An Analysis of the Effects of a Cabinetmaking Curriculum on Students' Problem Solving and General Reasoning Skills at Union Grove High School

by

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Abstract

The workplace of today and the future requires workers who have the ability to think, reason, and solve problems. The educational system needs to take responsibility for helping students learn these skills, yet there is minimal direct instruction or testing in these areas. The purpose of this study was to determine if students improve their general reasoning and problem solving skills through participation in high school woodworking and cabinetmaking classes. Seventy-two high school students were given The Test of Everyday Reasoning, which is a 35 question multiple choice test designed to target students' general reasoning skills. Mean scores were compared based on: a) students' year in school, b) progress through class, and c) number of woodworking classes taken. Results of the study showed minimal improvement based on students'

year in school, but significant improvement based on their progress through class and years of woodworking experience.

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Chapter 1: Introduction

In the last 50 years, the U.S. economy has relied heavily on manufacturing and mass production factories. Many of these jobs involved low skill repetitive tasks, for which workers were not required to use problem solving and higher level thinking skills. These jobs were plentiful, paid a living wage, and attracted young workers with minimal education and skills, but that is no longer true (Drake, 2000; Reich, 1994; Smith, 2002; Tyson, 2005). Over the last 50 years, these jobs have been steadily declining and are being replaced with jobs that require employees to "think, collaborate, communicate, cooperate, and create" (Kaplan-Leiserson, p.12). According to David Wyss, Chief Economist for Standard and Poors (cited in Bailey, 2003), one third of the nation's work force was employed in factories in 1950; it's now down to 11% and Laura Tyson, dean of London Business School, stated (cited in Bailey, 2003) "manufacturing employment has fallen steadily as a share of total U.S. private sector jobs, from about 35 percent in 1950 to under 13% today" (p. 3). Nationally known and respected columnist David Broder added (cited in Bailey, 2003), industrial jobs fell 17% from July 2000 to August 2003, a loss of almost one job in six.

In order to remain competitive in today's global economy, business and industry need to become advanced innovative places, designing and developing new thoughts, ideas, and products, organized around skilled people (Reich, 1994). Jeffrey King (1995) stated that "more and more firms are recognizing that market success is dependent on the creativity, ingenuity and the problem solving abilities of their employees" (p. 7) and B.J. Smith (2002) agreed, adding "employers today are looking for workers who possess 'hard skills' such as computer literacy, reading, writing and technical skills, but

more importantly 'soft skills' like interpersonal relations, critical thinking and problem solving" (p. 5). The Wisconsin Department of Workforce Development cited creative thinking as a skill needed in 16 of the 25 projected fastest growing jobs for 2002-2012 (Worknet, n.d.). Employers need to reevaluate what they look for in new employees. Satish Parekh (2005, columnist for the Baltimore Daily Record, reported that hiring workers based on technical knowledge and expertise is no longer enough. Problem solving skills are different from technical knowledge, and employers need to focus on a candidate's "ability to solve a myriad of unanticipated problems inherent to the job" (p. 12).

Secondary education needs to play an important role in training the future workforce by focusing on helping students learn to think creatively and become better problem solvers. The business community and educators have expressed concern about the deficiencies in students' skills, specifically in the areas of communication, teamwork, thinking and problem solving (Holter & Kroka, 2001; Pucel, 1999).

A recent study by the Organization for Economic Cooperation and Development (OEDC; cited in Shuster, 2005) found that high school students from the U.S. scored below average on an international math and problem solving test. Laurie Shuster reported that 5,456 students tested from the US had an average ranking of 28th out of the 40 countries tested on the problem solving portion of the test (Shuster, 2005). A report to Congress from the United States General Accounting Office stated that:

> Our educational system is not keeping pace with the demands of the changing economy. International competition is transforming the American workplace, increasing the demand for highly skilled workers

> across manufacturing and service industries. Employers want employees who can solve problems, share management responsibilities, and work in teams. Yet the nations schools are not educating many students to meet these demands. Only a small percentage of the nations students can perform tasks requiring complex reasoning and problem solving, and their achievement in mathematics and science lags behind that of their peers in other industrialize nations. (U.S. General Accounting Office, 1992, p. 4)

Through a series of interviews, Abbot and Warfield (1999) reported that this general lack of problem solving skills is a result of: a) lack of student motivation, b) lack of experience with problem solving, and c) inability to think critically. Collier, Guenter and Veerman (2002) added that students are not challenged to use problem solving skills in the classroom on a consistent basis.

In the past, education has focused on the end result, as opposed to the learning process. Students can get the right answer, but being able to understand the concepts makes all the difference. Information without interpretation is simply meaningless facts. Learning can be enhanced when students are engaged in complex situations and learn how to identify the real problems and work toward solutions (Costa, 2001). David Pucel (1999) reported that "a more thorough understanding of how problem-solving skills are developed challenge traditional education to change and adopt a new set of goals" (p. 7). Schools need to shift from teaching facts, memorization, and basic knowledge, to teaching students how to learn by promoting complex thinking skills such as critical thinking, problem solving, decision making, creative thinking, and other applied

knowledge and process skills (Holter & Kroka, 2001; Kaplan-Leiserson, 2004). All disciplines within a school have the opportunity and potential to help students develop higher level thinking skills. It is the responsibility of each teacher, to understand which skills best suit his/her curricular area, and incorporate the appropriate instruction necessary to help students develop these skills.

Career and Technical Education classes tend to contain real world and problem-based content, especially in the area of Trade and Industrial education. The nature of these classes inherently requires students to use general reasoning skills to solve problems.

The cabinetmaking curriculum at Union Grove High School involves three separate classes: a) Introduction to Woodworking, b) Intermediate Woodworking/ Cabinetmaking, and c) Advanced Cabinetmaking. Content is intertwined, and each class builds on the previous class. Instruction specific to problem solving is not a part of the cabinetmaking curriculum. Through the use of lecture, worksheets, demonstration, and written construction procedures, students are expected to complete projects specifically designed to enhance the lesson and teach the desired skills. Having the ability to interpret and follow instructions, apply reasoning skills, and think independently is necessary for the successful completion of these classes, but these are areas that many students tend to struggle. When students encounter a problem or are unsure about how to proceed, they will usually either ask the instructor for directions or proceed blindly. If students learn how to use problem solving skills and peer collaboration to interpret the instructions and then proceed on their own, they will be less reliant on the instructor and become more self-sufficient learners. Authors and Professors David

Knowlton and David Sharp (2003) stated that part of the educational process requires teachers to help students acquire problem solving skills so they will be better able to create and solve information-age problems. They added that "there is well-documented information that connects problem based learning and self-directed learning" (p. 6). Problem solving skills can be learned through the use of the following ideas: a) facilitate the acquisition of expert knowledge, b) develop an awareness of general problem solving strategies, c) focus on discovering and identifying problems, d) use external representations whenever possible, and e) mimic expert strategies (Bruning, Norby, Ronning, & Schraw, 2004).

