Appendix C: Working Drawing Grading Rubric

Working Drawing Grade Sheet

Name______________________________

Hour______

Dragster Body Length:	1	2	3	4	5
Dragster Body Width:	1	2	3	4	5
Dragster Body Height:	1	2	3	4	5
Wheelbase:	1	2	3	4	5
Axel Hole Above Bottom:	1	2	3	4	5
Axel Hole From End:	1	2	3	4	5
Power Plant Hole Depth:	1	2	3	4	5
Power Plant Wall Thickness:	1	2	3	4	5
Power Plant Center Line:	1	2	3	4	5
Screw Eyes Apart:	1	2	3	4	5

Total out of 50 ____________

Appendix D: Final Project Grading Rubric

CO-2 Car Grade Sheet

Name______________________________

Hour______

Does car match drawing:	1	2	3	4	5
Does car meet specs:	1	2	3	4	5
Aerodynamics:	1	2	3	4	5
Weight:	1	2	3	4	5
Rolling Friction:	1	2	3	4	5
Finish (paint):	1	2	3	4	5
Strength:	1	2	3	4	5
Car Completed & Raced:	1	2	3	4	5

Total out of 40 ___________

Appendix E: Student Satisfaction Surveys

7th Grade Student Satisfaction Survey

Name____________________

1. On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with the design process (3 types of drawings)?

0 1 2 3 4 5

Comments: ____

____

2. On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with the tools and methods you could use to make your car?

0 1 2 3 4 5

Comments: ____

____

3. On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with the overall way your car turned out?

0 1 2 3 4 5

Comments: ____

____

8th Grade Student Satisfaction Survey

Name____________________

1. On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with the way we made the clocks (custom versus mass production)?

0 1 2 3 4 5

Comments: ____

____

2. On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with the finished product (the clock)?

0 1 2 3 4 5

Comments: ____

____

3. On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with using the equipment/power tools?

0 1 2 3 4 5

Comments: ____

____

4. On a scale from zero (the lowest) to five (the highest), how would you rate your level of satisfaction with working in a group on a job task sheet?

0 1 2 3 4 5

Comments: ____

Appendix F: Objective/Standard Alignment Table

Seventh Grade
Salient Themes within Objectives and Standards

Learning Activity Objective	Science Benchmark	ITEA Standard
On a written exam, students will be able to **define design.**	None found	The **design is a creative planning process that leads to useful products** and systems. (ITEA p.95)
On a written exam, students will be able to **list and summarize the steps of the design process.**	Students should review and describe any completed piece of work and **identify the stages of problem identification, solution design, implementation, and evaluation.** (NRC 1996 p.13)	The engineering **design process involves defining a problem, generating ideas, selecting a solution, testing the solution (s), making the item, evaluating it, and presenting the results.** (ITEA p.102)
During an activity students will be able to use the design process **to solve real problems.**	Engineers, architects, and others who engage in design and technology use scientific knowledge **to solve practical problems.** (AAAS 1993 p.4)	**Design is a** creative planning **process that leads to useful products** and systems. (ITEA p.95)
During an activity students will be able to **create three types of drawings** (thumbnail sketches, design sketches, working drawings) for a project.	Students must consider constraints -- such as cost, time, trade-offs, and materials needed – and **communicate ideas with drawings** and simple models. (NRC 1996 p.13)	**Make two-dimensional and three-dimensional representations** of the designed solution. Two-dimensional examples include **sketches, drawings,** and computer-assisted designs (CAD) (ITEA p.121)

Eighth Grade
Salient Themes within Objectives and Standards

Learning Activity Objective	Science Benchmark	ITEA Standard
On a written exam, students will be able to **define manufacturing**.	None Found	**Manufacturing** systems **produce products** in quantity.(ITEA 2000 P.183)
On a written exam, students will be able to list and provide examples of the **three main categories of raw materials** used for manufacturing.	None Found	**Materials have different qualities** and may be classified as natural, synthetic, or mixed. (ITEA 2000 P.189)
On a written exam, students will be able to compare and contrast between **continuous, intermittent, flexible, and custom manufacturing**.	None Found	Manufacturing may be classified into types, such as **customized production, batch production, and continuous production**. (ITEA 2000 P.190)
On a written exam, students will be able to describe **advantages and disadvantages** of each **of** the three **types of business ownership.**	None Found	**Large corporations** typically **have their own marketing departments**, whereas **smaller companies** with limited resources may **contract with a marketing firm**. (ITEA 2000 P.190)