2007-02-02

Fostering Creativity Through a Nonlinear Approach to Teaching Technology at Wood River Middle School

Warren Edgar Hull
Brigham Young University - Provo

FOSTERING CREATIVITY THROUGH A NONLINEAR APPROACH TO TEACHING TECHNOLOGY EDUCATION AT WOOD RIVER MIDDLE SCHOOL

by

Warren E. Hull

A thesis submitted to the faculty of

Brigham Young University

in partial fulfillment of the requirements for the degree of

Master of Science

School of Technology

Brigham Young University

April 2007

BRIGHAM YOUNG UNIVERSITY

GRADUATE COMMITTEE APPROVAL

of a thesis submitted by

Warren E. Hull

This thesis has been read by each member of the following graduate committee and by majority vote has been found to be satisfactory.

Date	Jared Berrett, Chair
Date	Steven Shumway
Date	Kevin Burr

BRIGHAM YOUNG UNIVERSITY

As chair of the candidate's graduate committee, I have read the thesis of Warren E. Hull in its final form and have found that (1) its format, citations, and bibliographical style are consistent and acceptable and fulfill university and department style requirements; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

Date	Jared Berrett Chair, Graduate Committee

Accepted for the School

Date	Val D. Hawks Director

Accepted for the College

Date	Alan R. Parkinson Dean, Ira A. Fulton College of Engineering and Technology

ABSTRACT

FOSTERING CREATIVITY THROUGH A NONLINEAR APPROACH
TO TEACHING TECHNOLOGY EDUCATION AT
WOOD RIVER MIDDLE SCHOOL

Warren E. Hull
School of Technology
Master of Science

The purpose of this thesis is to address the following research questions: 1) what is the current status of creativity research in a typical classroom, and 2) how does an instance of exemplary teaching serve to encourage creativity in a technology education setting? The first research question is focused on through a thorough review of published literature on creativity in order to frame the second research question. The second research question is addressed by understanding how Mr. Brad Thode, the technology teacher at Wood River Middle School in Hailey, Idaho, encourages his students to be creative. By investigating this one program, it will provide a greater understanding and deeper insight into how to promote creativity in students. Specifically, a phenomenological case study approach is used to investigate Mr. Thode and his nonlinear teaching style and to see how he fosters and promotes creativity in his classroom and among his students. Special attention is given to practices, methods, traits, etc. that have the potential to be replicated or modified for use in other classrooms. Findings are framed in the four generally accepted components of creativity: person, product, process, and press. Results indicate that creativity can be modeled and recommendations for promoting creativity in the classroom are outlined.

ACKNOWLEDGMENTS

Special thanks are in order for my dear, beautiful wife, Marsha, and our wonderful children, Caleb and Hannah. Thank you eternally for your work with organizing my data, your patience with countless late nights without me around, your support in my endeavors, and other sacrifices made by you so this work might be accomplished. I will never be able to fully express in word or deed my gratitude and love for you. Simply, none of this would have been possible without you and your support.

Mom and Dad Hull, Mom and Dad Smith, and my siblings- I cannot begin to convey how blessed I am to have your example and support on every level. Thank you for living in such a way that has taught me how to maintain a happy home throughout all this, and for relationships that have kept my family anchored to sanity.

To Dr. Jared Berrett- mentor, example, and friend. Thank you for your patience with me, your work on my behalf, and those many sacrifices made by you and your great family. Your example has profoundly molded my personality, teaching practices, and philosophies in a positive way.

John and Tierney Smith, thank you for working two jobs and still staying up late to help transcribe data; and for being patient with me through all of this.

Dr. Shumway and Dr. Burr, thanks for your patience with me as a student, and your work and sacrifices on my behalf while serving on my committee.

TABLE OF CONTENTS

Chapter 1: Introduction

Background

As the Information Age edges out the Industrial Age, one can hardly escape the widespread effects of technology. All across the nation computer technology is creeping into schools, influencing the way we conduct business, changing the way we entertain ourselves, and - in light of recent political events - even altering the way we view our civil rights. On a global scale, technology is leveling the playing field of an increasing multinational marketplace. In an effort to keep costs down and production up, some large corporations in the United States look overseas to set up their fabrication plants and factories. Many appliances, clothes, video game consoles and other consumer products bear labels indicating that product was fabricated in a foreign country.

As society becomes more global and technologically dependent, those involved with public education are forced to undergo serious introspection and to look inwardly in an effort to understand how we can better meet the needs of the students and produce a workforce qualified for the future's challenges. In the Secretary's Commission on Achieving Necessary Skills, published by the U.S. Department of Labor, we are informed that "the globalization of commerce and industry and the explosive growth of technology on the job" are changing the terms of young people's entry into the workforce (SCANS, 1991). Schools all over the nation are opening their doors to computers and computer technology. For example:

> The Kittridge Street Elementary School, in Los Angeles, killed its music program last year to hire a technology coordinator; in Mansfield, Massachusetts, administrators dropped proposed teaching positions in art, music, and physical education, and then spent $333,000 on computers; in one Virginia school the art room was turned into a computer laboratory (Oppenheimer, 1997).

The SCANS report also indicates that schools and employers need to do a better job of preparing young people for work and their future. It found that, although good jobs will depend increasingly upon workers that are able to apply their knowledge, over half of the students graduating from high school don't leave armed with the knowledge or the foundation to secure and maintain a good job. "These young people will pay a very high price. They face the bleak prospects of dead-end work interrupted only by periods of unemployment" (SCANS, 1991). Specifically, decisions made today regarding education will largely determine how prepared the students are to hold "high-wage, high-skill jobs that add significant value within the world marketplace" (PCAST, 1997).

If one of the tasks assigned to public education is to develop students who are prepared and competitive in the workforce, then public schools and teachers have an obligation to keep informed about the advances in technology. Teaching the basic skill sets of mathematics, reading and writing remain critical, since there will always be a need for interpreting data, writing persuasively, and being able to keep track of financial gains and expenditures. However, as the United States' economy is influenced more and more by what occurs in other nations, there is a growing need for additional skills, skill sets that are based more on knowledge and one's ability to think and use information than on one's ability to manipulate a tool or operate a machine. Technological literacy is one's ability to learn to use technology, to learn through new technologies, and to learn about new technologies (Berrett, 2003).

Not only is technological literacy a growing necessity, but Pritchett (1996) points out also that in this information economy, changes in technology are so dynamic that one's education simply cannot end upon graduation from high school or even from a university. The need for an individual to be a life-long learner has never been greater, and organizations are taking more and more of an interest in the learning and development of their employees. “To stay competitive in the global job market, we must keep updating our education throughout our entire working lives” (Pritchett, 1996). Cameron (2000) makes it clear that as he interacts with employers on a regular basis, the employers express that they are more interested in the ideas of students and their ability to communicate and willingness to embrace new concepts than they are with the tools that the students know and can use.

There is a cry in industry for creative individuals. Goree goes so far as to suggest that in order “for our country to stay competitive in the international marketplace, we must produce more creative individuals. Society today is asking our schools for future employees who have effective communication, interpersonal relations, and creative problem solving skills” (Goree, 1996). The *Report to the President on the Use of Technology* (PCAST, 1997) supports this claim. In it, creativity is directly mentioned as a necessary competence for tomorrow’s workforce.

Creativity is an important component of this additional skill set that our students need in relation to education and societal growth. As our society grows increasingly complex and the amount of information in our society continues to mushroom, society’s problems require more creative solutions (Cole, et al, 1999). Creativity is emerging and being recognized as invaluable to an organization; and, in some cases, may be critical to a business’s long-term survival (Driver, 2001).

What some see as the “traditional” classroom - with its chalkboard and rows of orderly desks and a teacher lecturing from a book in the front of the room - often times tends to be less nurturing of creativity. Research carried out on encouraging creativity in students indicates that the development of a creative classroom is crucial for students' tendency to be creative (Fleith, 2000), and that after the fourth grade, a child's creativity begins to wane (Ford & Harris, 1992; Cole, et al, 1999; Shaughnessy, 1991; Anarella, 1999). Further research indicates that teachers don't intentionally try to inhibit creativity in their classrooms; they simply fail to *recognize* creativity. In fact, most educators believe that they encourage creative behavior in their classes (Sternberg & Lubart, 1991). Indeed, Fleith (2000) and Dawson (1997) both indicate that - in spite of self-reports indicating they enjoy having creative children in the classroom - teachers' perceptions of creativity and their descriptions of the ideal student don't coincide with behaviors and traits commonly associated with the creative being.

Creativity is a skill set that should become important to society - in action, not merely lip service. If we do not value creativity, the chances of it being encouraged or nurtured are bleak, at best. As more accountability is required from teachers and schools, some teachers focus more of their attention to "teaching to the test," and neglect, or even punish, those behaviors that have been found to promote creative behaviors. The result is that schools may become very short-term oriented, focusing on the next group testing scores, the next evaluation, the next state skills test, etc. Numerous schools place a greater emphasis on academic skills than creative skills (Ford & Harris, 1992). Peer pressure to conform, whether from a student's peers, parents, or teachers, is but one of many factors in our schools sabotaging creativity in education.

There has been much written concerning creativity and the creative process. In light of the literature reviewed for this research, however, there was no definite consensus regarding how creativity is defined (Nierenberg, 1982; Ford & Harris, 1992; Sternberg, 2001; Runco, et al, 1998; Starko, 1995; Sorokin, 1967; Honig, 2000; Perkins, 1988; Eisenberger & Cameron, 1998), and the creative process looks different to different researchers (Martindale, 1989; Isaksen & Treffinger, 1985; Osborn, 1957; Wallace, 1926; MacKinnon, 1978). Without knowing exactly what creativity is or what it looks like "in action," public schools may struggle with inspiring creativity in their classes and students. Few would dispute the need for creativity in the nation's classrooms. How one goes about cultivating and encouraging this trait in the margins of public schools, however, becomes a challenge for all teachers and teacher educators to tackle.

Problem Statement

Technology education is the study of technology designed to help students develop technological literacy, and is in a key position to encourage creativity in students. Curriculum is problem-based, and integrates math, science, and technology principles to further technological literacy (International Technology Education Association, 1995). By its very nature, technology education should encourage students to problem solve and to think critically; skills that often accompany creativity and arguably cannot be separated from it. In a recent case study at Wood River Middle School in Idaho, Berrett (2003) spent roughly four weeks observing students in the school's technology classes, and concluded that technology students were learning skills that "can be transferable to other situations and to their future in life." Some of the skills identified in Berrett's research included problem solving, time management, creativity, and how to be a self-learner.

Berrett documented "…I was impressed with their demonstrated ability to think for themselves, *to think creatively*[italics added], solve problems, and to logically describe what they were doing and why" (p. 12). On Brad Thode, Berrett wrote, "He has been creative, innovative, and progressive throughout his career…" He also cited an article written in a local newspaper, "The secret to the Thode's success is their teaching style. *Creativity is spawned naturally* [italics added] when the Thode's allow children to take ownership of their own learning" (Walworth, 1993).

While there are many studies that have looked at how teachers may foster creativity in students, no disciplined inquiry efforts to discover exactly how exemplary technology education teachers may foster creativity were found. The focus of this research, then, lies in creativity in the technology education classroom. How does Brad Thode, the technology teacher at Wood River Middle School in Hailey, Idaho, encourage his students to be creative?

Purpose and Motivation

The purpose of this study is to address the following research questions: 1) what is the current status of creative research in a classroom, and 2) how does an instance of exemplary teaching serve to encourage creativity in a technology education setting? The first research question is addressed through a thorough review of published literature on creativity, in order to frame the second research question. The second research question is addressed by understanding how Brad Thode, the technology teacher at Wood River Middle School in Hailey, Idaho, encourages his students to be creative. By investigating this one program, we are offered a greater understanding and deeper insight into how to promote creativity in students. Specifically, a phenomenological case study approach was used to investigate Brad Thode and his nonlinear teaching style and see how he fosters and promotes creativity in his classroom and among his students. Special attention will be given to practices, methods, traits, etc. that have the potential to be replicated or modified for use in other classrooms.

Outcomes

One outcome for this study is additional information to the educational field and specifically in the area of technology education. There is a need in this field for more research of substance; and research that provides a deeper understanding of the technology education field, rather than just a look at the surface (Hoepfl, 1997). This thesis is being written in an effort to strengthen the body of knowledge of teaching in the field of technology education. Research on creativity also has the potential to impact and reform education, from educational objectives to the manner in which educators present material in their facilities, from administrative routines and customs to the physical school environment (Fleith, 2000).

It is hopeful that the information disseminated through this study will serve to inform individuals committed to improving education, and offer them a chance to examine their own teaching, administrative, or organizational practices in light of a distinctive technology program. Teachers, teacher educators, administrators, policymakers, members of advisory committees or school boards, and others will be able to reflect on their own situations as they relate to education, and contrast with their own occurrences Mr. Thode's experiences and success in fostering creativity in his students. As more and more information and knowledge on the topic of creativity develops and gets tied in to the classroom, teachers will be better equipped to teach this skill to their students, and students will be better prepared to confront the challenges that lie ahead. Whether these challenges find them in a dynamic, international work environment, in community responsibilities, in a familial setting, or elsewhere, an increased propensity for creativity will serve these students well.

Chapter 2: Review of Literature

Sources for the review of related literature to the topic of creativity were retrieved from electronic data base searches of ERIC, ERIC Document Reproduction Services, Dissertation Abstracts International, the Brigham Young University Harold B. Lee Library in Provo, Utah, and the World Wide Web. Current periodicals and journals were scoured to obtain current data and trends in the classroom and industry as they relate to creativity. Key words used in the data base searches and the Internet searches include: creative, creativity, creative behavior, assessing creativity, creativity tests, creativity assessments, creative process, creative students, creative classrooms, creative teachers, foster creativity, encourage creativity, creative ability, creative skills, and cognitive creativity. From 1960 until 1991 alone, there were almost 9,000 works published on creativity (Runco, Nemiro, & Walberg, 1998). The focus guiding this research has been on what has been written on creativity as it applies to education, students, and understanding creativity in general and in technology. The review of literature emphasizes articles that touched creativity from the following angles: (a) understanding creativity, (b) comprehending four components of creativity, and (c) looking at practices teachers engage in that either encourage or inhibit creativity in the classroom.

Understanding Creativity

What is creativity?

One of the largest challenges facing this research is attempting to "set boundaries" around the term creativity. Typically, people narrowly define creativity as being associated with the arts, such as music, art, or movement (Rodd, 1999). Research makes it clear, however, that creativity reaches much further than the arts. Part of the difficulty in defining and understanding creativity reflects the fact that, as a whole, our society values creativity less than we do intelligence and one's ability to perform well academically, a partiality particularly evidenced in the public schools (Ford & Harris, 1992). This section attempts to bring greater clarity to exactly what is being observed and investigated in this research. What is creativity? Can it be defined and / or described? The review of related literature has yielded numerous and varied definitions of creativity.

The simplest definition of creativity identified was simply put: the sudden cessation of stupidity. Though humorous, this does little to help one grasp the concept of creativeness. Torrance (1963) defined creativity as "the process of sensing problems or gaps in information, forming ideas or hypotheses, testing and modifying these hypotheses, and communicating the results" (p. 4). A few years later (1969), he elaborated:

> Creative behavior occurs in the process of becoming sensitive to or aware of problems, deficiencies, gaps in knowledge, missing elements disharmonies, and so on; bringing together in new relationships available information; defining the difficulty or identifying the missing elements; searching for solutions, making guesses, or formulating hypotheses about the problems or deficiencies; testing and retesting them; perfecting them; and finally communicating the results (p. *vii*; see also Torrance, 1970, p. 1).

Torrance suggests that the preceding definition considers and includes the major aspects of most other definitions. Indeed, most definitions include an element of the production or generation of something new or original. Carter cites Gandini (1992) as identifying creativity as the making of novel thoughts, solutions, or outcomes based on previous experience and learning. Nierenberg (1982) suggests that whenever an individual does something new for himself or herself, that individual is being creative.

Consider Perkins' (1988, p. 311) discussion on creativity: "(a) A creative result is a result both original and appropriate. (b) A creative person - a person with creativity - is a person who fairly routinely produces creative results."

Perkins' definition of creativity introduces a second common element of creativity; the product, no matter what it may be, needs to have some value or a certain level of appropriateness in order to be considered truly creative. Other researchers embrace this idea. "Creative performance refers to novel behavior that meets a standard of quality or utility" (Eisenberger & Cameron, 1998, p. 676). "Creativity refers to the potential to produce novel ideas that are task-appropriate and high in quality" (Sternberg, 2001, p. 360). Most definitions that attempt to encapsulate creativity have in common their weight on the ability people possess to produce products that are novel or original and that are, to some degree, useful or appropriate.

Definitions of creativity centered on originality and usefulness capture only one way of viewing creativity. Starko (1995) suggests that a product or idea is considered creative as long as it has original or novel merit to the individual creator. Honig (2000) set aside the idea that a creative product needs to have utility or needs to meet some standard by suggesting that creativity is associated with fracturing old ideas and drawing new relations, with expanding the limits of intelligence and making sudden and amazing original connections. Sorokin (1967) goes so far as to suggest that only those activities which add something new and positive to "Truth, Goodness, Beauty and to other positive values" can be labeled as creative. Put more concretely, an individual or group is genuinely creative only if their activities actually enrich "science, technology, philosophy, religion, ethics, law, fine arts, economics, politics, language (means of communication) and practical ways of human life" (p. SOR-1A). That is to say, any activity that does *not* accomplish this is uncreative, regardless of what the impact may be on humankind or the world in which we live.