Statement of the Problem

Students in the cabinetmaking classes at Union Grove High School are required to read and interpret written and verbal instructions, then apply that information in a practical manner as they complete their projects. This requires them to use common sense and general reasoning skills. The curriculum does not include any training or instruction specific to problem solving. It is not known if participating in these classes will improve students' ability to think, reason and solve problems.

Purpose of the Study

The purpose of this study is to determine if the students at Union Grove High School improve their general reasoning and problem solving skills through participation in woodworking and cabinetmaking classes. The results of this study will be used to determine the value and importance of woodworking and cabinetmaking classes to students' development of general reasoning skills. Educational professionals could use

these results help determine the importance and value of teaching cabinetmaking at the high school level.

Objectives of the Study

This study sought answers to the following objectives:

1. Identify how participation in woodworking and cabinetmaking classes will affect students' problem solving and general reasoning skills.
2. Determine if specific sub-scale skills (inductive reasoning, deductive reasoning, analysis, evaluation, inference) improve as a result of participation in woodworking and cabinetmaking classes.
3. Determine if students' problem solving and general reasoning skills improve if they take higher level woodworking and cabinetmaking classes.
4. Determine if specific sub-scale skills (inductive reasoning, deductive reasoning, analysis, evaluation, inference) improve if they take higher level woodworking and cabinetmaking classes.

Importance of the Study

This study is important for the following reasons:

1. Students need to improve their problem solving skills. The changing workplace requires workers who can use their general reasoning skills, think independently and solve problems. The secondary school system needs to take responsibility for helping students develop these skills. Teachers in all disciplines need to examine their curriculums and find ways to help students improve their problem solving skills.

2. The effectiveness of hands-on instruction needs to be validated. Career and Technical Education (CTE) programs have always been recognized for helping students learn about and experience a variety of careers. CTE instructors have also touted the numerous additional benefits that come as a result of the hands-on, lab-based design and problem solving approach to instruction, but there have been few studies to support their claims. If CTE is to gain additional recognition for its contribution to education, there needs to be research that will support the value in these methods of instruction. The results of this study could provide a link between participation in CTE classes and student achievement.
3. If students become aware of problem solving and general reasoning skills in a cabinetmaking class, they may be able to apply those concepts in other classes and outside of school, giving them a deeper understanding about how to learn, and helping them think more independently.

Limitations of the Study

The following are limitations of this study

1. It could be difficult to determine if students' improvement is related to participation in woodworking and cabinetmaking classes or other outside influences such as: a) other classes that students' may be taking at the same time, b) students' experiences outside of school.
2. Time restrictions don't allow this study to track the same students through all three courses in the program. As students progress through the three levels of instruction they continue to use more complex thinking skills, make

connections to prior learning, use prior knowledge in different contexts, and self-assess their progress. There may be an exponential relationship between levels of instruction and improvement of general reasoning skills.

3. Students were assigned to testing groups as a result of class assignments. As a result, some of the groups had a low number of test subjects.

Definition of Terms

Following are terms that are used throughout this paper. Some of them are defined or explained in greater detail later.

Creative thinking - Using basic thinking processes to develop or invent novel, aesthetic, constructive ideas or products from precepts as well as concepts (Costa, 2001, p. 49).

Critical thinking – Using basic thinking processes to analyze arguments and generate insight into particular meanings and interpretations (Costa, 2001, p 49).

Decision-making – Using basic thinking processes to choose the best response among several options (Costa, 2001, p 50).

Higher order learning - Learning through exploring the foundations, justification, implications, and value of a fact, principle, skill or concept (Krulik & Rudnick, 1989, p. 3).

Problem - A situation, quantitative or otherwise, that confronts an individual or group of individuals, that requires resolution, and for which the individual sees no apparent path to the solution (Krulik & Rudnick, 1989, p. 3).

Problem solving – Using basic thinking processes to resolve a known or defined difficulty (Costa, 2001, p. 50).

Reasoning – The drawing of conclusions or inferences from observation, facts, or hypothesis. (Morris, 1973, p. 1086).

Analysis – To comprehend and express meaning. To identify the intended and actual inferential relationships (Blohm & Facione, 2001).

Evaluation – To assess the credibility of statements or other representations. To assess the logical strength of the actual or intended inferential relationships (Blohm & Facione, 2001).

Inference – To identify and secure elements needed to draw reasonable conclusions. To form conjectures and hypothesis. To consider relevant information (Blohm & Facione, 2001).

Deductive reasoning – The assumed premises purportedly necessitates the truth of conclusion. Using facts to establish a conclusion. Algebraic and geometric proofs in mathematics are examples of deductive reasoning (Blohm & Facione, 2001).

Inductive reasoning – An arguments conclusion is purportedly warranted, but not necessitated, by the assumed truth of its premises. Drawing a conclusion and using facts to determine if conclusion is accurate. Scientific confirmation and experimental disconfirmation are examples of inductive reasoning (Blohm & Facione, 2001).

Chapter 2 - Literature Review

Introduction

This chapter will begin by defining some of the terminology related to problem solving followed by discussion of the influence cognitive psychology has had on problem solving. The next section will outline the definition of a five-stage problem solving model. The chapter concludes by summarizing four elements that are key to effective problem solving.

Definition of Terminology

In their discussion of problem solving, many authors refer to critical thinking, with each author offering their own definition and view of what critical thinking is and the relationship between critical thinking and problem solving. Although there is no "one size fits all" definition of critical thinking, there are commonalities that can be drawn from the numerous explanations.

People need to think critically so they can make decisions and choices. This is true not only while they are in school, but also in their every day lives. Critical thinking is essential in applying all fields of knowledge, and requires students to consider general issues that cut across several domains (Bruning, 2004; Paul, 1993). Author, speaker, and staff development leader Richard Paul (1993) summarizes by stating, "critical thinking, in its legitimate, comprehensive sense applies to every academic discipline as readily as it applies to life beyond the ivory tower" (pg iii). He extends the definition to include these personal qualities,

> " critical thinking is not a skill or passion, but an attitude; along with humility, or the ability to admit you don't know, and self-confidence

enough to assert it, and the morality to feel it is wrong to act as if you know when you don't" (pg vii)

Critical thinking is more global and personal than simply following a process or solving a problem. It involves understanding the nature of a problem, analyzing arguments, generating insights into particular meanings and interpretations, developing cohesive logical reasoning patterns and understanding assumptions and biases (Bruning, 2004; Costa, 2001). Critical thinking is based on a students' set of beliefs and attitudes, which are built around integrity, humility, empathy, courage, the ability to be open and fair minded, and a sensitivity to others' beliefs, feelings and knowledge (Bruning, 2004; Paul, 1993). It involves cooperation rather than competition, and a willingness to suspend judgment. One must not only consider and appreciate the thoughts and ideas of others, but also have a genuine desire to explore viewpoints that are opposed to their own (Paul, 1993; Runco, 1994).