Much of the literature indicates that researchers view creativity more as a process than an entity that can be summed up in a concise definition. Torrance was very clear on his beliefs about creativity being a process (see page 21). Runco's survey of 143 creativity researchers (Runco, et al, 1998) suggests that researchers believe that creativity is "a complex or syndrome which draws from cognitive, affective, social, and perhaps even physical realms" (p. 1). A general consensus among researchers supports the view that the act of creation does not occur as a fixed point in time, but that it is manifested as a process that extends through time, varying in duration (Ford & Harris, 1992).

As early as 1926, Wallas (1926) laid out a seven-step creativity process. (1) Encounter is the stage in which a problem is identified or a challenge is identified to be addressed; (2) Preparation is the information gathering stage, where research is conducted; (3) Concentration is the time-consuming stage wherein effort is expended to solve the problem; (4) Incubation occurs when the individual cannot decide on a course of action. The individual leaves the situation alone, effectively removing him or herself from the situation; (5) Illumination is the stage in which the solution becomes apparent; (6) during verification the individual attempts to prove that he or she has indeed solved the problem recognized in step one; and in (7) Persuasion, the individual attempts to convince others that his or her product or idea solves the problem.

Sternberg (2001) didn't outline specific steps, yet reveals his confidence that creativity is indeed a process, when he wrote:

> Highly creative people decide, among other things, to redefine problems…, analyze their ideas…, attempt to persuade others of the value of their idea rather than expecting others readily to accept them…, take sensible risks…, seek bizarre connections between ideas that others do not seek…, and realize that existing knowledge can be a hindrance as much as it is a help in generating creative ideas (p. 361.)

Osborn (1957) recognized that creativity, as a process, can never be rated scientifically - that it is a dynamic and largely personal process - but outlined seven steps in a creative process that researchers seem to generally accept. He recorded those steps as: 1) Orientation, 2) Preparation, 3) Analysis, 4) Ideation, 5) Incubation, 6) Synthesis, and 7) Evaluation. Martindale (1989) lists four successive stages in the creative: preparation, incubation, illumination, and verification.

Ford and Harris (1992) define creativity as a process: "Creativity is a modifiable, deliberate process that exists to some degree in each of us. It proceeds through an identifiable process and is verified through the uniqueness and utility of the product created" (p. 187.) This definition of creativity introduces an important element not previously addressed in this review. Ford and Harris's idea of creativity proposes that if creativity can be laid out as a process, with identifiable components, then, to some degree, people may *decide* to adopt a more creative attitude and improve their creative performance. Or, looking at it from the other end, creativity may be taught or adopted. Other researchers also have been proponents of this notion (Sternberg, 2001; Torrance, 1970, 1971; Sternberg & Lubart, 1991; Rejskind, 1998).

This view is supported outside the research and educational realms as well. One only has to look at creativity training sessions, seminars, and "entrepreneurship programs" in large corporations such as Kodak, Hewlett-Packard, IBM, Goodyear, and Mead. Even Tom Peters, popular business thinker and management guru, makes a case for creative thinkers and employees in industry, those who are willing to "question accepted views and consider contradictory ones" (2005, p. 147)!

Creativity assessments vs. creativity indicators.

There is research implying that creativity can be evaluated or assessed. This thesis decidedly pays little attention to the assessment measures that have been developed to identify creativity or creative potential. Intelligence measures (such as IQ testing) and scholastic capacity are insufficient in evaluating creative abilities (Torrance, 1963, 1969; Taylor, 1964; Ford & Harris, 1992; Sternberg & Lubart, 1991; Kraft, 2005; Brown, 1989; Starko, 1995). And though it would be convenient, there is no "creativity quotient" as there is an IQ or intelligence quotient (Torrance, 1963). Research on creativity makes a distinction between the type of thinking associated with IQ tests and the type of thinking typically associated with creativity. Associated with intelligence is convergent thinking, which refers to the type of thinking that aims for a single, best or correct solution to a problem. Convergent thinking is quickly associated with conventional intelligence. Divergent thinking is viewed as the cognitive basis of creativity (Cropley, 1999). In contrast to convergent thinking, divergent thinking involves producing new and many possible solutions from the available information.

There are many factors leading to the decision to not discuss assessment measures that have been developed to recognize creativity or creative potential. The most obvious difficulty in assessing creativity is a lack of consensus on what actually constitutes creativity. How can you measure something if you don't know exactly what it is? Or, how can creativity be assessed until research agrees that it can be quantified? Another reason assessing creativity proves to be difficult has to do with creativity being so dynamic and “mysterious.” Does one test for the “creative genius” we see in Einstein and Monet and Michelangelo, or should the focus be on every-day creativity that appears as a normally distributed attribute? Also, Starko (1995) reminds us that researchers continue to disagree on whether “general” creativity can be identified and measured or whether creativity must be subject-specific. Different theories will measure or assess for different variables.

Creative products or ideas are meaningful only in the context of a system that judges it, and what may be deemed as creative in one environment or culture may not be creative in another (Csikszentmihalyi, 1996; Sternberg, 1985; Sternberg & Lubart, 1991). We cannot isolate individuals and their work from their context and expect to understand creativity (Fleith, 2000). Csikszentmihalyi (1996) claims that social recognition or acclaim is necessary for novelty to be labeled as creative. Through his lens, creativity isn’t a characteristic as much as it is an interaction among person, product, and environment. Individuals aren’t creative in a vacuum, but are creative within a domain or field. To assess an individual’s creativity in one setting may prove to be an inaccurate assessment when viewed through a different lens or when viewed in a different setting.

Ford and Harris (1992) also point out that opportunities for creative expression may be unequally distributed within a society. For example, racial minorities, people of low socio-economic status, and women are three groups that show a history of discrimination in many societies. Such discrimination may hinder the production of otherwise creative persons. As a result, administering an instrument aimed at assessing creativity in a typical classroom may produce biased or inaccurate results.

In comparing the development of intelligence testing and creativity-testing, Brown (1989) points out that one of the biggest flaws of creativity tests is that they only *appear* to have construct validity, and definitely have not established criterion validity. Brown outlines several problems that plague creativity research and the examination of developing accurate creativity tests- or, tests that actually measure creative production, including using inappropriate comparison groups, inferring causality from correlations, a prevalence of obscure and cryptic writing, and the use of introspective and retrospective data.

Torrance developed the Torrance Tests of Creative Thinking. Guilford developed tests for eight primary abilities that he theorized underlay creativity, as well as Guilford's Alternative Uses Task. Starkweather developed tests for pre-primary school-aged kids that look for curiosity and originality. Wallach and Kogan developed an assessment of creativity that has participants generate many possible items that contain a specific component, such as things that make noise. Mednick developed the Remote Associates Test. There's the Khatena-Torrance Creative Perception Inventory, the Creative Attitude Survey, Biographical Inventory- Creativity, the Creativity Assessment Packet, the Creative Behavior Inventory, the Creative Reasoning test, and the Group Inventory for Finding Creative Talent. Treffinger (1986) identified over sixty different instruments that he maintains are able to identify creativity. A brief search on the Internet will reveal myriad creativity tests, some with little or no merit, others with more. Today's creativity experts, however, look for certain characteristics that individuals who excel at divergent thinking appear to display instead of using a standardize test or some static, fixed method of assessment (Kraft, 2005). This research identifies such characteristics as "indicators of creativity."

Torrance (1963) suggests that creative abilities involve (1) sensitivity to problems, being able to recognize the challenge and its related difficulties; (2) fluency, or the ability to produce large numbers of solutions; (3) flexibility, the ability to produce a wide variety of ideas or use a variety of approaches; (4) originality, the ability to produce ideas that are off the beaten track or that other people do not produce; (5) elaboration (the ability to fill in the details); and (6) redefinition (define or perceive in a way different from the usual or established, intended way). Kraft (2005) reemphasizes verbatim these same traits, or indicators, of creativity. In a later publication (1969) Torrance includes an abbreviated list of 25 clues that creative behavior is taking place. A few of those clues are: boldness of ideas, tendency to lose awareness of time, self-initiated learning, eagerness to tell others about discoveries, and a habit of guessing and testing outcomes. Rodd (1999) boiled down the previous six indicators to simply: fluency, flexibility, and originality.

Risk-taking is an indicator that creative behavior is occurring (Meador, 1999; Sternberg & Lubart, 1991, 1993, 1996; Starko, 1995). Tackling obstacles is almost a certainty in creative endeavor because most such endeavors threaten or challenge some kind of established and entrenched interest (Sternberg & Lubart, 1991). Creative risk-taking opens an individual to criticism, ridicule or feelings of foolishness, as that individual is willing to think thoughts others are not, or to express ideas that are different (Starko, 1995). Starko (1995) offers other indictors of creativity: perseverance (see also Sternberg & Lubart, 1991), curiosity (see also, Martindale, 1989), finding order in chaos, broad interests (see also, Martindale, 1989), and tolerance for ambiguity (see also Sternberg & Lubart, 1991).

The aim of this research is not to concretely and unequivocally lay out the "correct" meaning of creativity; nor is it to persuade the reader of one idea or philosophy over another. If researchers and experts on the subject cannot agree or come to a general consensus as to what constitutes creativity, certainly it won't be decided in this research. Rather, it is expected that the prior discussion on creativity has served to inform and educate the reader as to current trends and theories, while allowing the reader to develop his or her own theories about what creativity may be and how it may be manifested. The following discussion regarding the four components of creativity will serve as the framework for organizing the collected data and findings of this thesis.

The Four Components of Creativity

Though much of the literature on creativity shows only some accord among researchers, there *is* general accord that creativity falls under the following four categories: a) the creative person, b) the creative product, c) the creative process, and d) the creative press, or, environment (Fleith, 2000; Houtz, 1994; MacKinnon, 1978; Shallcross, 1981, Brown, 1989; Kneller, 1965). Due to this consensus among leading researchers on creativity, particular attention will be given to these four elements. It is through the lens of these four components of creativity that the findings of this study will be explored and organized. To increase our understanding of creativity, the aforementioned categories are examined in detail.

Understanding the creative person.

Though one might wish otherwise, children learn very early in their lives that the behaviors valued by their parents and teachers are *not* the behaviors favorable to exploration, discovery, and creativity; but those behaviors that lead to conformism, passivity, and stereotypy (Alencar, 1989). What are these behaviors that are so often discouraged? What personality traits are exhibited in creative persons? Following are various perspectives offered by different researchers of creativity that describe the creative person.

Through his interactions with painters, musicians, photographers, writers, and actors, Lyman (1989) generated a list of nineteen descriptors that he feels capture the general traits that creative people exhibit. He writes that creative people: 1) are different, 2) are playful, 3) do not play by the rules, 4) are adventurous, 5) have trouble being accurate, punctual, and proper, 6) are funny, 7) are spontaneous, 8) are independent, 9) are sensitive to art and beauty in more than art and beauty, 10) are enthusiastic, idealistic, and responsive, 11) are bold, 12) see things where others do not, 13) take action, 14) push beyond, around, or through the wall, 15) are driven and passionate, 16) aren't content with the obvious, mundane, the mediocre, and the cliché, 17) know when to let go and how to do it, 18) are patient, and 19) don't mind being lost or feeling ambiguous.

Sternberg and Lubart (1993, 1996) describe their "investment theory" of creativity. They describe creative people as willing to buy low and sell high "in the realm of ideas" (1996, p. 683). To "buy low" indicates that an individual will pursue an idea that is unknown or that is not in favor but that has potential for growth. When these ideas are presented to others, they are received poorly and encounter opposition. The creative individual persists in spite of such opposition and resistance, and in due time he or she "sells high," moving on to the next unpopular or new idea. According to this investment perspective of creativity, creativity is the result of a convergence of six resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment.

The confluence of three intellectual abilities is of importance: 1) the synthetic ability to see problems in ways that others do not, 2) the analytic ability to realize which ideas are worth pursuing and which ideas should be let go, and 3) the practical-contextual ability to know how to get others to see the value of one's ideas. Creative individuals are able to think divergently about potential solutions to problems or challenges, and are able to use insight processes (selective encoding, selective comparison, and selective combination) in problem solving or completion of a project.

In the literature, Sternberg and Lubart concede that knowledge - meaning acquired data and facts - is a double-edged sword. Simply holding information in one's head does not qualify an individual as a creative person. On one hand, one cannot move forward in a domain without a useful knowledge of that domain. Knowledge helps one to produce work or ideas that are novel to a particular domain and helps in the production of high quality work. On the other hand, knowledge in a certain field can restrict one's perspective and reduce one's ability to produce novel ideas. One runs the risk of developing a closed mind, resulting in the inability to see beyond the way in which he or she has seen and confronted problems in the past.

An intellectual style of thinking is an inclination to use one's ability in a certain way. A "legislative style" is important to creativity. Said style is defined as "a preference for thinking in novel ways of one's own choosing" (Sternberg & Lubart, 1996, p. 684). A distinction needs to be made; this preference is not the *ability* to think. It is *not* the ability one has, but the propensity to *use* the ability one has.

Sternberg and Lubart point out that research seems to agree that there are a few common and important personality traits for creative functioning. They identify the following as relevant traits: 1) a willingness to tolerate ambiguity, 2) a willingness to take sensible risks, 3) a willingness to overcome obstacles, and 4) a willingness to grow. They also add that the creative personality needs a degree of self-efficacy (1993). In their investment perspective, buying low and selling high means defying the crowd, so that one has to be able to stand up for one's convictions. "In the face of criticism, sometimes there is little but self-esteem to get one through" (1993, p. 11).

Regarding motivation, Sternberg and Lubart note that creative people are task-focused (in contrast to goal-focused) and intrinsically motivated. They point to research that indicates that people rarely produce creative results in a field unless they love what they do and focus on the work at hand rather than the potential compensation. Three specific motivators that are task focusing are: 1) the motivation to achieve excellence, 2) the motivation to self-actualize one's potential, and 3) the motivation to satisfy a desire for intellectual novelty (1993). This is not to say that extrinsic motivation has absolutely no place in the creative process. Motivation can change over time; what one finds boring or tedious today may become interesting and engaging tomorrow.

Starko (1995) adapted from a synthesis generated by the writings of theorists a list of traits associated with creative individuals. She has the traits broken down into cognitive characteristics and personality characteristics, though she acknowledges that the distinction between the two is often murky. The cognitive characteristics are: 1) metaphoric thinking, or, being able to see parallels between unlike ideas, 2) flexibility and skill in decision making, 3) independence in judgment, 4) coping well with novelty, 5) logical thinking skills, 6) visualization, 7) escaping entrenched thinking, and 8) finding order in chaos. The personality characteristics are as follows: 1) willingness to take risks, 2) perseverance, drive, and commitment to task, 3) curiosity, 4) openness to experience, 5) tolerance for ambiguity, 6) broad interests, 7) value originality, 8) intuition and deep emotions, and 9) being internally occupied or withdrawn.

Csikszentmihalyi (1996*b*) offers a rather unique look at the creative person. After years and years of researching how creative people live and work, he uses the word "complexity" to sum up, in a word, what makes the creative personality different from others. Creative individuals "show tendencies of thought and action that in most people are segregated. They contain contradictory extremes; instead of being an 'individual,' each of them is a 'multitude'" (p. 36). He found that various opposing attributes are often present in the creative person, referring to these attributes as "The Ten Dimensions of Complexity." Creative people tend to have a great deal of physical energy, but are also often quiet and at rest. They tend to be smart, but are often naïve at the same time. Creative people are playful and disciplined, or combine responsibility and irresponsibility. The creative person alternates between imagination and fantasy, and a rooted sense of reality. Creative people are introverted and extroverted. They are humble and proud at the same time. Creative people are more likely to have the strengths of both genders. Creative people are both rebellious and conservative. Creative people are passionate about their work, but can also be exceptionally objective about it. Finally, the creative person's openness and sensitivity exposes him or her to pain and suffering, yet also to much enjoyment.

It is important to recognize creative traits in order to encourage and foster them. With so many different characteristics of creativity presented in the literature, one may presume that the traits common to creative persons are ambiguous at best. This is true to some extent, but then again, that's the nature of creativity! It's impossible to generate a concise list of personality characteristics that will describe all creative people. The characteristics of creative people differ from field to field, across domains, and in different environments. This may be seen as a weakness in identifying creative personality traits; however, it may also serve to motivate educators to be more accepting of behaviors that may initially be seen as threatening, disruptive, or unwelcome.

Understanding the creative product.

The majority of explanations of the creative product focus on two main aspects: originality or novelty and appropriateness or usefulness (Starko, 1995; Fleith, 2000; Sternberg, 2001; Eisenberger & Cameron, 1998). To generate a product that is both novel and appropriate generally requires that an individual step outside of the way things are normally done, whether that is physically or mentally. Creative production is unique and new, but it must also serve a meaningful purpose within a specific domain.