Critical thinking usually involves internal states and thinking that is directed toward "clarifying" a goal. Critical thinking is complex and encompasses many lesser skills. Situations that require critical thinking can be vague, poorly defined, and cut across several domains. Resolution may involve several possibilities or there may be no resolution at all. A students' ability to solve problems is affected by their ability to think critically.

Problem solving usually involves external states and thinking is directed toward "adopting" a goal. Problems tend to be more specific, well defined, and contained within a specific domain. Resolution involves utilizing domain specific

expertise and/or background knowledge in conjunction with a logical problem solving process (Bruning, 2004).

Another important distinction is the difference between a question, an exercise and a problem. A question is a situation that can be resolved by mere memory or recall. An exercise is a situation that involves drill and practice to reinforce a previously learned skill or algorithm (Krulik, 1989). A problem is a situation, obstacle or challenge that confronts an individual and is perplexing or difficult to figure out. When confronted with a problem, an individual or group sees no apparent path, and resolution requires analysis and synthesis of previously learned knowledge (Krulik, 1989; Paul, 1993; Runco, 1994). The key phrase in this definition of problem is "no apparent path". A situation is not a problem if it can be solved by simply applying facts or algorithms that have been previously learned. A problem, as defined by Krulik and Rudnick (1989), requires an individual to "synthesize previously learned knowledge and apply it in a different situation or context" (pg 3). Three criteria must be present for a situation to be a problem: a) Acceptance-an individual needs to accept the problem, which requires personal involvement. This could be a result of internal motivation (personal desire) or external motivation (peer, parent or teacher); b) Blockage - an individual's initial attempts at a solution are fruitless, and typical processes and methods of generating a solution do not work; and c) Exploration-Motivated by personal involvement, an individual seeks a solution by exploring new methods of attack (Krulik & Rudnick, 1989). Problem solving begins with an initial confrontation and ends with an answer. Frameworks, processes and critical thinking are used to determine additional information needed, synthesize previously learned knowledge, infer or suggest

alternative solutions, and select the best solution (Costa, 2001; Krulik & Rudnick, 1989; Paul, 1993).

The Evolution of Problem Solving

The definition of problem solving has evolved over time. In the early 1900's E.L. Thorndike proposed a theory, which suggested that problem solving consisted of a series of trial and error behaviors that would eventually lead to a solution. In contrast to Thorndike, John Dewey (cited in Bruning et al, 2004) viewed problem solving as a "conscious and deliberate process governed by a naturally occurring sequence of steps" (pg 163). Dewey suggested that problem solving was a teachable skill that consisted of five basic steps: a) presentation of the problem – perceiving a difficulty, or recognizing the existence of a problem, b) definition of the problem – defining the nature of the problem and identifying constraints to its solution, c) hypothesis development – suggesting one or more solutions, d) hypothesis testing – implications of the solutions are elaborated, and the best solution is determined, e) solution selection – determine which is best (Bruning, 2005; Runco, 1994).

For the 70 years following Thorndike and Dewey, numerous sociologists, anthropologists, scientists, mathematicians, philosophers, and psychologists such as Walles in the 1920's, Patrick in the 1940's, Osborn in the 1950's, Christensen and Frick in the 1960's, Guilford in the 1960's, Gordon in the 1970's, Landau in the 1970's, and Moriarity and Vanderbert in the 1980's have developed different theories and problem solving models, all of which contain varying degrees of Dewey's original framework. Although the basic problem solving framework has remained similar throughout the

century, there have been dramatic changes in the psychological approach to problem solving and learning.

Psychological Influence on Problem Solving

In the early 1900's, research using laboratory animals conducted by Clark Hill and Kenneth Spencer (cited in Bruning, 2004) concluded that learning involved associating or linking a stimulus with a response. Associationists believed that reasoning and learning were the result of random trial and error responses. These conclusions were extended to humans and associationism dominated the study of thinking, memory, and problem solving. Continued research was not able to make a connection between animal behavior and human behavior and by the 1950's, associationism began to lose favor and was replaced by behaviorism. Behaviorist theory was advanced by scientist/philosopher J.L. Skinner's belief that behavior and learning was influenced by environment and history, and could be shaped through the use or positive and negative consequences. Skinner contended that learning was random and could be controlled externally. Behaviorists believed that a correct answer, followed by positive reinforcement, would promote learning and memory development (Bruning, 2004).

The 1970's saw the dawn of the cognitive era. Although behaviorism is still present in education to this day, behaviorist theory is slowly being replaced by cognitive theory. The work of psychologists Jerome Butler in the 1950's and David Ausubel in the 1960's (cited in Bruning, 2004) theorized that memory and learning are internal, and controlled by mental structures and organizational frameworks. Learning is not a product of mechanical input and output, but rather something "learners construct in a

social context from their prior knowledge and intentions, and the strategies they use" (pg 9).

Cognitive psychology encompasses a large body of knowledge. Roger Bruning et. al. (2004) has developed seven themes to help explain cognitive psychology's relevance to learning and teaching.

1. Learning is a constructive, not a receptive process. Learning is more than memorization and facts, it is a product of the interaction among what learners already know, the information they encounter, and what they do as they learn. The goal of learning is to construct meaning and create a deeper understanding of content.

2. Mental frameworks organize memory and guide thought. Cognitive psychologists refer to schemata as mental frameworks used to organize thought. Information is not stored randomly, but organized and categorized in memory. Memory recall is activated by prior knowledge. Old and new information and knowledge are combined and restored, expanding the framework.

3. Extended practice is needed to develop cognitive skills. Automated processes allow students to perform complex tasks smoothly and quickly, without having to pay attention to the process. Through continued practice, these automated processes are performed with less reliance on working memory, giving students the ability to think and learn while doing.

4. Development of self-awareness and self-regulation is critical to cognitive growth. The study of metacognition refers to students becoming more aware of their own ability to remember, learn, and solve problems and become more strategic in their learning, or better able to manage their own thinking, learning and problem solving.

More important than knowledge and skill acquisition is a student's ability to think critically and understand what he/she has learned and how he/she has learned it.

5. Motivation and beliefs are integral to cognition. Recent studies have shown a connection between students motivational and belief systems and their level of achievement. If students want to learn, and believe they have the ability to learn, they will achieve at a higher level than students that do not.

6. Social interaction is fundamental to cognitive development. Cooperative learning, class discussion and peer interaction will help students achieve at higher levels. Through the use of observation, conversation and evaluation, students can learn from one another.

7. Knowledge, strategies and expertise are contextual. Information, skills and the methods students' use are organized in memory by their similarities. Learning can be improved by helping students make connections between present and past learning.

Rather than viewing learning and problem solving as externally controlled processes, cognitive psychology emphasized that people access their many internal "thinking" resources to construct or generate solutions. This discipline acknowledged that people are unique in their beliefs, skills, and experiences, so solutions will be unique as well.