Csikszentmihalyi (1996*a*) emphasizes the importance of looking at creativity within a specific domain rather than across all domains. One of the problems we face in trying to understand creativity is that the term as it is typically used covers too much ground; it's too broad. Csikszentmihalyi narrows the definition of the creative product to the following: Creativity is any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one (p. 28). Within each domain, there are individuals who act as gatekeepers to the domain. These experts in a given domain comprise that domain's *field*. Theirs is the task of choosing from among the novelties and deciding which new idea or product should be included in the domain. Starko (1995) brings this idea of novelty into the light of an educational setting, and makes it clear that the adult standard of novelty doesn't apply to children in the same way. A child doesn't have to come up with a product that has never before existed, but with a product that is novel to him or her.

The same holds true with appropriateness. A product may be deemed to be appropriate or useful relative to one's peer group and available source of information. If a student successfully communicates an idea or undertaking to solve a problem, his or her efforts may be considered appropriate. And, if he or she does so in a manner that is original for his or her age group, we may consider the efforts creative (Starko, 1995).

MacKinnon (1978) elaborated a few other criteria for a product to be truly creative. He adds that in addition to being novel and useful, a product must actually be produced. A fully creative product, he argues, must "be sustained, evaluated, elaborated, developed, and communicated to others" (p. 50). There are additional optional criteria that enhance a product's creativity. A fourth criterion, the first optional criterion, is that a creative product should be aesthetically pleasing; the solution must be true and beautiful. The second optional criterion, and one which is rarely achieved, requires that the product create new conditions of human existence, transcending and transforming the generally accepted experience of mankind. Examples of this level of creativeness could include Copernicus' heliocentric theory or Darwin's theory of evolution.

Taylor (1975) singled out five levels of creative production: 1) expressive spontaneity, 2) technical creativity, 3) inventive creativity, 4) innovative creativity, and 5) emergent creativity. *Expressive spontaneity* is concerned with open production with little, if any, significance to the reality of existing knowledge. Examples may be spontaneous finger painting, spontaneous or "free" writing, or delivering an unprepared talk. *Technical creativity* isn't necessarily concerned with novelty, although it does consist of an unusual mastery of knowledge and techniques or skills. In technical creativity we see skill at the expense of expressive spontaneity. The third level in Taylor's taxonomy is *inventive creativity*. There is no novel idea, but there is a new perspective and use of old things. The creative product is seen in the original use of materials; an individual is able to use his or her existing knowledge to move on to new styles. The fourth level of creative production is *innovative creativity*. The product in this level is clearly a result of one's understanding the basic principles and assumptions of a domain. The creative person in this level is able to make further use of, and expand upon, the existing system. The last level is *emergent creativity*. This level is the most complex in Taylor's taxonomy. The creative production in this level is entirely original. It is a result of integrating and assimilating the most intangible principles and postulations.

Understanding the creative process.

Though some would disagree, creative processes can be taught and can be integrated into the classroom (Torrance 1969, 1970, 1971; Ford and Harris, 1992; Sternberg, 2001; Sternberg & Lubart, 1991). The following concepts of the creative process indicate that creativity isn't a trait that is distributed to only a select few from birth. On the contrary, teachers, parents, and other individuals that find themselves in educational responsibilities may carefully teach a student or a child how to act creatively by guiding them through a process. To be sure, creativity will manifest in different ways and in different people, but it may be encouraged and strengthened in us all.

MacKinnon (1978) has categorized the following distinguishable phases or stages in the process: 1) a period of preparation during which one acquires the necessary experiences, cognitive skills and techniques which make it possible for him or her to identify a problem, 2) a period of concentrated effort to solve the problem, which may happen quickly, but more oft than not it involves so much tension, frustration, and discomfort that the individual is led to 3) a period of withdrawal from the problem (commonly referred to as *incubation*), leading to 4) a moment of insight accompanied by the excitement and elation of the restructuring "a-ha" occurrence, and 5) a period of verification, evaluation, elaboration, and application of the insight one has experienced.

One of the earliest attempts to make sense of the creative process was provided by Wallace (1926). As he concluded, the four stages are: Preparation, Incubation, Illumination, and Verification. In *Preparation*, the individual gains a solid understanding of the content area (or, Domain). Csikszentmihalyi (1996*a*) notes that the nature of the domain will influence the amount of time this stage lasts. For example, mathematics and physics are organized relatively tightly, allowing a young person to quickly absorb the rules and start to make an impact on his or her domain. For the same structural reasons, when a novelty is proposed in math or physics, it is immediately recognized and, if practicable, it is accepted. In contrast, it may take a social scientist years or decades to fully assimilate his or her domain; and if he or she does produce a novelty, it takes the field years to assess whether it's important enough to add to the knowledge base. *Incubation* is the time a creative person takes away from the problem he or she is working on. This gives the new ideas time to be filtered, and allows the subconscious to mull them over. The mind takes the generated ideas and juxtaposes them with other seemingly unrelated information, resulting in new combinations of ideas that produce one or more solutions. This is referred to as the *Illumination* stage, or the *A-ha* moment. The last stage is *Verification*. The creative mind tries to make sense of the new solutions spawned from the previous stage. Different ideas for solving the problem are evaluated. These stages may seem to be intangible and too ambiguous to teach, but these stages may be nurtured in a classroom where the teacher gives students time for reflective thinking and opportunities to practice or experience the stages.

Osborn (1957) writes that the creative process "usually includes some or all of" (p. 115) the following phases: 1) *Orientation*- splitting up a problem into specific sub-problems, 2) *Preparation*- gathering pertinent data, 3) *Analysis*- breaking down the relevant material, 4) *Ideation* (used to be *Hypothesis*)- piling up alternatives by way of ideas, 5) *Incubation*- backing off for the purpose of inviting illumination, 6) *Synthesis*- putting together the pieces, and 7) *Evaluation* (used to be *Verification*)- judging the resultant ideas. Osborn makes it clear that the aforementioned steps are presented merely as an aid to assist in the understanding of the several phases of the creative process. The creative person may skip over one or more of the phases. It is noted, however, that orientation and ideation are too frequently overlooked and in need of greater emphasis.

It is noteworthy that the creative processes seem to reflect Bloom's (1956) higher-order thinking: analysis, synthesis, and evaluation. According to Bloom, as an individual progresses from the lower-order levels of thinking (knowledge, comprehension, application) to the higher-order levels, he or she is able to think more complexly and draws closer to true subject mastery. Various classrooms typically don't nurture these higher-order levels of thinking, yet the students need time and opportunities to experience all three. They need experience analyzing situations and problems, looking for and identifying the relationships between the parts and the whole; they need to practice putting these parts together again in novel and unique ways (synthesis)- a key component of the creative process; and they need time for evaluation- for constructing a new product, decision, or value.

The process of the Creative Problem Solving (CPS) model was originally developed by Osborn and Parnes, but has been manipulated and modified by several theorists over the last thirty years. What sets it apart from other descriptors of the creative process is that it was designed to not only describe the creativeness, but to allow people to use it more effectively. Each version of the CPS model features a series of steps that include both divergent and convergent stages. Isaksen and Treffinger (1985) present the CPS model as a basic course. They have three components divided into six particular stages. The three components are: 1) Understanding the Problem, 2) Generating Ideas, and 3) Planning for Action. These components are executed in six stages: 1) Mess-Finding, 2) Data-Finding, 3) Problem-Finding, 4) Idea-Finding, 5) Solution-Finding, and 6) Acceptance-Finding. Each stage begins with the generation of numerous options (divergent thinking), but these options are focused, and only the best options are carried over to the next stage (convergent thinking).

The first stage is *Mess-Finding*. This consists of finding a broad problem or area of concern - evaluating all the "messes" one encounters in one's life - and choosing an area for continued deliberation. *Data-Finding* involves gathering all the information one can as it relates to the mess. This stage used to be called Fact-Finding, but the name didn't reflect the need to gather impressions, opinions, etc. as well as facts. In the third stage, *Problem-Finding*, the most important data from stage two is used. This stage is usually more specific in CPS than in common usage; alternative problem statements are generated using "IWWMW," or, "In what ways might we…" (Starko, 1995). Selecting a broader problem statement will obviously lead to a broader range of possible solutions. In *Idea-Finding*, various ideas are produced for the selected problem statement; and those ideas are evaluated in the fifth stage, *Solution-Finding*. In this stage, different criteria are generated to evaluate each of the proposed ideas. Finally, in *Acceptance-Finding*, plans are made to implement the selected solution. Attempts are made to identify potential difficulties and resources. The result of the last stage is generally a plan of action, complete with resources, responsibilities, and steps clearly delineated.

Understanding the creative press.

As was noted earlier, much of the literature indicates that it is impossible to separate creativity from its context. Csikszentmihalyi (1996*a*) emphasized the importance of social evaluation in determining whether a product or idea is truly novel.

An idea or product needs to be referenced to some standards within a specific domain. Creativity isn't something that happens inside one's head, but is an interaction between the individual and a socio-cultural context. The question he poses is, "*Where* is creativity?" rather than, "What is creativity?" It is the environment that evaluates the creative product (Sternberg & Lubart, 1993).

Dawson (1997) informs the reader that environmental context is recognized as a critical factor in whether or not a child's creative talents will be expressed. As an example, Dawson points out that factors shown to limit or restrict creativity, such as time limits and the presence of rewards, are often present in school environments but lacking in non-school settings, which may account for the tendency some kids have to show higher levels of creativity in non-school situations. "In school, the motivators tend to be goal-focusing ones. Grades, praise from teachers, the desire to please parents, or the desire to appear competent and achieve in front of one's peers are very salient" (Sternberg and Lubart, 1993). The abovementioned motivators are not inherently negative, but they may do more to inhibit than encourage creativity in students.

Sternberg and Lubart (1993) observe that in order for creativity to exist, the environment needs to be supportive and rewarding of creative endeavors. According to their research, the environment affects creativity in three ways: 1) the surroundings may encourage creativity, 2) the environment needs to have an established reward system for creative ideas, and 3) the environment evaluates creative products. Creating such an environment is particularly challenging in a classroom setting; most classrooms are set up to produce children who are "smart", but not necessarily creative.

Csikszentmihalyi (1996*a*) singled out seven elements of the creative school environment: 1) well-prepared and trained teachers, 2) realistic expectations of high performance, 3) materials and intellectual resources, 4) recognition of creative potential, 5) providing opportunities for children to identify their hopes and then exploring them, 6) opportunities for self-direction, and 7) appropriate rewards that encourage intrinsic motivation. Sternberg and Lubart (1991) indicate that the creative environments could be improved if schools let students define problems, put more emphasis on ill-structured rather than well-structured problems, encourage legislative intellectual styles, teach knowledge for use rather than for exams, encourage risk-taking, and place more emphasis on intrinsic motivation rather than motivating through grades.

Driver (2001) advances the idea that there are cultural factors that may do more to nurture creativity than merely giving adequate time for creative thinking and resources to experiment. An organization that wishes to develop a creative environment needs to adopt values, beliefs, and norms that encourage creative behaviors. Specifically, there needs to be a perception of support for creativity (especially at the top of the organization), encouragement of diversity in perspectives, and the freedom to take risks and initiate unofficial activities.

Shaughnessy (1991) advocates that an educational climate conducive to creativity consists of communication, consensus, consistency, clarity, coherence, consideration, community, cohesiveness, commitment, concern, care, and cooperation. Environments that encourage independence, risk-taking, and intrinsic motivation have been found to be most advantageous to creativity (Cole, et al., 1999). Teachers should tolerate dissent, encourage their students to trust their own judgments, emphasize that everyone is capable of creative thoughts or products, and promote creative thinking through brainstorming and modeling.

Shallcross (1981) emphasizes that the creative environment does not equate to chaotic conditions that allow individuals total freedom to express themselves. In a classroom setting, it does not imply total abdication of the role of the teacher as the accountable or responsible person, nor does the creative environment reflect an unstructured, anything-goes situation. On the contrary, creative productivity impresses upon the individual self-discipline, and is most effective when he or she is provided with sufficient structure to feel fundamentally secure. "People are more willing to risk if they know their whole foundation won't be obliterated as a possible consequence" (p. 14).

Shallcross (1981) breaks down the creative classroom into three key factors: the physical, the mental, and the emotional. The *physical climate* needs to provide a setting that affords the kinds of spaces appropriate to different types of activities. She recommends that kids be taught to respect each individual's private space and possessions. She rationalizes that if, in creative behavior, we ask students to take risks and try new things, then we need to guarantee them some privacy while they are in the process of risking. Other physical-climate factors include having areas to display students' work, keeping resources within reach, and allotting kids with a secure place of their own to keep the material on which they are working.

A variety of stimuli are necessary for the *mental climate*. Due to the differences in learning styles and the individuality of learning, this variety will account for the differences to what each student will respond. The mental climate should be challenging but not overwhelming. In fact, early challenges or assignments provided to students should have some measure of built-in success, so that the students may be encouraged to move ahead and confront greater challenges. As students progress, the challenges should become developmentally harder. Teaching students creative problem-solving techniques helps them to develop a positive sense of their mental abilities. Woven throughout the mental climate is flexibility. Flexibility increases an individual's options, thus promoting risk taking; which, in turn, allows students to face increasingly difficult challenges with a sense of excitement and anticipation, rather than trepidation or anxiety.

The teacher that provides all the right measures of physical and mental climates does his or her students a great disservice if he or she doesn't provide an *emotional climate*. The supportive emotional climate affords students the personal refuge and confidence to respond to the other two climates. This security comes from a knowledge that the ground rules established in the class will not be violated. These ground rules assure the students that they can grow at their own rate, that their work will remain private until they are willing to share it, and that they can take pride in their possible differences. It is absolutely essential that an atmosphere of trust be established and maintained, requiring a constant manifestation and reinforcement. Students need to be kept informed constantly of what the agenda is for the class. Honest, prompt feedback is also crucial to developing a healthy emotional climate. Criticism needs to reflect that the *product* is beneath the individual's usual performance or potential ability, not that the *person* isn't worthwhile.

Teacher Practices

Creativity in the classroom and the way it is.

Across the nation, the classroom environment that fosters and nurtures creativity may be the exception to the rule, rather than the norm. Alencar (1989) notes that in most countries, children are brought up in conditions that repress creative potential by a social environment that criticizes or even punishes children for creative behavior. Research indicates that teachers may tend to be autocratic, repressive, and do little to encourage individuality or creativity (Davis, et al, 1999). Many classrooms lack democracy, and students fear their teachers. In many instances, the teacher serves as the “fount of knowledge” and the students are the empty, open containers anxiously awaiting knowledge to be poured in.

The literature suggests (Ford & Harris, 1992; Cole, et al, 1999; Shaughnessy, 1991; Anarella, 1999) that a child’s creative aptitude thrives at about four and a half years of age. Upon entering kindergarten, a drastic decrease is seen. This decrease is followed, however, by a period of slow gain for two or three years. A drop occurs again around the beginning of the fourth grade. This may be attributed to formal education placing too much emphasis on traditional ways of learning and teaching. Shaughnessy (1991) suggests that the following may cause this loss of creativity: too many true-false, multiple choice, etc. tests, an over-reliance on convergent thinking, too much TV and too little creative activities outside of school, mainstreaming, an increase in single-parent families, increasing specialization, an over-reliance on “technique,” teacher overload, underachievement on the part of students, and minimal outside reading. While not all of these factors are controllable, many of Shaughnessy’s ideas seem valid.

Consider the following actualities of a typical school (Manzo, 1998): 1) the problems most in need of creative solutions generally are socially "off limits," therefore problematical to define or convey; 2) most classrooms are set up to transmit existing knowledge, which tends to conflict with the generation of new knowledge; 3) by definition, students are "quasi-ignorant," so it doesn't make sense to invite them to think critically or creatively about what they don't yet fully know about or understand; 4) most teachers have not been educated in a climate conducive to creativity, leaving them unable or unsure of how to encourage or allow creativity; and 5) most current academic tests reward convergent thinking, often excluding divergent thinking. These factors discourage creative and critical thinking.

Dawson's (1997) review of previous research suggests that teachers' descriptions of the ideal pupil seldom include those behaviors indicative of creativity. Rather, teachers value those traits that are not highly correlated with creativity (such as being obedient, being popular with peers, being willing to accept the judgments of authority, etc.) Dawson's review also showed evidence that teachers tend to dislike children who display characteristics of creativity, and in some cases the teachers act toward such children with contempt. Dawson points to Einstein as an example. Einstein's first headmaster concluded that Einstein's choice of occupation was irrelevant, as he would most likely fail at anything he tried to do. In an after-school interview young Einstein had with a science teacher, Einstein was told he was a "bad" influence on the other students, causing them to lose respect for the teacher. The teacher compiled a list of embarrassing questions Albert had posed. Included in this list were questions like: "Why can't we feel the earth move?" "What is space?" and "What keeps the world from flying into pieces as it spins around?" (Torrance, 1970, p. 17).

In light of this, teacher self-reports indicated that teachers liked having creative children in the classroom! Further research was conducted to investigate this contradiction. This additional examination suggested, as did the first, that teachers dislike creative behaviors and traits. Again, another study was undertaken to try and explain the incongruity between the teacher self-reports and the differing evidence. Results from this study indicated that teachers' views of creativity were considerably different than the traditional view. As an example, teachers viewed characteristics such as "sincere" and "responsible" to be among the most typical of creativity, whereas "impulsive," "nonconformist," and "makes up the rules as he or she goes along" were among the least indicative of creativity.