The Five-Stage Problem Solving Model

Based on these seven themes, Roger Bruning et.al. (2004) have developed a general problem solving model that can be applied in different domains. Although it is similar to Dewey's early 1900's model, it was influenced by twenty first century cognitive development theory.

Stage 1 - Identifying the Problem

Problem identification or problem finding is the most important and challenging aspect of problem solving. Albert Einstein (cited in Runco) has been quoted as saying "the formation of a problem is often more essential than its solution" (pg. 42). Three obstacles students face when trying to identify a problem are: a) they are not in the habit of searching for problems, and do not actively seek them out, b) their background knowledge is usually limited, c) they don't take the time to fully understand the problem before seeking a solution.

Research by Getzel and Czikszentmihali (cited in Bruning etal. 2004) found that the more time students spent identifying a problem, the more successful they were at solving the problem. Additional research by Gick and Hayes in the 1980's (cited in Bruning etal. 2004) also found that the amount of time spent in the initial stages of problem finding was directly related to successful problem solving. As students spent more time identifying problems, they found a greater number of solutions and when faced with difficulties, had a greater tendency to discover alternative approaches. Another important aspect of problem identification is the student's ability to think critically, or the ability to view a problem from many perspectives, and explore solutions that are not consistent with the problem. Research by Runco and Okuda (cited in Runco, 1994) found a positive relationship between problem finding and divergent thinking.

Stage 2 - Representing the Problem

Most problem solving solutions require analysis, synthesis and other higher order thinking skills. This usually requires the use of more information than can be stored in

short term or working memory. Using internal and external representations will help students organize information. Diagrams, graphs, pictures, equations, 3-D models and flow charts are examples of external representations. Internal representations are procedures, processes, guides or roadmaps that students have used in the past. These processes are stored in memory and can be recalled when the student needs to use them. Holtoak (cited in Runco, 1994) suggests that these representations contain four kinds of information: a) goals or desired outcomes of the problem solving effort, b) knowledge and objects used in the problem solving effort, c) the procedures or processes used to manipulate or use the knowledge, and d) the constraints placed on the solution. Representations help students categorize the problem, or understand the nature of the problem, and help them generate creative and unique solutions (Bruning, 2004; Paul, 1993; Runco, 1994).

Stage 3 - Selecting an Appropriate Strategy

Students may answer a question through the use of a formula or algorithm. On the other hand, solving problems is much more complex and difficult to learn and requires the use of a series of tasks and thought processes linked together to form a set of heuristics. Educators and authors David Knowlton and David Sharp (2003) defines heuristics, in the context of problem solving, as "experientially derived cognitive 'rules of thumb' that serve as guides in problem solving processes. Heuristics guide problem solvers by helping them simplify choices regarding the numerous immensely complex and imperfectly understood factors that act simultaneously to shape problems" (pg 53). There are numerous heuristic models that can be used to help guide students through the problem solving process, but they are difficult to use and require extensive

instruction. It is important for instructors to keep in mind that the key to problem solving is not finding the answer as much as understanding the process. (Bruning, 2004)

Stage 4 - Implementing the Strategy

Successful implementation of a strategy is dependent upon how well the student has identified and represented the problem and selected an appropriate strategy. Successful problem solvers tend to be more willing to a) change strategies, b) consider more solutions, c) evaluate solutions more carefully, and d) recall workable conclusions. (Bruning et al., 2004).

Stage 5 - Evaluating solutions

There is a positive relationship between self-evaluation and improved learning. Analyzing the product and examining the process are two types of evaluation. When analyzing the product students need to ask themselves if the end result was the best available, how the solution compares to others and are there other solutions that were not considered. When examining the process students should consider how well they did, what they did right or wrong, and how they could improve.

Conclusion

Although there is still controversy about the best strategies for teaching problem solving, it is generally agreed that acquisition of domain specific knowledge is essential to any problem solving effort. If a homeowner opens a water faucet and nothing comes out, efficient use of problem solving strategies will be meaningless without some background knowledge and/or skills pertaining to plumbing and water systems. Improving students' expert knowledge within specific domains is the most important aspect of problem solving. Another important aspect to improving problem solving is

helping students learn how to use a problem solving model. Studies have shown that students' problem solving ability may be improved through the use of a sequential problem solving process. Bruning's five-stage problem solving model provides an outstanding framework to help students learn about problem solving. The most crucial stage of any problem solving model is problem identification or problem finding. Studies have shown that successful problem solving is directly related to the amount of time spent during the initial stages of problem finding. Finally, effective problem solving is directly related to the students' ability to think critically. When students are able to open their minds and think "outside the box", they see things in a different light and will be better able to generate ideas that are unique, novel and creative.

Chapter 3: Methodology

Introduction

The methods and procedures used in this study are explained under the headings of a) subject selection and description of sample, b) instrumentation, c) data collection and d) data analysis.

Subject selection and description of sample

A total of 72 students participated in this research study. These students were enrolled in either Introduction to Woodworking, Intermediate Woodworking and Cabinetmaking, or Advanced Cabinetmaking at Union Grove High School during the 2006-2007 school year. Students were selected because they registered for a woodworking/cabinetmaking class during that academic year. Introductory classes had a large concentration of freshmen and sophomores, intermediate classes were usually sophomores and juniors, and the advanced class was restricted to juniors and seniors. Ninety-two percent of the students were males while 8 % were females.

Instrumentation

Comparative research was used in this study. Experimental research was not an option because students were pre-assigned to groups based on their class schedules for the 2006-2007 school year. Students were given the Test of Everyday Reasoning (TER) for the pre-test and post-test. The TER is a 35 question multiple-choice test designed for use with middle school students, high school students, and adults. The TER targets those reasoning skills regarded to be essential elements for an individual's education and success in everyday life. The items, ranging from simple to

complex, require making a judgment about the choice to select by using skills such as analysis, interpretation, inference, evaluation, and explanation. For example, an item may require proper analysis or interpretation of the meaning of a sentence. Or, an item may require drawing the most reasonable inference from the information provided, evaluating an argument that is presented, or explaining the reason a justification offered for an inference is strong or weak. Some items depend on a person's skills in interpreting and reasoning with the information provided in charts and graphs, a vital part of living and working in the world today.

All the TER items are given in standard English. No technical vocabulary is used. The items are set in everyday contexts and address topics that are familiar to the general population. The only background knowledge assumed is that which is readily achievable through normal maturation and elementary schooling.

Data Collection

All students who participated in woodworking classes at Union Grove High School during the 2006-2007 school year were given consent forms to be signed by their parents and returned during the second week of their respective classes.

Students enrolled in Introduction to Woodworking during first semester were given a pre-test during the ninth week of class and a post-test during the eighteenth week of class. Students enrolled in Introduction to Woodworking during second semester were given a pre-test during the second week of class and a post-test during the eighteenth week of class. Students enrolled in Intermediate Woodworking and Cabinetmaking and Advanced Woodworking and Cabinetmaking were given a Post-test during the eighteenth week of class.