More often than not, teachers don't actively seek to discourage creativity, but merely fail to recognize it (Sternberg and Lubart, 1991). While most educators believe that they encourage creative behavior, Sternberg's and Lubart's analysis of creativity suggests that teachers are as likely to work against the development of creativity than in favor of its promotion. They offer suggestions for schools to implement change; though they admit that for schools to put into practice such ideas it would take a rather deep-seated and underlying revaluation of what schooling is all about.

Fleith's research (2000) on teacher perceptions of creativity in the classroom environment offers teacher-generated descriptors of the classroom environment that inhibits creativity. Teachers who participated in the interviews reported that the classroom climate, the activities, the teacher's attitudes, and the educational system all contribute to restrain creativity. Classroom climate factors included: students believe that they cannot share their ideas; their ideas, when shared, are ignored; mistakes are not tolerated; and one correct answer is required. Examples of activities that can discourage creativity are rote, drill-work and large numbers of worksheets. Controlling teachers was also highlighted as a restraining characteristic of student creativity. Educational traits that were highlighted as inhibiting creativity were: timed testing, structures and schedules, lack of time, and too much curriculum to cover.

In her research, Fleith also asked seven experts on creativity to participate in the study to help establish a theoretical framework. They too were asked to describe a classroom environment in which student creativity is discouraged. They suggested that the following factors serve to restrain creativity: teacher-centered teaching strategies and assignments with a lot of directions; a limited and rigid physical environment that doesn't allow students to participate in a variety of activities nor does it allow for interaction among children; teachers who do not accept student ideas, who expect little creativity from their kids, and who limit their students' choices; an environment of fear; accepting the one, right answer; little acceptance for a variety of students' products; extreme levels of competition; and an overabundance of extrinsic rewards.

Kneller (1965) looks at the obstacles to creativity through the lens of four periods of formal education. In the early childhood years, our culture increasingly tends to shorten the period of play and imagination, "so that by the time the child has developed intellectually to the stage at which he can engage in sound creative thinking he [or she] has come too often to regard his [or her] imagination as an inferior faculty" (p. 74). The child doesn't abandon his or her creativity spontaneously, but does so due to pressure from adults who want the child to think “realistically.” Books and toys become more and more practical and realistic.

In the elementary school period, teachers’ decisions to maintain discipline at the expense of spontaneity and enterprise hinder creativity. Perhaps more so a stumbling block to creativity is pressure of the peer culture. Kneller (1965) describes this pressure as being reinforced by the tendency of teachers to stress harmony of the group rather than the progression of individual students. Overemphasis on gender roles is another strong obstacle in the elementary school years. Since creativity seems to call for both sensitivity and independent thinking (generally thought of as a feminine trait and masculine trait, respectively) it remains important to develop both masculine and feminine traits in both genders.

By the high school years, the pressure of one’s peer group only increases. More now than ever, students are expected to behave according to gender stereotypes. Their work is expected to be submitted on time and accurate rather than original. Emphasis is placed largely on the acquisition of knowledge instead of using or applying knowledge. They may face ridicule or disappointment from parents or peers if they don’t choose from among conventional careers (Kneller, 1965).

In college, students again are discouraged from displaying creativity. The over-emphasis on the attainment of knowledge, rather than an original use of it that students experienced in high school, continues unabated. Curriculum is minutely organized instead of encouraging the discovery of knowledge for oneself. Often teachers and students are estranged from each other. The primary means of teaching is lecture, and there is an over-reliance on textbooks (Kneller, 1965).

Creativity in the classroom and the way it could be.

Torrance (1970) offers numerous suggestions for improving the classroom. He writes that teachers need to respond to the creative needs of the learner. He identifies creative needs as those that lead us to respond constructively to new situations (rather than simply adjust or adapt to new or existing situations). Some of these needs are: the need to be curious, the need to meet challenges and to attempt difficult tasks, the need to give oneself completely to a task, the need to be honest and search for the truth, and the need to be different or to be an individual. Torrance recommends that educators genuinely know their students. Teachers should actively seek to build creative skills and creative-reading skills.

Anarella (1999) points out that teaching creativity incorporates form and structure as well as freedom of thought and expression. It is appropriate to encourage each student with an imaginative and creative impetus with which he or she can create the frame for his or her own life, but to also supply the tools for establishing that frame. In order to create, one must have a plan, structure, and form. Risk-taking is important to developing creativity. Today, however, there is still too much emphasis on the correct answer or question for the students to ask. In allowing questioning, students are given an opportunity to stretch their world.

Cromwell (1993) directly addresses schools and gives recommendations for change. In general, schools need to create environments that promote, support, nurture, and celebrate creativity. They should provide first encounters and ongoing connections with various types of creativity. Schools need to promote risk-taking, imagination expanding activities, and a climate of openness. Teachers and administrators need to create an environment that is structured but not rigid; one that is open to new discoveries, connections, and ideas; respectful of the individual but aware of the communal aspect of being.

Sternberg and Lubart (1991) explain the six resources that children need to be taught in order to develop their creativity: intelligence, knowledge, intellectual style, personality, motivation, and environmental context. Often times, major creative innovations involve redefining an old problem in a new way. In order to *re*define a problem, students need to be given an option to define the problem in the first place. It is rare that schools afford students this luxury. If teachers are to turn schooling around to emphasize creative definition and redefinition of problems, they need to relinquish some of the control they typically maintain to students. Students need to take more responsibility for the problems they choose to solve, and teachers need to take less. Also, to encourage students to think more insightfully, educators need to increase their use of ill-structured problems that will allow for more insightful thinking.

In order to make a contribution to a field of knowledge, one must have knowledge of that field. However, there is difference between knowledge and *usable* knowledge. Memorizing facts and obtaining tidbits of information to simply pass a test or jump through a hoop is a poor objective- for such facts are easily forgotten. Knowledge becomes useable when presented in a context that builds connections to knowledge in other domains or when it is apparent to the learner that such knowledge has relevance in an ever-changing world. Frequently, the context in which students acquire knowledge is far different from the context in which they must use it- in effect rendering their knowledge unavailable. Students generally don't attain knowledge in a way that causes it to be useful to them. In addition, students are not taught in a way that makes it clear to them why the information being presented to them is important. Learners need to be shown why what they are learning should matter to them, or they cannot be expected to retain what they are taught.

Educators need to be aware of the tradeoff that may develop between knowledge and flexibility. There is a danger that with increasing knowledge students will lose creativity by losing the ability to think flexibly about the domain in which they are working. By helping learners acquire useable knowledge, that flexibility is more likely to be maintained. Finally, teachers need to model creativity if they desire such an attribute to evolve in their classes.

Intellectual styles, personality traits, and motivation.

Intellectual styles are the ways in which people choose to use their intelligence as well as their knowledge. Creative students are likely those with a *legislative* tendency. They enjoy formulating problems and creating new systems of rules and new ways of seeing things. The creative student not only has the ability to see things in a new way, but also enjoys doing so.

According to Sternberg and Lubart (1991), creative people share particular personality traits. The common personality attributes are important to long-term creativity. They are: tolerance of ambiguity, willingness to surmount obstacles and persevere, willingness to grow, willingness to take risks, and the courage of one's convictions. Creative students need to realize that a period of ambiguity is the rule, not the exception to the rule, in creative work. Giving students more long-term assignments will allow them to experience this. Confronting obstacles is almost a certainty in creative work because most creative undertakings threaten some sort of established interest. A student that has a creative idea and is able to get others to accept that idea may feel highly rewarded for that idea. It may then become difficult to move onto other ideas. Long-term creativity requires that one be willing to grow- to move beyond his or her first creative idea and even to see problems with what at one time may have seemed to be a superb idea. Schools aren't generally conducive to risk-taking. In contrast, students are as often as not punished for risk-taking behaviors. In addition, many teachers don't model risk-taking behavior. Such teachers are unsure of how to deal with students who take large risks. A common result of this is stereotyped thinking. Schools teach most students to believe in themselves, specifically, those who receive high grades. However, the skills one needs to merit high grades aren't necessarily the same skills one needs to be creative.

Two kinds of motivation are mentioned as being important to creativity: intrinsic motivation and the motivation to excel. Both lead to a focus on tasks rather than on external rewards. Studies show that intrinsic motivation is important to fostering creativity; yet schools motivate mostly through grades- the criterion of success. Students who may have once performed well for love of an intellectual challenge may come to perform just well enough to earn their next A. Motivation to excel is defined as a desire to achieve competence in one or more of one's endeavors. In order for a student to be creative in a particular field, he or she needs to be motivated to *excel*, and not merely to be competent. Experience bears witness that the excellence schools encourage is rarely the excellence needed to achieve *creative* excellence.

Sternberg and Lubart (1991) encourage educators to spark creative ideas, encourage follow-up of creative ideas, and evaluate and reward creative ideas. Teachers need to find ways to encourage creative synthesis of knowledge rather than focus on memorization and a little analysis. They need to find ways to encourage inventing new concepts rather than merely learning about and dealing with existing ones. Teachers should find ways to allow students to follow-up with creative ideas by working around normal requirements to invest additional time into the creative endeavors. Finally, teachers need to find ways to evaluate and reward creativity. Most report cards don't reflect an assessment of creative behaviors or skills.

Sternberg and Lubart's theory of creativity is a "confluence" theory. They acknowledge that the elements of creativity they discuss work interactively together. The implication for schools is that addressing just one or two of the resources they mention will not be sufficient to produce creative thinking or behaviors. One of the greatest stumbling blocks they see to creativity is a view of the "ideal student" that does not particularly feature creativity. They cite research suggesting that teachers value behaviors that don't necessarily lead to creativity, but that allow for greater conformity in the classroom. In order for schools to change, educators and educational environments need to first *value* creativity!

Kneller (1965) recommends that teachers train the mind to think creatively at the same time that it is learning to think logically. Students should be taught to have original ideas. Teachers in all subjects and at all times can accomplish this. If students are urged to think originally, however, than teachers need to be prepared to respect their ideas and compositions. In order to prevent students from going too far with originality, a balance must be struck between mental discipline and mental freedom.

Educators also have a duty to encourage learners to examine new ideas on their merits and not dismiss them as fanciful or without worth. One way to learn to appreciate the new is to be made aware of the crucial gaps in one's present knowledge. Mankind creates knowledge as he explores his environment and proposes hypotheses to explain it. Teachers should emphasize that the more we discover the more we tend to realize how incomplete our knowledge is.

To promote creativity, educators need to occasionally allow spontaneous expression. If a lesson starts to drag, hold a "brainstorming" session. Look for diversity once in a while and forget the criterion of relevance. See what different ideas can be generated- the more numerous the ideas the greater the chance of generating a winner. The more unusual the ideas are the better; it's easier to tone them down than to tone them up. Teachers should encourage students to be fluent in their ideas. Learners should be challenged with provocative ideas. They must value and have confidence in their ideas in order for them to develop creativity.

Teachers can teach students to be puzzled by what other people take for granted, to be sensitive to problems. Teachers should continually try to probe or "unsettle" students by asking, "What would happen if…?" "What would it be like if…?" or "How does this influence…?" Students need to be encouraged to seek out and consider ideas that challenge their current beliefs. They need to be allowed to follow the implications of their ideas or knowledge before their minds are stocked with information their teachers.

Because creativity also involves self-direction, the creative student must be allowed to intuit his or her own ideas, and then be able to verify his or her ideas. "To learn creatively is above all to learn on one's own initiative" (p. 86). The teacher should appreciate and esteem such self-initiated, sustained learning and evaluate it equally with the tasks he or she has set for the students. This also indicates that students be allowed to make some mistakes unsupervised, since they often lead to fruitful insights.

Fleith (2000) writes that the creative environment in an educational setting includes the following components: allowing time for creative thinking; rewarding creative ideas and products; encouraging sensible risks; allowing mistakes; imagining other viewpoints; exploring the environment; questioning assumptions; finding interests and problems; generating multiple hypotheses; focusing on broad ideas rather than specific facts; and thinking about the processes. Cho and Kim (1999) offer the following suggestions for teachers: teachers need to share power and allow children to help plan activities; teachers should show respect for unusual questions, ideas, and solutions (including encouraging risk-taking); teachers should show children that their ideas have value by constructing a non-threatening environment; teacher should fully understand creative activities; teachers need to allow flexible schedules and curricula; and teachers should suspend judgment of children's ideas.

In addition, instead of merely passing on knowledge, teachers should "teach children *how* to think, so that children can learn to make use of information" (Rodd, 1999, p. 351). It isn't the teachers' responsibility to teach their students *everything* they need to know; nor would it be possible to do so. Instead, teachers' fundamental role is to help their students find for themselves what they need to know (Todd & Shinzato, 1999).

Students need to be taught how to learn and think for themselves, and discouraged from being "spoon-fed" information to be regurgitated later on a test.

Peterson and Harrison (2005) listed several important attributes important to the development of creativity in the technology classroom. The excitement of *challenge*, they impose, is at the heart of a creative classroom. Challenges motivate students to succeed, and often lead them to focus on the task rather than the potential reward. The creative classroom makes available *resources* for students to use. This includes not only knowledge and information, but also tools, materials, and time. The physical classroom *environment* can also impact students positively and inspire creativity. "Scores on creativity tests are affected by the types of stimuli to which students respond" Starko, 1995, p. 324). Peterson and Harrison point to Starko's synthesis of research that indicates that students are more likely to generate fluent responses in an environment that is stimulus-rich rather than stimulus-poor. Recognizing, rewarding, and encouraging creativity comprise an *atmosphere* wherein students can develop their own creativity. They need to be open to new ideas and help each other to be creative. Diversity needs to be encouraged. *Technology of creativity* allows students to develop a problem solution that is original and useful. Such technology includes the use of proven tools (such as brainstorming) within the context of a creative problem-solving model in order to form effective resolutions to practical problems. Finally, it is important that all these attributes be found within a greater *educational environment* that supports and fosters creative ideas and behaviors. Other teachers, administrators, parents, and even the community need to encourage and recognize and reward the creative efforts of students.

Cole, Sugioka, and Yamagata-Lynch (1999) conducted a qualitative study that investigated a supportive classroom environment for developing student creativity. The results of that study showed four areas as important characteristics of the supportive environment for fostering creativity: 1) personal teacher-student relationship, 2) assessment, 3) openness and freedom of choice, and 4) classroom activities. The instructor of the classroom under scrutiny placed a heavy emphasis on establishing a *personal relationship* with students. The instructor viewed his role in supporting creativity as being an audience for students and giving them feedback, rather than as an authority figure on creativity. The instructor also relied on non-standardized methods of *assessment*. Assessment was determined by the students' creative solution to the problem, how well the students executed the solution, how much work the students put into the assignment, and the students' written analysis of their creative process. Learning was portrayed as an ongoing process. The instructor encouraged *independence and freedom of choice*; and promoted a diversity of ideas, reminding students in his class often that there was no one right answer. One method he used to accomplish this was to integrate choices into each assignment while maintaining a degree of guidance through outlining basic requirements. Finally, the instructor gave instruction in creative processes such as divergent and convergent thinking. *Classroom activities* used to encourage creativity in students included brainstorming, thumbnail sketches, matrixes, and working in small groups. He also promoted convergent thinking by encouraging students to engage in research before beginning divergent thinking.

When one looks at creativity in the classroom, there is a perceptible gap between "they way things are" and "the way things could be." Certainly, however, this doesn't hold true for literally *every* classroom across the nation! This review of literature has highlighted what occurs in many classes and why such practices serve to stifle rather than support creativity. It has also drawn attention to certain methods or practices that would function to aid students in developing creativity and thinking more creatively. Each one of these methods and practices falls under one of the four components of creativity: person, product, process, and press. As mentioned earlier in the chapter, these four main elements of creativity will serve as the framework for the findings presented in chapter four.

Chapter 3: Methodology

Research Design

Through this study, an in-depth look at creativity in Mr. Brad Thode's technology program at Wood River Middle School in the Blaine County School District takes place. The selection of a technology education program was made based on the background and interest of the researcher. The choice of this specific technology program was chosen for the following reasons: (a) Previous on-site visits had been carried out prior to this research, (b) The technology program at Wood River Middle School was accessible and the teacher was willing to allow the study to be conducted, and (c) The program was identified as "exemplary" and as one where the students were thinking creatively by Berrett (2003) in his case study of the same program. Such identification was made after looking at the "track record of innovation and success" of the program; speaking with numerous leaders and professionals in the technology education field; searching out award-winning technology education programs and investigating which were most exemplary; and finally visiting the Wood River Middle School technology program.

As noted earlier, this study uses a phenomenological case study approach. The primary data were collected over a period of three days. The first day was spent gathering data via field notes and non-participant observations. Day Two included observations, field notes, and semi-formal interviews with Mr. Thode and his equally capable teaching partner, Mr. Walrath. Additional data was accumulated on Day Three through administration of written student questionnaires. Photographs of the technology lab and classroom were taken intermittently during the three days. At the end of each day the observations were typed and reviewed, and the interviews with Mr. Thode and Mr.

Walrath were transcribed within one week of the case study's end. Secondary data collected during Berrett's initial research were significant in completing this study.

In order to carry out this study, qualitative methods were employed. Denzin and Lincoln define qualitative research as "a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible" (2000, p.3). All qualitative research is based upon the philosophical assumption that reality is constructed by individuals interacting with their social worlds. Qualitative researchers, then, are interested in making sense of the meaning the research subjects have constructed; or, how they make sense of their world and the experiences they have therein (Merriam, 1998).

The chief focus of qualitative research studies is to increase understanding of a social setting or activity as viewed from the point of view of the research participants (Gay & Airasian, 2003). We learn from Gay and Airasian that qualitative research is guided by five general characteristics that most types of qualitative studies typify. First, the sources of data are real-world situations, and the researcher spends his or her time in the natural non-manipulated setting. Second, qualitative research data are descriptive and present themselves in the form of field notes, interviews, observation records, etc. Third, qualitative research emphasizes a holistic approach and focuses on the processes as well as on the final outcome. Fourth, qualitative data are analyzed inductively and patterns and relationships are allowed to emerge from observing or collecting multiple instances. Finally, the researcher strives to describe meaning of the finding from the perspective of the research participants, not of him or herself (2003).

Qualitative researchers traditionally employ different methodologies to approach different goals or objectives. This study follows a case study approach, which focuses on "the characteristics of a single person or phenomenon" and seeks to understand a single person or an entity (Gay & Airasian, 2003, p. 169). The single most defining characteristic of case study research lies in delimiting the object of study, the case. This idea that the phenomenon under investigation has limitations or can be "fenced in" has been labeled as a phenomenon that occurs in a "bounded context" (Miles & Huberman, 1994). The case study method "allows investigators to retain the holistic and meaningful characteristics of real-life events" (Yin, 2003, p. 93). The research focuses on Mr. Thode and his technology program, taking into consideration his teaching practices and interactions with his students, and the physical environment in which he teaches. It is anticipated that the data generated from this research will offer additional understanding of how to encourage and foster creativity in the classroom. This is the "bounded context" for this study.

Also influential to this research and data collection is a phenomenological approach. Phenomenology was developed as a method to enable "a clear and unbiased study of human consciousness and experience" (Cross, 2003). Edmund Husserl, father of phenomenology, hoped to remove the outside observer from interpreting human experience; thus giving researchers the chance to ascertain the essential elements of a subject's experiences as they occur. Phenomenology attempts to "produce clear, precise and systematic descriptions of the meaning that constitutes the activity of consciousness ... how objects are present to the various modes of conscious experience and how meaning presents itself in experience" (Polkinghorne, 1989, p. 45).

Stated in other words, phenomenological inquiry has a goal of developing an illuminative understanding of an experience (Garza, 2006). Commonly, conducting interviews and scrutinizing and evaluating the typed transcriptions form the backbone of phenomenological research (Cross, et. al., 2003). Understanding the environment at the technology program at Wood River Middle School and the phenomenon experienced by the students and Mr. Thode is important to this research. Though this study is neither a full-blown case study nor a phenomenology, it relies heavily on both of these research traditions to create a disciplined method of understanding creativity in Mr. Brad Thode's classroom.

Inquiry Methods

The use of multiple methods of data collection that are humanistic and interactive is common in qualitative research (Creswell, 2003). In mixed-method research, the researcher utilizes qualitative research methods alongside quantitative research methods for different reasons. The researcher may seek to offset the limitations of one method of research with the other method, may seek to increase validity, or may wish to provide a richer, well-rounded description of the phenomenon. This research doesn't use mixed *methods* of data collection, but uses *multiple* methods of gathering data. Labeled "within-method triangulation" (as opposed to "between-method triangulation" which occurs across quantitative research methods and qualitative research methods) (Jick, 1979), the idea is to use more than one qualitative method of data gathering to capture the phenomenon with greater internal consistency or reliability. This is also called triangulation, and uses the analogy of military strategy navigation to use multiple reference points to locate an object's precise location (Jick, 1979). One basic, underlying assumption is that the weaknesses of each method will be compensated by the strengths of the others. Another important supposition of triangulation is that it allows the researcher to find multiple sources of knowledge formation that corroborate the evidence being presented. Information for this study was gathered using a balance of observations, field notes, interviews, a student questionnaire that was completed by four of Mr. Thode's technology classes, and utilizing data from Berrett's initial research.

Understanding through observations.

Observations were used in the research to provide a lens through which the reader is able to understand the setting and context of Mr. Thode's classroom, teaching strategies, and technology lab. These observations were initially to be non-participant observations, however it became necessary to interact with the students and instructors in order to gather additional information through formal and informal interviews (see *Interviews* below). As a non-participant observer, the researcher spends time in the field with the participants to generate data, but does not extensively interact or interfere with the participants or the behaviors under observation. The observations capture the interactions between the students and the teachers, Mr. Thode and Mr. Walrath, and capture the interactions of the teachers and the students with their environment. The evidence gathered through direct observation may prove useful in offering additional information about the classroom and how creativity is being developed. The emphasis is on understanding the natural environment as experienced by Mr. Thode and his students, with no intent on the part of the researcher to change or influence that environment (Gay & Airasian, 2003).

Recording field notes.

Detailed descriptions of the observations were recorded as field notes. Containing both "emic data" (describing what is seen or heard) and "etic data" (describing the researcher's thoughts or ideas about the description), field notes were handwritten daily during the normal school hours, and typed up each night for later analysis. Critical to the research, the field notes were analyzed to build the framework that helps depict and make sense of the case and the research participants. The field notes provide a rich description of Mr. Thode and Mr. Walrath's interactions with the students, the students' interactions with their peers, the teaching methods employed by Mr. Thode, and the interactions of the students with the technology lab. They note what occurred and are supported by reflective notes wherein personal thoughts were recorded.

Conducting interviews.

Two types of interviews were conducted during the course of this research, informal interviews and formal, or structured, interviews. Informal interviews are largely unstructured, wherein the questions are prompted by the flow of the conversation. According to Merriam (1998) these interviews follow no predetermined set of questions and the interview by its nature is exploratory. These types of interviews were held as I spent time in the classroom and technology lab and wanted to understand how the students made sense of their own experiences as they related to creativity in Mr. Thode's classes. Students were asked questions related to the projects they were currently working on as well as their attitudes and thoughts on some of the structure of the tech class in which they were enrolled.

Also, two formal interviews were held with Mr. Thode and Mr. Walrath. The format remained somewhat flexible, allowing the conversation to flow smoothly; but both interviews were guided by questions that had been predetermined and typed out. Both formal interviews were recorded via digital recorder and transcribed within a week of the interview. Transcripts from both interviews were compared with student questionnaires to identify emergent or divergent themes and used to address the research question.

Administering a questionnaire.

A short questionnaire was developed based on the four components of creativity (person, product, press, and press) and administered to students in four of Mr. Thode's classes including: NASA Tech class, two of his 6th grade Tech classes, and an Advanced Tech class. Student participation in the questionnaire was completely voluntary; and student rights were protected and anonymity was guaranteed. Questionnaires were identified and organized only by class period. The focus of the questionnaire was to gain a deeper understanding and insight into the student's own personal perceptions of creativity and to try and comprehend how they viewed their class through a lens of creativity. The questions were formed based on the theory of creativity through which the data were filtered in the research.

Taking photographs.

A handful of photographs are also included (see Appendix) to provide the reader a visual concept of the environment in which Mr. Thode works and teaches. Creswell (2003) points out that one use of audiovisual materials, such as photographs, is to provide an opportunity for "reality" to be shared, as experienced by participants. "Photography can produce data that enlarge our understanding," including "the formation of one's own definition of the situation" (Denzin & Lincoln, 2003, p. 191). By viewing the photos, the reader will be able to paint a more accurate mental picture of the tech lab and classroom and more correctly make connections with the research provided here.

Analyzing secondary data.

Existing data from the initial 25 days of in-class observation in Berrett's original study were available and extremely useful in this study. The data were reviewed and analyzed over a period of several months. Student surveys from three different classes (Tech I, Tech II, and Advanced Tech) were reviewed and instances of the four components of creativity were identified. There were 77 returned student surveys and 119 sound instances. Audio interviews with Mr. Thode, the Wood River Middle School Principal, and others were also examined for pertinent information. Additional information regarding Mr. Thode's nonlinear teaching method was culled from Berrett's dissertation.

Threats to Validity

Internal validity deals with the issue of how research findings are congruent with reality (Merriam). External validity is concerned with how findings can be applied to other situations; or, whether or not a study's findings can be accurately generalized (Yin). Much has been written on validity as it applies to qualitative research, and it is important to note that the aim and intent of this particular study is simple: increased understanding. This is consistent with the underlying philosophical assumptions of qualitative research, that reality is "holistic, multidimensional and ever-changing" (Merriam, p. 202), and that what is being observed and recorded is merely how the research participants understand the world. This study was conducted to assist the researcher in trying to understand creativity in technology education generally speaking; however, creativity is an extensive and complex topic for research. By understanding more wholly one outstanding instance of creativity being fostered in a classroom and comparing and contrasting that instance with the researcher's lived experiences in the classroom, a stronger comprehension and awareness of creativity will form. Similarly, the reader (with his or her own interpretations of the findings presented and his or her own lived experiences) will be able to draw inferences and make generalizations.

The primary threat to this research is bias of the researcher. Every researcher views his or her world through the lens of his or her lived experiences; this is inescapable. In an effort to counter researcher bias as data is interpreted or analyzed, thick description and within-method triangulation are employed. Multiple methods of data collection were used. A secondary threat to the research was the limited time spent in direct observation at the Wood River Middle School. This was addressed by triangulating the data gathered during my time at the middle school with the 25 days' worth of data collected for Berrett's dissertation. Another unique threat to validity is the choice to pattern this research after a case study tradition and a phenomenology tradition. To some, fusing the two research traditions together may weaken the overall integrity of this study; however, after reviewing both methodologies, it was the author's opinion that drawing from the strengths of both research methodologies served to better meet the needs of the study overall.

Among other threats to validity, Campbell discusses the Guinea Pig Effect and interviewer effects (Campbell, 2001). The technology program at Wood River Middle School is accustomed to receiving visits from the press, student teachers, and over one hundred visitors each year who are interested in the unique program. Mr. Thode and Mr. Walrath have been interviewed multiple times by local and other newspapers, as well as by other individuals. The threats to validity caused by these effects are minimal in this case study.

Chapter 4: Findings

Home to several ski resorts and named for the Big Wood River flowing through the region, the Wood River Valley refers to a region in Idaho referring including resort communities of Hailey, Ketchum, and Sun Valley. With peaks soaring up to 9,200 feet high, the southern edges of the Sawtooth National Forest and Challis National Forest enclose the resort area. Catering to a more affluent crowd, Sun Valley offers myriad activities, such as fly fishing, skiing, dog mushing, ice skating, hiking, white-water rafting, skateboarding, biking, or enjoying a horse-drawn sleigh ride. Sun Valley has one of the largest tax bases in Idaho; however, Hailey is known as a suburban community to Sun Valley because many of those who work to support Sun Valley's economy can't afford to live there. As the feeder town to Sun Valley and Ketchum, Hailey is home to a diverse ethnic and socioeconomic populace. The only middle school in the Blaine County School District, Wood River Middle School was constructed in 1996 and is nestled on the north side of Hailey.

The Creative Person

Mr. Thode's background.

Walking briskly towards the back door to greet us, Mr. Brad Thode (see Appendix, Photograph 1) stopped short as he crossed paths with one of his students. She looked too old to be anything less than one of his advanced students. With a wily smile hiding behind his neatly trimmed beard he asked, "Would you like a drink?" He held out a Styrofoam cup. Erin reached out to accept his offer, then rolled her eyes upon realizing that the bottom of the cup had been cut out. "It's for tomorrow's demonstration on superconductivity," Mr. Thode chuckled, apparently pleased with himself.

Turning towards us he proudly stated, "One of my best NASA Tech students." Mr. Thode motioned for us to follow him to an appropriate location where we could securely drop off our equipment. Turning over his shoulder to Erin, he asked, "Are you coming?"

"Sure!" she answered.

"Cost you five bucks!"

"Whatever, Mr. Thode."

"Okay… four bucks," he shot back. Erin smiled and shook her head as she followed behind us.

In attempting to discover how Mr. Thode is encouraging creativity within his classroom and in his students, it is critical that one takes a closer look at Mr. Thode himself. Having been at Wood River Middle School previously, I was accustomed to his personality. In over thirty years of teaching in public education, Mr. Thode has developed a thriving program, bustling with students and technology projects and assignments. Mr. Thode is a successful balance of humor and work, of play and business. He is able to laugh at (or tell) a good joke, and then just as quickly deliver instructions and fully expect that his students go and get their work done.

Previous research published about Mr. Thode and his program and teaching methods indicates that the students enrolled in Mr. Thode's classes overwhelmingly enjoy his classes and the activities in which they participated (Berrett, 2003). Following are some of the phrases recorded by students in Mr. Thode's different classes. Student responses were overwhelmingly positive: "If you don't get something, he will explain it;" "…we get to try things out;" "I like the way he teaches because he makes it fun;" "He does hands-on teaching;" "…although Tech is challenging, for me it is also a lot of fun;" "He knows when to teach you and when to let you find out things for yourself;" "…he makes it a fun class and teaches at the same time;" "He treats us like people rather than… stupid little children like some of the other teachers." The list of positive feedback regarding Mr. Thode and his classes is extensive. To be non-discriminatory, there is a small number of students that didn't have such an optimistic experience. Two common grievances among them were Mr. Thode's firmness and his habit of being a stickler for correct grammar.

Mr. Thode has been awarded Teacher of the Year awards from various national, state, and local institutions; and has been the recipient of awards from Apple, IBM, and other large organizations. He has served on committees for NASA, NSTA and NSF, and is the president of a high-tech start-up company. He has carried out technology seminars in over half of the nation's fifty states, presenting at more than fourteen universities and colleges, numerous conference presentations, and conducting seminars for many state technology organizations. He served on the International Technology Education Association (ITEA) advisory council and was the president of Idaho State's ITEA association, and has authored more than five textbooks dealing with teaching technology.

Similar to its instructor and creator, the Wood River Middle School Technology Education Program is also dynamic and hard to take in. In a very literal way Mr. Thode has dedicated countless hours to develop and advance this program. The ITEA awarded Mr. Thode's technology program the Program of the Year in the late 1980's. Again, in the mid-1990's, his program was awarded the ITEA's Award of Distinction. On average, Mr. Thode's program receives over one hundred visitors each year. His classroom and various labs are equipped with state-of-the-art technologies, largely funded through donations and grant monies that Mr. Thode vigorously pursues. The data for this research was gathered as Mr. Thode's career is waning, but after more than three decades of teaching and building a phenomenal program, he is still incredibly innovative and visionary when it comes to education in general and his technology program specifically (see Appendix).

Mr. Thode's current philosophies.

In our formal interview Mr. Thode's passion for education was more than evident. He was quick to point out that our system of education is "an ancient system based on farm societies… and it needs to be looked at again." Thode's passion for education, this motivation for being a change agent in education, stems largely from his own educational experiences growing up. For example, in our interview Mr. Thode related that when he was in middle school, semi-conductors were being developed. This was the beginning of the computer chip era, and our society changed in a very dramatic way. He recounted, "Not one of my teachers knew anything about it or bothered to tell any of the students about it. And one of the reasons I became a teacher is because that quite frankly pissed me off…" He went on to express that it wasn't until he was in college that he learned about semi-conductors. "And now there are super-conductors; and it turns out that super-conductors have been around since the early 1800's but people didn't bother to teach about it," he said.

This feeling - this *frustration* - expressed in the interview, prompted him to go into education. This is what gives Mr. Thode the mindset that educators should "give students the facts as they stand today and give them a challenge of, 'Now, how are you going to apply this? What could it mean? What could it mean in the future?'" Give them a challenge. After more than thirty years of teaching, Mr. Thode continues to challenge his students and provide them with opportunities to *think* for themselves and draw connections between the content they pick up in their various classes.

He openly admits that his somewhat deviating philosophies regarding education have gotten him into trouble with different teachers of various content areas. "Why do we spend six weeks or more out of the year having students study poetry? …we're making students study something that is pretty much just a special interest of the language arts teacher; and I guess you could fall to the technology teacher and say, 'Well, your special interest is video or audio production,' or something like that; but how many of the students going out of school are going to end up being poets and how many are going to end up in the communications industry… so you can justify it only to a certain degree." Mr. Thode views education partially through the perspective of running a business; there are certain things that are nice-to-know ("Many people pragmatically looking at it would call it 'fluff.'") and there are certain things that are need-to-know.

Mr. Thode as a teacher.

Mr. Thode never misses an opportunity to teach. From the moment he unlocks the doors to his tech facilities to the moment the last student heads home, he is teaching and explaining and pointing out little facts and tidbits of information. One of the lectures Mr. Thode delivered while the research for this study was being collected was based on superconductivity.