Data Analysis

Test results were calculated using the mean from the total score and five sub-scales (inductive reasoning, deductive reasoning, analysis, inference, and evaluation). Test scores were compared to determine if there had been improvement and if so, the level of improvement, based on three criteria: a) year in school (freshman, sophomore, junior, senior) b) progress through class (second week, ninth week, eighteenth week) c) number of woodworking classes taken (introduction-1, intermediate-2, advanced-3).

Limitations

There were four limitations noted by the researcher, which were:

1) Students could have remembered information from the pre-test that they used on the post-test.

2) There was no control over the sample. Students were grouped based only on class schedule.

3) The study lacked internal validity. It was difficult to tell if improvement between pre–test and post-test was a result of participation in woodworking classes, instruction in another class, or learning outside of school.

4) The study lacked reliability because: a) it was only used for a short time period, b) it was only given to woodworking classes, and c) some test groups had a low number of students.

Chapter 4: Results

Introduction

This first section of this chapter will discuss the demographic information of the test participants, followed by an item analysis. The last section will review each research objective followed by a series of explanations and graphs to illustrate the test results.

Demographic Information

A total of 72 students (22 freshmen, 20 sophomores, 11 juniors, 19 seniors) participated in this study. Ninety-two percent of the participants were males and eight percent were females. All participants were enrolled in one of three woodworking/cabinetmaking classes offered at Union Grove High School in the 2006-2007 school year. All classes were 90 minutes in duration and met five days per week for a total of 18 weeks. The following charts show specific demographic information.

2006-2007 – Semester 1			
Class	Students	School Year	Treatment
Introduction to Woodworking	32 28 male 4 female	20 Freshmen 6 Sophomores 4 Juniors 2 Seniors	Pre-test – week 9 Post-test – week 18
Advanced Woodworking & Cabinetmaking	15 15 male 0 female	0 Freshmen 0 Sophomores 2 Juniors 13 Seniors	Post-test only – week18
2006-2007 – Semester 2			
Class	Students	School Year	Treatment
Introduction to Woodworking	9 6 male 3 female	2 Freshmen 6 Sophomores 1 Junior 0 Seniors	Pre-test – week 2 Post-test – week 18
Intermediate Woodworking & Cabinetmaking	15 14 male 1 female	0 Freshmen 10 Sophomores 2 Juniors 3 Seniors	Post-test only– week 18

There were three Introduction to Woodworking classes. One class was given the Test of Everyday Reasoning (TER) in the second week, and the 18th week and the other two Introduction to Woodworking classes were given the TER in the ninth week and the 18th week. There was one Intermediate Woodworking/Cabinetmaking class and one Advanced Woodworking/Cabinetmaking class. These classes were given the TER in the 18th week only.

Item Analysis

All students took the TER, which was a 35 question multiple choice test designed to target students' general reasoning skills. All 35 questions were classified as inductive or deductive, with each question assigned one of three sub-scales: analysis, inference, or evaluation. Students received a total score and five sub-scores. There were three comparisons made between students using all six scores (total, inductive reasoning, deductive reasoning, analysis, inference, evaluation): a) scores were compared based on students' class in school (freshman, sophomore, junior, senior), b) students' progress through class (second week, ninth week, eighteenth week) and, c) number of woodworking/cabinetmaking classes taken (Introduction – 1, intermediate – 2, advanced – 3).

Research Objectives

This study sought to answer four main objectives. These will be discussed individually:

1. Identify how participation in woodworking and cabinetmaking classes will affect students' problem solving and general reasoning skills.

All students' results were compared, using the mean score, based on their year in school (freshman, sophomore, junior, senior). Results were also compared based on how students progressed through the Introduction to Woodworking class (second week, ninth week, eighteenth week).

Figure 1 shows mean scores for all years (freshmen, sophomore, junior, and senior) from all classes combined (Introduction, Intermediate and Advanced) in the eighteenth week of class.

Figure 1:

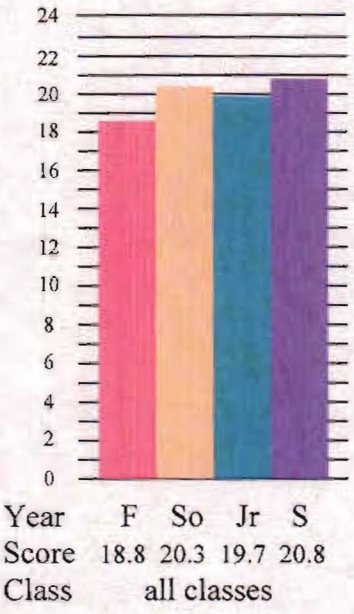


Figure 2 shows mean scores for all students (freshmen, sophomore, junior, and senior) as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 2

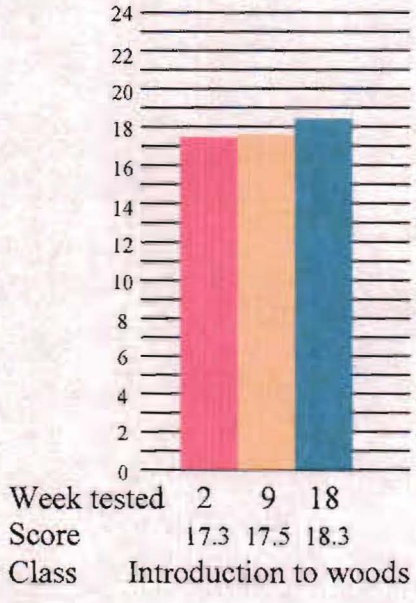


Figure 3 shows mean scores for all freshmen as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 3

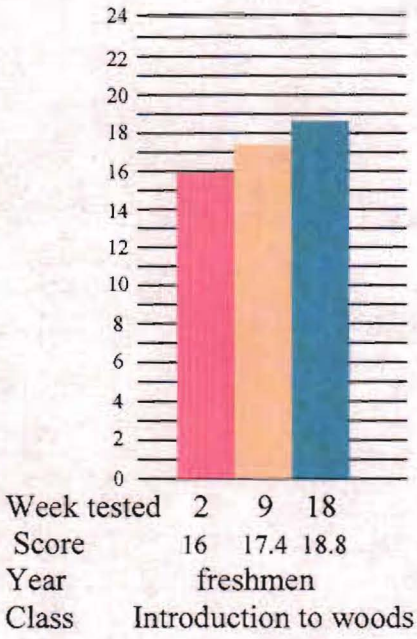


Figure 4 shows mean scores for all sophomores as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 4

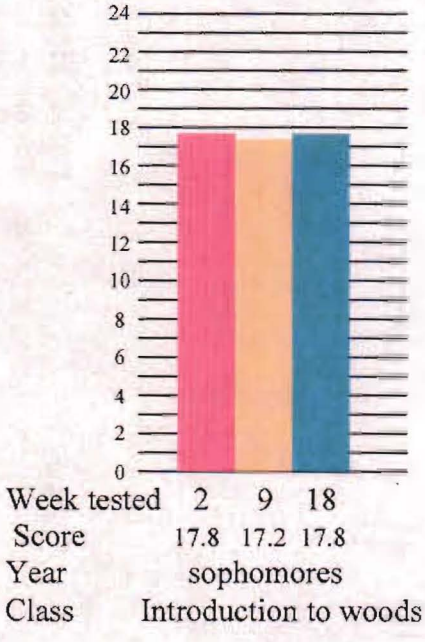


Figure 5 shows mean scores for all juniors as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 5

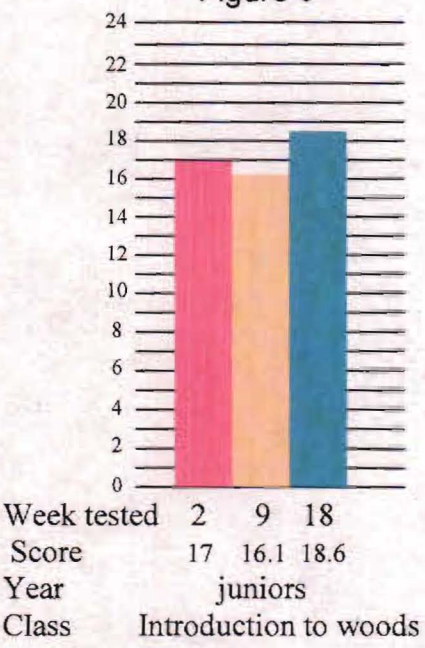
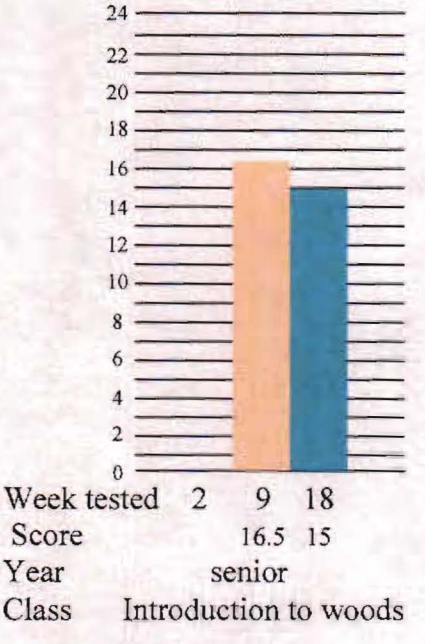


Figure 6 shows mean scores for all seniors as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 6

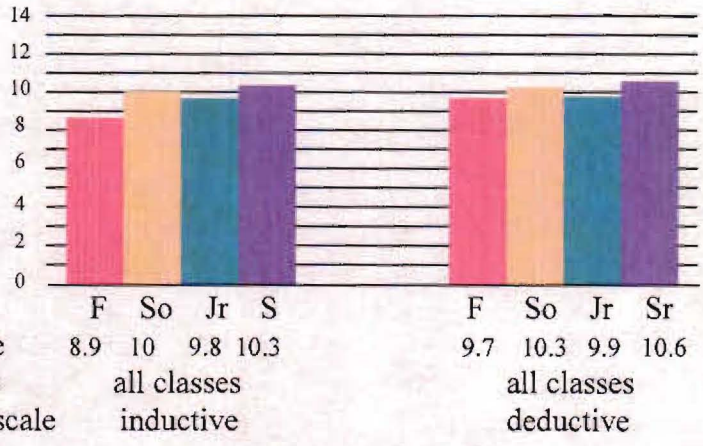


2. Determine if specific sub-scale skills (inductive reasoning, deductive reasoning, analysis, inference, evaluation) improve as a result of participation in woodworking and cabinetmaking classes.

All students' results were compared, using the mean score, based on their year in school (freshman, sophomore, junior, senior). Results were also compared based on how students progressed through the Introduction to Woodworking class. Scores were separated into the five sub-scales (inductive reasoning, deductive reasoning, analysis, inference, and evaluation).

Figure 7 shows mean scores, separated into the five sub-scales, for all years (freshmen, sophomore, junior, and senior) from all classes combined (Introduction, Intermediate and Advanced) in the eighteenth week of class.

Figure 7



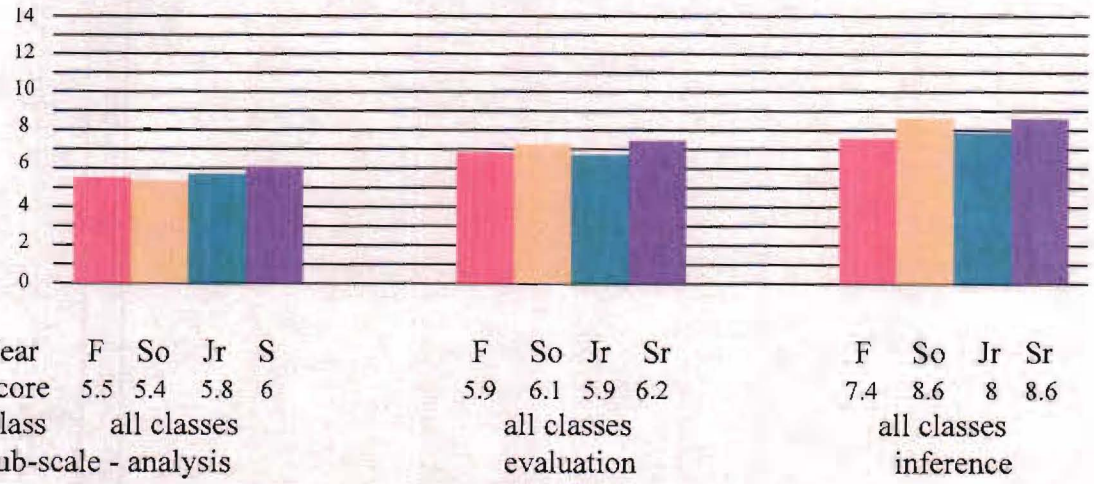


Figure 8 shows mean scores, separated into the five sub-scales, for all years (freshmen, sophomore, junior, and senior) as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 8

Week tested	2	9	18	2	9	18	2	9	18	2	9	18	2	9	18
Score	7.7	8.8	8.9	8.7	8.6	9.4	4.6	4.8	5.3	4.8	5.3	5.7	7	7.3	7.3
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	Introduction to Woodworking														

Figure 9 shows mean scores, separated into the five sub-scales, for all freshmen as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 9

Week tested	2	9	18	2	9	18	2	9	18	2	9	18	2	9	18
Score	7	8.9	8.9	9	8.9	9.9	4	4.9	5.5	4	5.7	5.9	8	7.3	7.4
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	freshmen														