The little table toward the front of the classroom was cluttered with various items needed for the lecture (see Appendix, Photograph 2): a handful of *balloons, a banana, a spool of wire, Styrofoam cups, earth magnets, Mr. Thode's mug of tea, a ceramic insulator, clear tape, a special flask containing liquid nitrogen, and a sign with "Please Do Not Touch" written in bold, red letters. Nearby, a small, digital camcorder rested on a tripod aimed at the demonstration table. Mounted on the wall behind the table, a large television projected the camcorder's image so the entire class could clearly see what transpired during the demonstration. Curious about the odd-looking flask of liquid nitrogen, Oscar raised his hand and inquired, "How did you make it?" "I didn't make it. I bought it," Mr. Thode responded. "But you ask a really good question. They make it by…" Mr. Thode went on to teach the class about boiling points of different gasses and how scientists are able to separate the different gasses at their boiling points.*

The discussion about gasses and their boiling points wasn't addressed in all of the classes. Mr. Thode saw an opportunity to teach and adjusted his lecture and demonstration to squeeze in that little tidbit of information. On another occasion, Mr. Thode overheard some students talking about hydraulics and joking around. In what seemed like less than a nanosecond, Mr. Thode had turned it into yet another opportunity for teaching, starting up a "casual conversation" about viscosity and double-acting pneumatics. "Not 'double-acting' as in acting in a play…" he looked at a nearby student and joked, "Ah! The light bulb just went on! I heard it - it's only a 25-watt bulb - but I heard it!"

Another attribute Mr. Thode possesses is that of profound knowledge. After years of teaching technology, writing textbooks for teaching technology, expanding his lab, pursuing new and exciting projects, etc., he has developed an immense and seemingly endless well of knowledge in his vast content area. He is informed about systems, agricultural technology, photography, video editing, welding, satellite technology, transportation technologies, materials properties, physics, etc. During my brief visit at Wood River Middle School I observed him teach different small groups of students a wide variety of things. He taught that tin and lead compose solder, he taught the meaning of Greenwich Mean Time (YYYY/DDD/HH:MM:SS) and its relevance to the students, and he taught the meaning of "casters" and how they fit into the plans for the planned space walk simulator. Coming from Mr. Thode, it seems effortless; and it's a wonderful tribute to him as a committed teacher and scholar.

The Creative Product

Some of the most intriguing, and perhaps the most important, products that Mr. Thode's students leave with are intangible. They're not a finished product or even a pearl of information that will guarantee a fast track to wealth and fame. Amid all the products generated in Mr. Thode's classes, the students gain certain skills that will benefit them in any occupation or endeavor they choose to tackle or are confronted with later in life. Such transferable skills are arguably of more consequence than anything else they learn in Mr. Thode's classes. These competencies will greatly assist the students as they interact with and leave their mark on an ever-changing and transforming world.

Transferable skills- student ownership.

Ownership and responsibility come immediately to mind when identifying a few of these transferable skills. In everything he does, Mr. Thode makes sure that he does not take the burden of learning from the students and upon himself. He recognizes that is *not* his responsibility to learn on behalf of the students. Rather, Mr. Thode sees his role in the classroom as presenting his pupils with information, challenges, opportunities, resources and mentorship, all of which work together to create an environment rich with learning opportunities. His students are then left to choose for themselves whether or not they want to get anything at all out of the class. Those that choose to learn put forth an incredible amount of effort to do so. Those who choose the contrary are left with natural consequences of their decisions, most often poor performance marks on a report card or the loss of privileges in the lab.

The ability to leave the responsibility and ownership of learning with each individual student is apparent in every dynamic in Mr. Thode's tech program. Students are left to choose which assignments they will complete and in what order they will complete them. Mr. Thode takes every opportunity available to teach, formally and informally, in and out of the classroom. Students are held accountable for their choices and behavior. "Why did you choose to do that?" is a query commonly heard in response to a flawed decision made by a student. In such a way, students are forced to look at themselves introspectively and own up to their mistakes or poor choices. Most students learn pretty quickly how serious Mr. Thode is about having them own their education, and are more than willing to act accordingly.

Though the main focus of Mr. Thode's teaching methods is not to have students "get good grades," such high marks are a natural consequence of the students taking control of their education. It's not uncommon in Mr. Thode's classes for a number of students to have failing or barely passing grades on their mid-term reports. One student told me, "By midterms, only a few people had all the projects signed off, but by the end of the trimester most people bring up their grade to an A… for most people." Students are expected to manage their time in such a manner that they accomplish their assignments in a timely fashion.

Transferable skills- learning how to learn.

Learning how to think and problem-solve, or "learning how to learn," is another indispensable transferable skill acquired in Mr. Thode's classes. I spoke with a couple of students in the seventh grade Tech Class who were rebuilding an old RC airplane. I asked them what was wrong with the old plane. "Bad electronics, it had holes in the wings and some broken parts." I followed up by asking what they did to fix the old plane. "We repaired the electronics, patched the wings and we're going to look for or order the missing parts." My curiosity picked up. "How did you know how to fix the electronics? Did Mr. Thode teach you?" I asked. They proudly answered, "No, we were already kind of interested in planes, so we looked around in magazines and on the Internet. We just compared the electronics to another plane that's wired similarly and fixed it." One of the two kids pitched in, "We had to build the electronics from scratch and build parts…"

That brief and seemingly simple conversation had quite an impact on me. Here were two kids in the seventh grade who were given a little freedom to tailor an assignment to their unique interests, and they promptly stepped up and taught themselves what they needed to learn! The appropriate resources had been extended to them - safety gear, the Internet, magazines, electronic components and parts, etc. - and Mr. Thode maintained a watchful eye on them; but the actual learning was executed by the two students. They encountered challenges throughout the entire process, but were able to troubleshoot their way through them. When I left them they were spray painting the airplane and using a piece of physics software to test the plane's launch. The last time I saw them, Mr. Thode was telling them to ask another faculty member for some RC plane fuel so they could start the newly renovated engine.

In another demonstration of students learning how to learn on their own, I was conversing with a small group of kids who were working on the space station. One of them commented to me, "We're learning how to steer something while it's in space. We had to learn it by ourselves…" I asked why Mr. Thode hadn't simply told them how to do it. "I think he just wants us to learn it on our own." "Would you rather that he just told you how to do it?" "No, I think it's better that we have to do it." What was most impressive throughout the dialogue was the apparent clarity these students had regarding one of Mr. Thode's aims. It's not his style to spoon-feed his students, and his students largely recognize this and appreciate it. In his words, Mr. Thode likes to "give students the facts as they stand today and give them a challenge of, 'Now how are you going to apply this? What could it mean?'"

Transferable skills- time management.

Unlike many traditional education classes, Mr. Thode's students are expected to manage their own time. The distinctive nonlinear teaching method Mr. Thode employs prompts him to give numerous assignments throughout the trimester to his classes and then allow the students the freedom to choose which assignments they will work on and in what order they will work on them. It is not uncommon for Mr. Thode to *not* reproach students who choose to use their time poorly. He is aware that the natural consequences that follow their poor decisions often serve as better teaching opportunities than if he were to reprimand them or "force them" to remain on task. For a small number of students, Mr. Thode needs to intervene and remove their privileges to work in the tech lab. Students in this category are given assignments out of books, and have to "earn back" the opportunity to work in the lab.

Transferable skills- social interactions.

As flexible and student-driven as Mr. Thode's classes are, it would be almost impossible for a student with a passing grade to *not* improve upon his social skills. Assignments requiring individual work are intermixed with assignments that require teams of two or small groups. As individuals, the students created and launched their straw rockets. Teams of two students tackled an animation assignment. A small group of students were working together on the Mars rover. Occasionally a disagreement evolved between two or more students. As quickly as the disagreement arose, it was resolved. Mr. Thode's students learn that he does not play the "babysitter" role. He will allow students to come to their own conclusions on how to resolve certain issues. He may ask a few questions to help them reach an agreeable arrangement, but his tendency is to *not* step in and "solve the problem" for the students. On one occasion I witnessed two students disagreeing with each other regarding an animation assignment they were working on. They each allowed the other to speak his mind without interrupting or criticizing, and within minutes they were back to work. I wondered if the scene would have played out the same if it had occurred in a different class. As Mr. Thode's students progress through the trimester and become accustomed to his nonlinear teaching style, most seem to learn how to resolve challenges maturely and interact with their peers respectfully.

Transferable skills- troubleshooting and problem solving.

When he lectures, Mr. Thode reinforces the notion that students need to think for themselves by asking numerous questions, not the type that elicit "yes" or "no" answers, but the type that really force the kids to think. He commonly challenges his students with, "What are your predictions?" or, "What do you think will happen?" Both serious and silly answers are entertained and discussed briefly before Mr. Thode proceeds to demonstrate or disseminate information. Wrong answers aren't ridiculed and students are not belittled; rather, the correct answers or predictions are explained carefully, often with the use of more questioning! In such a manner, students are exposed to a positive model of problem solving and troubleshooting. As Mr. Thode carefully leads his students down new paths, he talks them through the steps and appropriately explains the necessary information, ensuring that each student has an equal opportunity to learn how to learn.

Another natural outcome of the nonlinear teaching style Mr. Thode employs is that his students learn how to problem solve, how to face a challenge, an uncertainty, or a problem and not go running to the teacher for help as a first resort. Sometimes this has to be taught overtly. The problem solving steps are posted clearly on the white board.

James was struggling. He simply didn't get it. He logged in to the computer next to the food preparation area in the resource room, and found the correct URL. He stared blankly at the screen, wondering where he was supposed to enter the information… and was his information even correct? His hand shot up into the air for the third time in less than five minutes. Before Mr. Walrath reached his side, James blurted out, "I don't get it. Where do I go from here?"

Rather than address the question in frustration, Mr. Walrath quickly collected his thoughts and calmly explained, "James, you're not learning anything. You're afraid to click on a button, to take a risk to see what's happening. You're not going to hurt anything at all there; and this is set up so you can explore and find the answer." Mr. Walrath proceeded to demonstrate the problem solving steps for James, asking aloud, "So, here's my problem; what are my different solutions? You know, I have a bunch of them; but to start I need to choose one of those and I need to test that idea and I need to evaluate the results. And, if it doesn't work, I need to be not afraid to retry…"

Students are expected to take notes on class lectures. One of the first things I noticed Mr. Thode do whenever a student approached him with a question about an assignment was refer him or her back to his or her notes. "Have you looked at your Tech Notes?" he would inquire of the student. On other occasions, Mr. Thode would guide students through different problem solving steps covertly, asking the right questions to help students derive their own solutions. This is not to say that Mr. Thode refused to offer his help or wouldn't answer a question posed by a student. But the expectation was apparent; students are expected to think for themselves and do everything in their power to use the vast resources at their fingertips to problem-solve. It is expected that students will make mistakes, and Mr. Thode is skillful in helping his students turn their mistakes into learning opportunities. This adds to the overall creative environment of the tech lab, and students learned that making mistakes is an important part of learning.

The transferable skills taught overtly and subtly by Mr. Thode to his students could occupy an entire chapter in and of themselves! Acting as responsible citizens within a community, problem solving and teaching oneself, time management, communicating clearly and effectively, owning up to one's mistakes, taking pride in one's work, etc. All these skills and more are, to some degree, assimilated by his students and carried into other classrooms and situations.

Other creative products.

The students were totally enthralled in the lecture. Mr. Thode had demonstrated how extreme cold alters the properties of various materials. He used liquid nitrogen to "ice" his tea (see Appendix, Photograph 3); had inflated a balloon, dipped it into the flask of liquid nitrogen and showed the class how the balloon "re-inflated" after he removed it from the flask; and had taken a crumbly bite of a frozen marshmallow (see Appendix, Photograph 4). They were riveted.

"Let's go a bit further. A lot of teachers stop here, and that's unfortunate, because there's more to the story. This could change your life," Mr. Thode explained as he wrapped up the superconductivity lecture. He pushed his students to think about the ramifications of the demonstration. "How could this change your *future like semiconductors changed mine?" he challenged. "Think of sports with shoes that levitate, transportation if your battery never died, your wrist watch having more power than the world's fastest computer, or trains that levitate off their tracks and travel at 400 mph instead of 65 mph! What if we figured out a way to pave our roads with superconductors, and instead of tires we had magnets on our cars? What are your predictions?"*

Reflecting back on the demonstration where liquid nitrogen was used to levitate the magnet, Niels responded timidly, "But how could they keep the roads cold enough?"

Pleased by his participation, Mr. Thode respectfully acknowledged Niels' question. "Right now there's a race among certain research centers and universities to *make this all work at room temperature," he responded. "This is what happens when you mix math, science, and technology! In three or four years there'll be a lot done with superconductors, and I hope you look back to this class and say to yourself, 'I studied that in middle school!' You'll be one of the very few that can say that."*

Another student, fascinated with what had been shown in class, brought the class's attention back to the demonstration table, where the liquid nitrogen had dissipated, and the magnet - now at room temperature - had fallen out of levitation. "If you poured liquid nitrogen on the magnet while it sits on the superconductor after it warms up enough so that it's not levitating anymore, would it levitate again by itself?" he asked. His question was rewarded with a broad smile and an enthusiastic, "I don't know! Let's get to your question immediately and try it!"

Mr. Thode poured liquid nitrogen on the magnet onto the resting magnet, which remained on top of the superconductor. "Hmmm… but if we lift it up, it'll probably levitate…" Mr. Thode carefully picked up the magnet off of the superconductor, let go, and the magnet remained suspended in the air (see Appendix, Photograph 5). The students, once hushed in eager anticipation, were now chattering animatedly amongst themselves. Mr. Thode brought order to the class by giving them their next assignment, "You have two choices, you can either draw it out or write it up; invent something that uses levitation properties…" The class dispersed when he finished talking and immediately scattered to various parts of the technology facility.

What of the actual, concrete products in Mr. Thode's classes? What kinds of projects and assignments are the students doing? Are the projects that different than other technology programs or classes? The answer is yes and no. Much of the work done in Mr. Thode's classes is similar to that done in other classes and technology programs, yet there are some projects and activities that are very unique to Mr. Thode's program. Even those assignments that resemble work done in other classes seems to come to life in a whole new way as Mr. Thode masterfully takes assignments one step farther; often demonstrating principles by engaging his students in fun, memorable experiments or other illustrations that require participation from the students.

The first assignment typically given to first-year students in Mr. Thode's class is to draw an accurately scaled blueprint of the technology program facilities. Certainly this isn't a completely unique or earth-shattering assignment. However, few technology programs have twelve separate rooms and second story mezzanines! By giving such an assignment, Mr. Thode offers his students an opportunity to familiarize themselves with what can be an intimidating environment. Room by room the students measure and sketch out dimensions, learning the layout of the technology facility and getting to know what is available to them and what is expected of them.

New assignment- the International Space Station.

There are other assignments that are pretty unique to Mr. Thode's program. As I conducted my research, a new assignment that has never before been done in the middle school's technology classes was introduced.

"Your new assignment will be to take a photograph from the International Space Station!" boldly announced Mr. Walrath. Again, the class broke out into what seemed like a thousand hushed conversations as a wave of excitement rolled through the class. "We'll use the Internet to relay our information to UC San Diego, who will in turn relay

our information to the ISS. The information we send will control a camera on the space station, and that data will be sent back to earth."

With their attention glued to the front of the classroom, it was no challenge for Mr. Walrath to teach the students about Greenwich Mean Time (GMT), latitude and longitude, how to figure out if the photo would be taken at day or at night, how weather patterns factored in ("Do you want your photograph to be clouded over?"), about the two different lenses available to the students - one 50 mm lens and one 180 mm lens, and which orbit the International Space Station would be in. "The photographs have to be planned three orbits ahead," explained Mr. Walrath.

Many of the students spent the remainder of the period troubleshooting the new assignment. Mr. Walrath tried to print off information regarding the GMT and different latitudes and longitudes, but when he looked at the paper sitting in the printer tray he realized that the printer had cut off the GMT information. Erin piped up from the back of the class, "We had that problem last time, and we changed the way it printed."

"You mean you changed the orientation of the paper?" queried Mr. Walrath.

"Yep!"

"Thanks." Mr. Walrath made a few changes and re-printed the information for the class. He spent a few minutes answering a variety of questions thrown at him from all over the classroom, and then proceeded to wander among the students, looking over their shoulders and observing their work. He paused to speak with a female student working along the back wall. "Is that going to work, Nesi?" he asked. "Remember that the 50 millimeter lens captures a 40 mile footprint, but the 180 millimeter lens captures a 10 mile radius. How far off of the orbit are you?"

Nesi smiled sheepishly, "A lot…"

Patiently Mr. Walrath explained, "It looks like you're about 450 miles off course!" Nesi kind of laughed, deleting the information she had entered in the computer and looking a bit more closely at the paper next to her computer.

His students were instructed to connect to a camera on the International Space Station and take a photograph of a place of the students' choosing on Earth. The students were able to shape the assignment according to their interests and life experiences by selecting what the photograph would be of: Area 51, Cuba, the Great Wall of China, and coral reefs were all places I heard being discussed. The students got to choose between two different lenses and were given instruction accordingly. They had to learn about Greenwich Mean Time and latitude and longitude. There were connections to geography and history made in class discussions. The students had to use their math skills to calculate a specific time and place for their photograph. Connections to real jobs and occupations were made and discussed.

Students in Mr. Thode's classes have helped build a flight simulator (see *Appendix, Photographs* 6-8) and a human wind tunnel (see *Appendix, Photographs* 9-10), and are in the process of building a Mars rover (see *Appendix, Photographs* 11-12). They go one step beyond designing and building a Styrofoam car to safely house an egg; they actually strap the egg in their cars and launch them down a crash test track to witness firsthand how well (or poorly!) their cars were engineered. They analyze the performance of their vehicle and find ways to better their design. One of Mr. Thode's former eighth grade students contacted a professor and asked him about his research on superconductors. This professor was so impressed that an eighth grade student had read up on his work that he e-mailed her a list of chemicals and supplies she would need to make her own. With Mr. Thode facilitating, she made her own superconductor! The list goes on and on. From clean rooms to giant robotic arms to hydroponics to hologram and laser technology to making their own fiber optic cables, Mr. Thode's students are offered countless opportunities for growth, learning, and developing their technological literacy.

In spite of these more concrete products just mentioned, the truly important products are the students that are leaving with critical transferable skills. Mr. Thode realizes that all of his students won't be employed in a clean room, nor will they all be operating robots or making films or engineering safer vehicles. He uses these activities and projects, however, as tools to teach critical, transferable skills to his students. He uses current and dynamic technology to create situations and an environment that is fun, challenging, and meaningful. In such a manner, he is able to bring "real life" into his classroom and lab and allow his students to *experience* the technology- teaching his students on a level that is far more meaningful than simply answering questions at the end of a chapter in the assigned textbook then moving on to the next chapter.

The Creative Process

Mr. Thode's unique nonlinear approach.

Mr. Thode has developed a very unique process for assisting his students through the learning process, one that revolves around student directed, rather than teacher directed, learning. He employs a unique teaching style he describes as a "nonlinear" teaching method. In an effort to explain the nonlinear teaching method, Mr. Thode likens it to the Internet, where an individual begins at a certain point but is able to navigate to various sites and different pages according to his or her interest. Such navigation is nonlinear, seemingly random. "You start out surfing the Web where you start out looking for something but you find out something else that you never even thought of," Mr. Thode explained to me. Berrett (2003) refers to this teaching technique as "managed chaos."

In the nonlinear approach to teaching, the kids "can jump from one assignment to the next…" in hopes that students will "feel free to start out doing one assignment and jump from that to the next in whatever order that's most interesting to them, or where their efforts are best applied at a certain time." Students work on different projects at different times, with the idea being that the teacher can capitalize on the teachable moment. This nonlinear approach to learning is based largely on the interests of the teacher, the interests of the students, the current technologies and technological trends, the availability of resources, and past success. As such, the number and type of assignments varies from trimester to trimester and from year to year. Also weighing in is time; Mr. Thode has only one trimester (roughly 75 instructional days) with each class, making it a little more than difficult to get heavily involved with projects that demand too much time.

In order for the nonlinear teaching method to be successful, the first assignment given to a class is one that the entire class can begin working on together (typically the floor plan assignment). Then, when Mr. Thode observes that a handful of students are finished, he'll introduce the next project to the entire class. He proceeds in this manner, always remaining one or two steps ahead of the class, introducing new projects as needed and desired. Year after year, Mr. Thode's curriculum changes according to current technologies, the learning pace and success of the students, and the interests of both the teacher and student alike.

Another integral piece of nonlinear teaching is the method of delivering information. Mr. Thode spends, on average, substantially less than half of each class period lecturing in traditional direct instruction. Typically, upon introducing a new assignment, Mr. Thode will record the assignment's name on a large piece of white paper hanging on the whiteboard in the front of the classroom. Each student is responsible for taking notes. They write down on a Tech-Notes sheet the objectives, the essential details, and the requirements for the assignment, as well as the real life applications Mr. Thode outlines and the impacts that the technology in mention has on our society. Students are encouraged to keep thorough notes by being referred back to them when they approach the teacher with a question regarding an assignment. By disseminating information in this manner, the kids get the crucial information and lectures are kept effectively short. This allows the kids time to *experience* technology and its ramifications, rather than merely talk about or hear about it.

Another critical aspect of Mr. Thode's nonlinear teaching method is the previously mentioned student accountability and ownership of their learning. I asked one of the students in the NASA Tech class, "You have ten assignments and you can do them in any order you want and your only deadline is get them done by the time your grades are posted. Do you like it this way?" "Yeah," he responded. "For example, on the Interactive Physics one, we had to design and test different designs for the Mars Rover. I had to do it like three or four times because mine wouldn't work. If I had a deadline on it, I would have gotten a bad grade and I wouldn't have gotten any other work done!"

Students literally have complete control over their grades and can earn any grade they desire; *if*, as one student indicated, "If you work hard."

It seems that Mr. Thode has high expectations of his students, especially considering the fact that they're "only" middle school-aged kids. By requiring them to take concise notes, allowing them to choose the order of their assignments, giving them liberties to tailor their assignments to their interests, and having high expectations of them, Mr. Thode allows, and expects, his students to take ownership of their own learning, a concept that traditionally gets lost in the "spoon feeding" of traditional classrooms.

The Creative Press

The physical technology education facilities.

With twelve rooms and literally thousands of square footage to its name (see *Appendix, Photograph* 13), Mr. Thode's lab is more than a sight to behold. Upon entering the main doors to the technology room, one stands in the Tech Lab (see *Appendix, Photograph* 14). It accommodates a car crash test track, a hovercraft test track (see *Appendix, Photographs* 15-16), two CNC mills, a bank of computers, a couple satellite dishes, an industrial robot arm (see *Appendix, Photograph* 17), a handful of work benches, an extremely realistic replication of a space station (see *Appendix, Photographs* 18-19), a science exploration area, an micro gravity simulator (see *Appendix, Photograph* 20), a laser-guided straw-rocket launcher (see *Appendix*, *Photograph* 21), a clean room camera, etc. The technologies and content that are accommodated in the Tech Lab are always changing, according to student and teacher interest.

The Resource Center and classroom are to the east. The Resource Center houses another set of computers (where the video yearbook is created), small robots (see *Appendix, Photograph* 22), a food technology preparation area, a linear video editing system, and a blue screen. The classroom is where delivery of instruction takes place (see *Appendix, Photograph* 23). It is set up with white boards, a projector, tables and chairs, and a smart board. Mr. Thode makes a point to keep his lectures brief, giving his students enough information to get them started on their assignments, but not taking more time than is needed. In fact, the classroom is used more as a work area than a typical classroom. More than ten computers line two of the walls, and during my brief stay the classroom doubled as the room in which the students filmed their animations (see *Appendix, Photographs* 24-25) and worked on their International Space Station assignment. Student portfolios are also kept in the classroom.

To the south of the classroom are the audio and video studios. The audio studio acts as a smaller version of a radio station, where students create a short radio program that is broadcast up to a mile away. Students learn about radio broadcasting and use equipment like audio mixers, compact disc players and burners, microphones, and an FM stereo transmitter (see *Appendix, Photograph* 26). The video studio makes even many high school video studios pale in comparison! Flanked by a small control room (see *Appendix, Photographs* 27-28), the video studio is set up to mimic a real production studio. A professional looking table and two chairs are set up against a backdrop of Sun Valley (see *Appendix, Photograph* 29), and are flanked by three cameras, one set up to capture talents one and two together, and the other two to get camera shots of the individual talents. Program and preview monitors are available so the students acting as talent for the day can tell when they are live on air and which camera is filming. Both the video studio and the video control room are lined with panels for muting acoustics, and the two rooms are separated by windows so the camera operators and talent can be seen by the director and producer from the control room. The student director and producer communicate the types of shots they want to the camera operators via headsets.

Immediately west of the video room is a small welding lab (see *Appendix, Photograph* 30). Occupied by different types of welders (MIG, arc, and oxy acetylene), a plasma cutter, a grinder, a small foundry, bench shear, box and pan brake, and other welding tools, the room is large enough for maybe one or two students at a time. However, most of the equipment is portable and can be hauled around the lab or outside for the fabrication of projects.

West of the welding lab is the "Fab Lab" or, fabrication lab, where most of the student designs are constructed and produced and become a working reality (see *Appendix, Photograph* 31). Tools in the Fab Lab include such things as a table saw, a jointer, and planer, hand tools, a band saw, a table saw, a sanding station, a scroll saw, a metal lathe, another CNC mill, drill presses, vices, file sockets, a shop vac and parts drawers. All of this is complimented with the proper safety measures - a fire door, curtains, and a dust collection system. The back half of the Fab Lab is used for storing materials such as lumber. Tools and equipment for plastics processing and fabrication are also available to students near the Fab Lab. Exiting Mr. Thode's tech lab through a door in the back of the Fab Lab and into a small parking area leads one to the life-sized, two person hover craft that Mr. Thode and his students received as a donation and are considering rebuilding.

Three darkrooms lie just north of the Fab Lab. Rather than process and develop film, these dark rooms house such technologies as laser holography, the creation of fiber optics, and a clean room (see *Appendix, Photograph* 32). Students participate in an assignment where they don clean suits (donated from Micron) and experience a controlled environment dealing with microchips. There is a video camera inside the room and an intercom system that allows a teacher's aide to communicate with students inside the clean room and guide them through the assignment. Also in these back rooms is a small area where students can experience hydroponics.

In the middle of it all sits Mr. Thode and Mr. Walrath's office (see *Appendix, Photograph* 33). It has windows on literally every side, offering the instructors a view into virtually every part of the tech lab. There are a couple of computers, and the desks are littered with papers, books, magazines, and other office supplies. Mr. Thode doesn't spend very much of his time in the office when his students are in the tech lab.

There is so much to take in it's unbelievable! It wasn't until my second and third visits to Mr. Thode's lab that I finally started to appreciate the experience. The point of all the rooms and space and projects and equipment and tools is *not* whether or not the students experience *all* of the technology in the lab. The idea is that each individual student has an opportunity to learn the principles of technology through a very hands-on and challenging method, even tailoring their learning after their own interests to varying degrees. Mr. Thode is exposing his students to current and progressing technologies, offering each student a chance to learn in his or her way about the world around us. Mr. Thode's lab is more than merely eye-candy or a program with a lot of toys. It's a breeding ground for learning and creativity!

The intangible press.

It's easy for one to get caught up in all the "stuff" found in Mr. Thode's tech lab. Most people have never been in such an awe-inspiring classroom. Over 4,000 square feet of gadgets and technology - truly inspiring and innovative projects - fill twelve different rooms. Computers adorn many of the walls. Huge satellite dishes are suspended from the ceiling two stories overhead. The students are all over the place, in the clean room, welding on the chassis of the mars rover, preparing the day's video announcements from the video control room, working on the school's yearbook, or creating an animation in the classroom. It's undeniable that Mr. Thode has developed a very successful technology program at Wood River Middle School. In addition to a truly creative physical environment, Mr. Thode works equally hard at developing and maintaining a creative intangible environment.

Mr. Thode's teaching pedagogy.

Mr. Thode is not one to waste time, nor does he appreciate his time being wasted. As a result, you can guarantee that when you attend one of his lectures, it will be meaningful, to the point, and will end when it should end. There's no way to accurately pinpoint an "average time" Mr. Thode keeps his students in the classroom attending one of his lectures or demonstrations. I've seen him lecture as long as an entire class period and as short as five or ten minutes. No matter the length of the lectures, they are always dynamic and shifting. As each student brings different needs, questions, and learning styles to the table, Mr. Thode goes to great lengths to tailor his lectures and demonstrations to each student. Whether they are right or wrong, playful or genuine, each answer offered by a student receives Mr. Thode's attention. When asking his students what materials might act as insulators, the answers included plastic, rubber, wood… and French bread. "French bread?" he repeated with a smile. Without missing a beat he held up a ceramic insulator from high-tension wires on a power pole and continued with the lecture and demonstration.

Two other qualities that stood out about the manner in which Mr. Thode delivers his lectures are that he peppers his students with questions throughout the lecture, and that he is constantly hounding his students to make connections to the world at large. Not only do the questions serve to keep the kids paying attention and focused, but also the questions he poses require thought on the kids' part. He elicits predictions and thoughts from his students. He rewards thoughtful comments with positive remarks like, "You know what you just showed me? You showed me that you're thinking ahead of me!" He has no problem with deviating from the lecture he gave in the previous period to address a question that takes the lecture down a slightly different course. And, ever the master teacher, he always manages to cover the critical points and neatly tie any deviation from the main point back into the lecture. His lectures are frequently couched in applications to industry, other curriculum, and real world context. By frequently discussing what's happening outside of their classroom, Mr. Thode's students are able to draw deeper meanings from the lectures and assignments.

As enthralling and intriguing as his lectures are, it comes as no surprise that equal amounts of consideration and thought go into the labs and assignments that engage Mr. Thode's students. Similar to his dynamic and personal instructions and class presentations, Mr. Thode's labs change year after year after year. As technology progresses and shifts, so do Mr. Thode's labs and the assigned work in his classes. Some projects span many years, such as the Mars rover his students were working on, or the space station that was continuously being added to and improved over time. Some projects cover a few weeks or months. The boys that were repairing and detailing the RC airplane started and finished that particular project within the trimester they were enrolled in Mr. Thode's class. Depending on how hard they work, some students finish particular projects or assignments within a matter of days, like drawing an accurate, to-scale floor plan of the technology lab. At any given point in time, the work occurring in the technology lab is current and challenging.

Student-directed learning in the creative environment.

Another large factor in developing a creative environment is allowing the students to, in some form or another, influence the direction of the curriculum. There are certain elements in the technology lab that are decidedly born out of Mr. Thode's interests. The numerous projects relating to space and the NASA program make it clear that Mr. Thode has an affinity for space, the cosmos, and the technology related thereunto. There are other elements in the technology lab, however, that came about because of student interest, such as the flight simulator. Mr. Thode has shown that he is very open-minded and susceptible to suggestions from students regarding projects that should be taken into consideration. Some ideas come to fruition; others are never undertaken or are never completed. No matter whether or not the projects are completed, Mr. Thode's willingness to seriously consider student-generated ideas builds strong ties of trust and deep appreciation with his students, further strengthening the priceless rapport that Mr. Thode enjoys.

An example of student ownership- the video yearbook.

Along with his willingness to pursue his students' ideas, Mr. Thode allows his students the freedom to take ownership of their work. This was addressed in the section treating the creative product; however, it also plays a crucial role in the creative press. Mr. Thode's students and their ideas are respected in his classes, which, in turn, encourages the students to be more open and bold and take greater pride in their work. It's cyclical in nature, and has the students' best interests at heart.

Mr. Thode takes every opportunity to teach and guide his students, but is by no means a micromanager! Students in Mr. Thode's classes can expect that they will be asked to shoulder the burden of their own learning and education. I watched as the students enrolled in the Publications class worked diligently to accomplish the yearbook tasks that had been assigned to them.

It was painfully obvious that they took their work seriously, though, not so seriously that they weren't laughing and joking with one another. They went through periods of quietly working; then would interrupt one another to share the latest song they had fabricated. Hanks, George, Sarah, and Jennie occupied three of the iMacs along the back of the resource room. Each sported a large pair of headphones.

The only sounds coming from the three students was the quiet "click, click" of the mouse… then, "Hey! George! Jennie! Guys, listen to this!" Hanks all but yelled. He unplugged his headphones, and the soulful melody he had pieced together flowed from the computer's speakers. "Do you like it? I figure we can use it for the band section!"

"It's not really upbeat enough," Sarah rejoined.

"Yeah," George piped in. "It needs more beat. More rhythm! Like this *one!" with that, George unplugged his own headphones and turned up the volume. The bass popped a little with each beat, crackling through the speakers. Bum. Bum. Bum… "Oops. I need to play with the levels a bit… but do you guys like it?"*

When queried about what it was they were working on, four students patiently explained that they were creating music for the school's video yearbook. They clarified that due to copyright issues, they were permitted to use only thirty seconds or ten percent of a copyrighted song (whichever is less). When pushed and asked who gave them that information, the response was clear and pointed, "Copyright law." I asked them to explain the parameters of their assignment, and was simply told that they were free to create the music as they saw fit, but that they "[had] to have a theme." After a few minutes of observing the students adeptly navigate through the different workspaces, menus and functions, I inquired as to whom had taught them how to use the software. The proud answer was, "We did!" "*How* did you learn it?" I pushed. "We played with it!" one student responded. Another furthered, "We all love music anyway, so it's fun to create it; *and* we know it's going to be in the video yearbook, so we're excited to see it there…"

As we become an increasingly technological society, we witness an increase in online piracy, illegal downloading and similar "cyber crimes." In such a strong digital era in which these kids are growing up, it was extremely commendable that the students working on the video yearbook were informed about copyright laws that impacted their work; and more so that they actually heeded those laws and found a way to work within legal constraints. The students working on the music for the video yearbook were excited to be doing something they love! The work on which they were eagerly laboring played strongly on their interests; and they were tickled at the idea that their work would be featured on the school's video yearbook. It was equally notable that the students learned the software - Apple's Garage Band - by playing with it and from occasional visits to the Help menus, and not from sitting in a classroom listening to lectures or having a teacher walk them through it.

An example of student ownership- the Apple Core project.

Another impressive incident of student ownership and responsibility was exemplified by a project that a small number of students had taken upon themselves to enter a prototype game board into a national competition. The inspiration for their idea came about after they had witnessed a number of disabled war veterans from Iraq and Afghanistan skiing in the Sun Valley area. Initially the students wanted to create a ski-bike apparatus geared toward individuals with physical disabilities; but over time the idea evolved into a game board they called Apple Core ("apple" being representative of education in general and "core" embodying the core classes)(see *Appendix, Photographs* 34-37). As their ideas changed over time, however, the element of tailoring the final product toward persons with disabilities remained strong.