Figure 10 shows mean scores, separated into the five sub-scales, for all sophomores as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 10

Week tested	2	9	18	2	9	18	2	9	18	2	9	18	2	9	18
Score	8.5	9.3	8.7	9.3	7.8	9.2	5.3	5.2	4.9	5.3	4.8	5.5	7.2	7.2	7.4
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	sophomores														

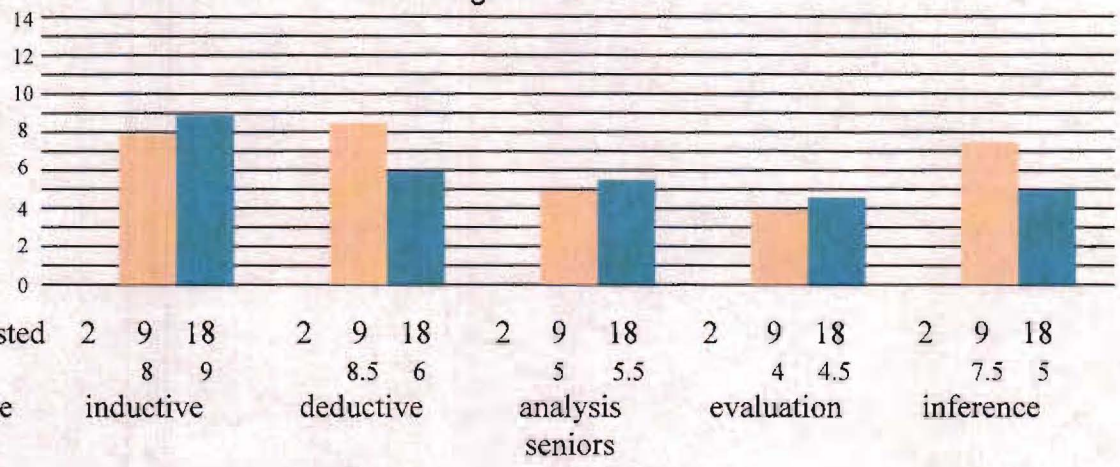
Figure 11 shows mean scores, separated into the five sub-scales, for all juniors as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 11

Week tested	2	9	18	2	9	18	2	9	18	2	9	18	2	9	18
Score	4	8	9	4	8.2	9.6	1	4.3	5.6	3	4.2	5.6	4	7.5	7.4
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	juniors														

Figure 12 shows mean scores, separated into the five sub-scales, for all seniors as they progressed through the Introduction to Woodworking class. Students were tested in the second week, ninth week, and the eighteenth week.

Figure 12



Week tested	2	9	18	2	9	18	2	9	18	2	9	18	2	9	18
Score		8	9		8.5	6		5	5.5		4	4.5		7.5	5
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	seniors														

3. Determine if students' problem solving and general reasoning skills improve if they take higher level woodworking and cabinetmaking classes.

All students' results were compared, using the mean score, based on their year in school (freshman, sophomore, junior, senior) and how many woodworking classes they had taken (introduction - 1, intermediate - 2, advanced - 3). For example, all sophomores who completed one class (Introduction) were compared to all sophomores who completed two classes (Intermediate).

Figure 13 shows mean scores from all years combined (freshmen, sophomore, junior, and senior) based on number of woodworking classes taken (Introduction - 1, Intermediate – 2, Advanced - 3). Students were tested in the eighteenth week of class.

Figure 13

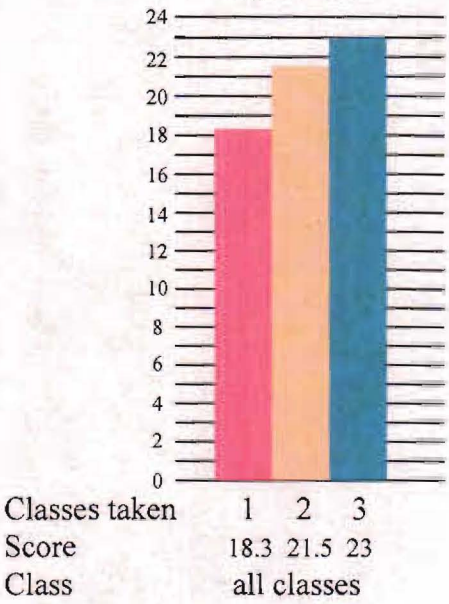
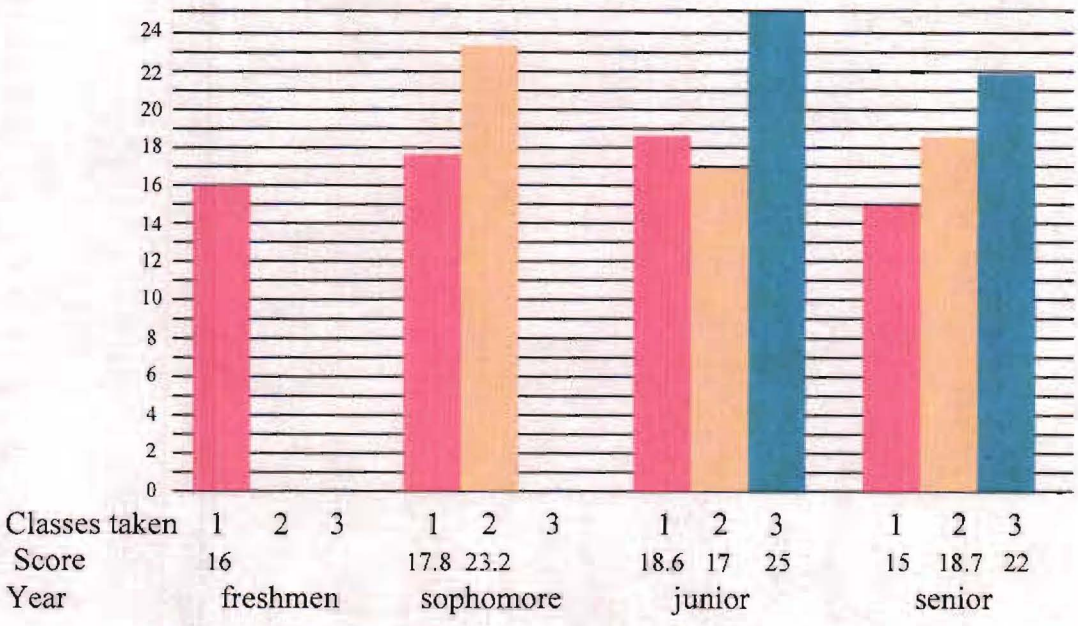


Figure 14 shows mean scores, separated by year in school (freshmen, sophomore, junior, and senior) based on number of woodworking classes taken (Introduction - 1, Intermediate - 2, Advanced - 3). Students were tested in the eighteenth week of class.

Figure 14



4. Determine if specific sub-scale skills (inductive reasoning, deductive reasoning, analysis, inference, evaluation) improve if students take higher level woodworking and cabinetmaking classes.

All students' results were compared, using the mean score, separated by year in school (freshman, sophomore, junior, senior) and how many woodworking classes they had taken (Introduction – 1, Intermediate – 2. Advanced – 3). For example, all sophomores who completed one class (introduction) were compared to all sophomores who completed two classes (intermediate). Scores were separated into the five sub-scales (inductive reasoning, deductive reasoning, analysis, inference, evaluation).

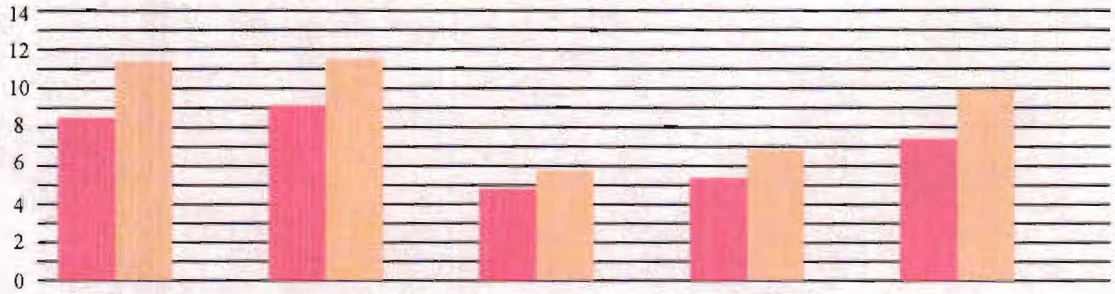
Figure 15 shows mean scores, separated into the five sub-scales, for all students combined (freshmen, sophomore, junior, and senior) based on how many woodworking classes they had taken (Introduction – 1, Intermediate – 2. Advanced – 3). Students were tested in the eighteenth week of class.

Figure 15

Classes taken	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Score	8.8	10.7	11	9.4	10.8	11.6	5.3	5.6	6.4	5.7	6.7	6.4	7.3	8.9	9.7
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	all students at eighteen weeks														

Figure 16 shows mean scores, separated into the five sub-scales, for all sophomores based on how many woodworking classes they had taken (Introduction – 1, Intermediate – 2. Advanced – 3). Students were tested in the eighteenth week of class.

Figure 16



Classes taken	1	2	1	2	1	2	1	2	1	2
Score	8.7	11.5	9.1	11.7	4.9	6.9	5.5	6.9	7.4	10
Sub-scale	inductive		deductive		analysis		evaluation		inference	
Class	all sophomores at eighteen weeks									

Figure 17 shows mean scores, separated into the five sub-scales, for all juniors based on how many woodworking classes they had taken (Introduction – 1, Intermediate – 2. Advanced – 3). Students were tested in the eighteenth week of class.

Figure 17

Classes taken	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Score	9	9.5	12	9.6	7.5	13	5.6	4.5	7.5	5.6	7	5.5	7.4	5.5	12
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	all juniors at eighteen weeks														

Figure 18 shows mean scores, separated into the five sub-scales, for all seniors based on how many woodworking classes they had taken (Introduction – 1, Intermediate – 2. Advanced – 3). Students were tested in the eighteenth week of class.

Figure 18

Classes taken	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Score	9	8.7	10.8	6	10	11.2	5.5	5.3	6.3	4.5	6	6.4	5	7.3	9.3
Sub-scale	inductive			deductive			analysis			evaluation			inference		
Class	all seniors at eighteen weeks														

Chapter 5: Discussion

Introduction

This chapter will discuss the researcher's interpretation of the test results, followed by recommendations as how to improve this study and elaborate on these results for future research.

Conclusion

It would be expected that as students progress through high school their reasoning skills would improve naturally as a result of advanced education and general life experiences. When all students' total mean scores (range=6-32) were compared by year in school, there was only a slight improvement between freshmen and seniors (freshmen – 18.8, sophomores – 20.3, juniors – 19.7, seniors – 20.8). It could be concluded from this study that these students showed only minimal improvement in their general reasoning skills as they progress through high school.

Student progress was tracked through an eighteen week Introduction to Woodworking class. Graph 2 showed a one point improvement between the beginning of the class (17.3 in the second week) and the end of the class (18.3 in the eighteenth week). A one point improvement over one semester would translate into an eight point improvement over the course of an eight semester high school experience. Given that the students in this study only showed a two point difference after eight semesters, a one point improvement after taking a one semester woodworking class is a substantial increase.

Students were compared based on how many woodworking classes they had taken. Graph 13 showed a 4.7 point improvement between students who had

completed one class and students who had completed three classes (one class – 18.3, two classes – 21.5, three classes – 23). These results show a substantial improvement as a result of three semesters of woodworking/cabinetmaking experience.

Students who took more advanced woodworking/cabinetmaking classes had a tendency to be older, so the study compared the scores of students from the same year in school, based on how many classes they had taken. Graph 14 showed improvement in almost every year: a) sophomores, one class – 17.8, sophomores two classes – 23.2, b) juniors, one class – 18.6, juniors two classes – 17, juniors, three classes – 25, c) seniors, one class – 15, seniors two classes – 18.7, seniors, three classes – 22. These results show a substantial increase in results for students who continued to take more advanced woodworking/cabinetmaking classes.

Scores were also calculated based on five sub-scales: a) inductive reasoning, b) deductive reasoning, c) inference, d) evaluation, and e) analysis. Sub-scale scores had a tendency to follow the same pattern as total scores, although there were differences as to which sub-scale score was higher or lower. When mean scores for all students and class combinations were analyzed, results showed the greatest improvement in inference, followed by analysis, inductive reasoning, evaluation, and deductive reasoning.

The purpose of this study was to determine if participation in woodworking/cabinetmaking classes would have an effect on students' general reasoning skills. Based on the results, it can be concluded that students will improve their problem solving skills and general reasoning ability, as a result of participation in woodworking/cabinetmaking classes at Union Grove High School.

Recommendations

If this study were to be replicated, there are a few suggestions that could be considered:

- Run a t-test to check for statistical significance.
- The test at the class mid-point could be eliminated. The tests at the beginning and end of each class were the most beneficial.
- The test should be expanded to include more students, to ensure that each testing group had at least 15 students. Increasing the number of test subjects would add validity to the results.
- Expand the testing to include woodworking/cabinetmaking programs from other schools to determine if the results from this study are consistent with other woodworking/cabinetmaking programs or they are unique to Union Grove High School.
- Expand the testing to include other disciplines within the Trade and Industrial Education area. Compare and contrast scores from students in machine shop, metal fabrication, auto technology, etc. Compare students from technology education programs to students from traditional trade and industrial education programs.
- Expand the testing to include other disciplines within the school. Compare and contrast scores from other elective classes and academic areas. Scores could also be compared based on grade point average (GPA) to see if there is a correlation between GPA and reasoning skills.

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