The students involved with making the Apple Core game went through numerous concepts: miniature board games, foam core board games, cutting out bites at different locations of the apple-shaped game board, etc. A blind alumnus was invited into the classroom to offer his feedback and suggestions on how the game could be improved. He made certain recommendations that were implemented readily: recessing certain areas of the game board and typing the certain game pieces in Braille. Earlier in the trimester, one of the students had taught himself how to use the lab's newly-acquired CNC mill, and his skills were tested and put to use. He struggled in the beginning with how to make the game's apple design, and predicted that it would take at least three hours (if not more) to complete the task. The following day this same student had a "eureka" moment and completed the task in little more than an hour and a half!

The students put in roughly ten hours over the weekend as their deadline approached; and arrived an hour and a half prior to the beginning of first period on Monday… leaving the school at 7:00 p.m. that same night. The game pieces were created first out of foam, then molds were created and the pieces were cast in molten aluminum in the foundry, and the final pieces were machined and hand-painted. Every step of the way the students were comparing the content of their game against the core curriculum for second and third grade students (the intended target audience), which the Apple Core students had pulled from the district office.

Throughout the entire production of the Apple Core game, the students were in charge. It was their idea initially to develop a device that would meet the needs of a disabled populace. It was the students' own impetus that motivated them to go through numerous revisions and design possibilities. It was the students making the concept drawings and interacting with the blind alumnus to fine-tune their game. It was the students who worked the equipment in the foundry and who figured out how to correctly program and run the CNC mill ("*I* couldn't even tell you how to run the CNC mill!" Doug told me in all seriousness). Again, the students involved with Apple Core demonstrated ownership in a very impressive way, willingly sacrificing hours and hours of their time to develop a very authentic game board prototype. Along each step of the way, the teacher acted as a facilitator, staying out of the way as the students took charge of their learning experience. Perhaps more rewarding to the teacher than the finished Apple Core product was the smiles on the students' faces as they beamed with pride while showing off the result of their frustrations and their hard work.

Safety first!

Another critical component of Mr. Thode's technology program that helps form such a unique, creative environment is how seriously he takes safety. His students learn quickly and learn well what is expected of them in such a large and potentially dangerous environment. While they learn that risk-taking encourages - is even necessary - for their success, their risks are calculated and reasonable. Each student enrolled in a technology class gets his or her photograph taken and creates a Tech ID badge (see *Appendix, Photograph* 38) that must be worn at all times in the lab. Any student caught violating the rules gets a corner of his badge cut off, and loses his rights to work in any of the labs that comprise the tech lab. During my short stay with Mr. Thode, I made a point to observe the board where the student badges are hanged. Not one of the badges had a corner cut off. In asking Mr. Thode about it, he indicated that it is a very rare occasion that he is forced to remove a corner from a student's badge; but indicated in the same breath that he won't hesitate to do it. His students know this, and don't push the limits.

One example that illustrates this point happened while Mr. Thode was giving his lecture on superconductors:

The small Canon camcorder was placed on a tripod about a foot away from the demonstration table. It was wired into the large television mounted high up on the wall, offering the entire class an opportunity to see the demonstration without missing any of it *due to the kids in the rows closest to the table standing up or sitting on the backs of their chairs to get a better view. The white sign on the table left no room for questions or doubts. "Please Do Not Touch," it plainly stated in red letters.*

The 6th Grade Tech class started to trickle into the classroom. As if drawn by the earth magnets on the demonstration table, Josh inched closer and closer to the table and the camera. The warning sign wasn't enough to arrest his inquisitive nature. Leaning over, he peered through the viewfinder on the camcorder. No one said anything. Inquiringly, Josh reached out and tentatively touched the tripod, moving the camera maybe a fraction of a portion of an inch. The image on the television barely shifted.

"Why did you choose to do that?" demanded Mr. Thode. "If you know it's not yours to mess with, why did you choose to do that?" Quickly, Mr. Thode turned to Mr. Walrath and began discussing whether or not they should cut a corner off of Josh's Tech ID badge.

After hastily and profusely apologizing, Josh was let off with a stern warning. Visibly shaken, Josh made his way to his seat and waited for class to begin. The class started without further incident, and within a few minutes, Josh was fully wrapped up and participating in the superconductor demonstration.

My initial reaction to the manner in which Mr. Thode and Mr. Walrath handled the situation was one of surprise. It seemed like such a little deal; the camera barely moved, and nothing was knocked out of place. After a little more thought, however, it became clear that there are rules clearly set in place, and the expectation is that the students follow the rules unequivocally. In this manner, the safety of each student is guaranteed and the privilege to work freely in the lab remains in place.

As mentioned previously, a main, unique factor that molds the creative press in Mr. Thode's classes is that each class and each assignment is structured to teach students more than merely technology skills. By using a nonlinear approach to teaching, the students in Mr. Thode's classes also have incredible opportunities to learn much about themselves, their interests and disinterests, how to interact with others, and many other important transferable skills such as time-management, social skills, and problem solving skills. More oft than not, the students aren't really cognizant of the fact that they're learning such skills!

Person. Product. Process. Press.

These four general elements of creativity have provided the framework for discussing the findings of this research. They have provided simplicity in organizing the collected data, and allowed for a straightforward sense of orderliness. However, the nonlinear teaching method Mr. Thode has implemented in his teaching is difficult at best to capture, describe, and summarize in an orderly way. It is equally difficult to pull out a single important element of the nonlinear teaching method without also discussing one or two other elements, also equally important.

There are many elements within the four main components of creativity that are interchangeable and interdependent. Safety in the technology facilities is essential to encouraging creativity, yet safety is also a part of the creative person and safe thinking is a part of the creative product. Many of the components of the creative product - ownership and responsibility, time management, problem solving, learning how to learn - are integral components of the creative process and cannot be separated from the nonlinear teaching methods Mr. Thode uses. They also are equally important in forming the intangible creative press existing in Mr. Thode's classes.

Every effort has been made to present the findings in such a way as to allow the reader to understand and fully experience Mr. Thode, his nonlinear style of teaching and teaching pedagogy, and the environment, both tangible and intangible, that prevail in the technology education program at Wood River Middle School. The data presented is dynamic and intricate, with each element of creativity pointing back to one of the remaining three; and it is problematical at best to try and scrutinize one component under a microscope while completely ignoring the others.

Chapter 5: Conclusion

The final chapter in this thesis is intended to provide a final summation of the research, as well as offer some applicable dialogue for individuals in a position to affect change in some form or another in education. While we cannot escape the persisting expansion of international trade and intertwined economies, we can positively influence the role that education and we play on this integrated, worldwide stage. "In particular, the decisions we make today with respect to the education of our children will determine in large part whether they are prepared to hold high-wage, high-skill jobs that add significant value within the world marketplace, or are instead forced to compete with workers in developing countries (where economic output is likely to increase steadily over time) for the provision of commodity products and low-value-added services" (PCAST, 1997).

As technological advancements and changes continue to pop up with increasing frequency, it becomes progressively and intensely more difficult to stay atop of it all without readjusting one's skill sets and knowledge. Requiring a child to successfully complete one additional credit in a core subject area will probably not ensure that child secures a better paying job or a higher quality of life. The knowledge and skills needed to achieve or maintain success are constantly changing. It becomes the responsibility of educators to better equip students, not necessarily with more textbook knowledge, but with different types of skills. Such skills include, but are not limited to: problem solving, time management, creativity, and how to be a self-learner. Specific to this research, there is a very real need for education in general to support changes that will increasingly cultivate and encourage creativity in individual classrooms across the nation.

In the *Report to the President on the Use of Technology* (PCAST, 1997), creativity is directly mentioned as a necessary competence for tomorrow's workforce; or, for today's children attending schools nationwide. By its nature, technology education should be one area in education where creativity is fostered and developed among students with relative effortlessness. Mr. Thode's technology program at Wood River Middle School is definitely a place where creativity is strongly promoted and developed. This study has been undertaken to understand how Mr. Thode encourages creativity in his technology education classes. Data collected at the Wood River Middle School was filtered through four generally accepted components of creativity: a) the creative person, b) the creative product, c) the creative process, and d) the creative press, or, environment.

Summary of Findings

Summarizing the creative person.

Mr. Thode's personality exhibits several of Lyman's (1989) nineteen descriptors of traits common among the creative person. Mr. Thode is playful, adventurous, funny, and can be spontaneous when appropriate. He is enthusiastic. He is bold. He takes action. He is passionate about education and about the children that pass through his classes. He is not content with the mundane or mediocre. He is patient. He doesn't mind not having every single answer to every single question posed to him.

According to Sternberg and Lubart (1996; Starko, 1995), one cannot move forward in a domain without a useful knowledge of that domain; for knowledge allows the creative person to produce work or ideas that are novel to a particular domain and helps in the production of high quality work. Mr. Thode has developed a profound knowledge of technology and technology systems. His nonlinear teaching style allows for some ambiguity. He is willing to take sensible risks and willing to work hard to overcome obstacles. The manner in which he works with and mentors his students gives evidence that he himself is willing to grow. All these traits are common among the creative person (Sternberg & Lubart, 1993).

Other traits of the creative person also outlined by Sternberg and Lubart (1993) that Mr. Thode exhibits are his drive to achieve excellence in himself and his push to encourage his students to do the same. Two of the recurring dissatisfactions among students who participated in a questionnaire are his demands for correct grammar and his firmness, both of which he does out of the best interests of the students and not for any self-serving reasons. Mr. Thode stated, "We get more out of students because… even though we are going to give them some grief if they come to us without capitals and periods, they've learned something. It's not a punitive situation; it's a 'How hard is it to put a dot on the end of a sentence?' We remind them that we started teaching them that in second grade; so, we can make a joke out of it, but they're learning that it is serious."

Responses to the student questionnaire distributed during my data collection found many strong occurrences of creativity in the element of the creative person. An analysis of 77 student surveys in Berrett's (2003) data supports this finding. Student answers point out common characteristics: sense of humor, fairness, interest in helping students succeed, enthusiasm for the content, and respect. Following are some comments made by a small handful of Mr. Thode's students: "They open our minds to new things and if you can think of something to try they'll help you succeed at it." "They help me by showing me more ways to be creative." Mr. Thode gives "us the opportunity to try new things and learn in the process." "They kind of help by inspiring you to try something new." "They encourage you to think on your own instead of them telling you what to do." "He treats us like people rather than things or stupid little children like some of the other teachers."

The analysis of Berrett's interviews, responses to student questionnaires, formal interviews conducted, and observations illustrate that one of the way's Mr. Thode encourages creativity in his classes and works to develop it among his students is by *exemplifying* creativity! His students probably don't always recognize it for what it is, but it's always there in various forms: the ambiguity that allows the students to explore and develop their own ideas, the push for quality work and excellence, the novel ideas, etc. The ideas captured in the students' words are rich with support that Mr. Thode is indeed a creative person. One student summed it up rather well by stating, "Mr. Thode and Mr. Walrath can run this facility *only* with creativity; that is why everybody has fun in Tech!"

Summarizing the creative product.

It is commonly accepted that the creative product needs to be both original (or, novel) as well as appropriate (or, useful). With the data collected and organized, countless "creative products" emerged, each one noteworthy in its own right. From the clean room to the holographic technology to the space station spilling onto two levels to the flight simulator to the radio broadcasting, the Wood River Middle School technology program is certainly home to myriad novel and appropriate projects, technologies, and products of the technology program (see Appendix).

More than the concrete products outputted in Mr. Thode's technology program, however, it was the more subtle products that his students leave with that really stood out.

Nationwide, there are many good technology teachers who could fabricate similar projects. With the proper equipment, resources, and determination, there aren't many projects in Mr. Thode's lab that couldn't be duplicated elsewhere. Also, it's certain that the transferable skills emerging from Mr. Thode's classes will also be found in other schools and in other technology education programs across the nation, but not typically at the advanced level or with the same degree of frequency that they occur in Mr. Thode's classes. It seems that few classes or teachers allow students to engage in learning the material on such a personal level. It's simply awe-inspiring to see such "young" students learning critical skills as taking ownership of their own education, taking responsibility for their choices and actions, problem solving, creativity and critical thinking. What makes *these* products so original is that the individuals acquiring these products are preteens or barely older! What makes these products so useful is their critical nature in the escalating intercontinental economic competition.

When viewed through Csikszentmihalyi's "domain expert" lens (1996*a*), it is not unreasonable to claim that, having authored over five textbooks on the subject of technology and technological processes, and leading such a distinguished career, Mr. Thode may justly be considered an expert in the field of technology education. As he interacts with his students, Mr. Thode is constantly being forced to choose what to keep and what to eliminate from his curriculum. The assignments and projects in his classes are forever changing. Ironically, one thing that remains constant and unvarying is the opportunity he provides his students to develop certain crucial transferable skills.

Are these transferable skills actually being produced? MacKinnon (1978) would argue that if no product is actually being produced, it certainly couldn't be labeled as creative. Are Mr. Thode's students actually acquiring said transferable skills? Berrett's research (2003) compellingly indicates that indeed they are learning such skills. By their own admission, Mr. Thode's students are attaining these important transferable skills. "They guide me and help me solve problems with my own answers, but they make it interesting." Mr. Thode encourages creativity "by letting us figure things out." He pushes "me to learn how to do things on my own." Mr. Thode teaches "new things that can help me work out my own problems" and gives "the guidelines but not saying you have to do it a certain way." He lets "you build your own things instead of making you build a certain type of thing."

The creativity found in and among the products in Mr. Thode's technology classes is a culmination of many factors; Mr. Thode's personality, the environment that Mr. Thode has worked so tirelessly to bring to life, the students and their eagerness to experience technology, and the nonlinear teaching style Mr. Thode has polished over a long, fruitful teaching career all work together to provide creative products. Whatever the reason or combinations of reasons, the products Mr. Thode's students yield appear to effortlessly meet the standards commonly accepted in published research on creativity. Be they physical projects or transferable skills that Mr. Thode's students are bringing to life, the products in his technology education program are both original and appropriate.

Summarizing the creative process.

Published researchers of creativity agree, with few exceptions, that creativity can be developed; or, that creativity can be broken down into palatable stages that can be imitated and refined. Though researchers don't agree on exactly what those stages are, the literature on creativity suggests some commonalities among the different theories of the creative process. Osborn made it clear that the different steps in the creative process are presented merely as a support in researching creativity and to raise awareness of the creative process (1957). The creative person may skip over one or more of the phases. Common among many of the theories are a stage of preparation, followed by a stage of development, a subsequent stage of incubation and illumination, and finally, a stage of substantiation or authentication.

In the beginning phase of the creative process, individuals gain a solid understanding of their particular domain, accumulating the necessary skills, knowledge, experience(s), and techniques of the domain. The nature of the domain will influence the amount of time this period takes (Csikszentmihalyi, 1996*a*). In the second stage of the general creative process, data, possible solutions, and other information are evaluated and potential solutions generated. Typically, this phase is followed by a stage of incubation; and the problem is left alone for a spell. During this period of separation, the subconscious mind juxtaposes and contrasts ideas; and possible resolutions or answers are born, oftentimes, solutions that the conscious mind wouldn't have generated. Finally, in the final general stage of verification, the creative mind makes sense of these new solutions and judges their relevance, eventually settling upon and implementing the best solution for the occasion.

Mr. Thode's nonlinear teaching style allows for and strongly promotes the creative process. Mr. Thode efficiently teaches his students regarding each assignment. On Tech Notes (see *Appendix, Photographs* 39-40) sheets, each student documents the key points of each lecture, noting the objectives, essential details, and assignment requirements. They also record real life applications and impacts that the specific technology has on our society. Students observe demonstrations, watch videos, make connections between previous knowledge and the material being presented, and do the assignments hands-on. In this manner, students are actively learning about their domain - technology education - and going through the preparation stage of the creative process.

Development occurs as students are sent out into the lab where they are forced to complete the assignment on their own, in pairs, or in small groups. They are involved with brainstorming, problem solving to generate various possible solutions, evaluating their potential solutions, and trying to determine or predict the outcome or outcomes of their solutions and hypotheses. There are some classrooms that choose to gloss over this part of the creative process. In the interest of time, or teaching to a mandated test or some other very real motive, teachers often resort to "spoon feeding" the answers to their students, cutting corners, or glossing over portions of the curriculum, all of which comes at the sacrifice of the students' education.

This is definitely not the case in Mr. Thode's lab. He seems to *thrive* on this part of the creative process. This appears to be where his passion lies, interacting one-on-one with the students, bouncing from one location to another in his rather large lab. As he sees it, "failure" is as much a critical part of learning as "success." His classes, and personality, are such that thinking outside of the box and taking risks in education are encouraged and rewarded; not restrained or stifled. Deadlines are loosely set up, allowing learning to occur at an individual pace. In such a setting, "failures" are bound to occur; and yet his students seem to enjoy more frequent and more resonant "successes;" and, where failures do occur, they are recurrently used as valuable teaching moments.

The third phase in the general creative process happens in varying degrees and with varying frequency in Mr. Thode's classes. During the time that this research was conducted, the period of incubation and illumination seemed to occur more among the older students who were participating in more advanced classes. This stands to reason, since students returning to take additional classes from Mr. Thode are already familiar with the flexibility they are given as well as the responsibility he places squarely on their shoulders. The students tackle more complex problems and choose to participate in more involved and complicated projects. Naturally, this will lead to more questions, glitches, and challenges… leading to more apparent "a-ha" moments. A perfect example of such a moment would be the student participating in the Apple Core project who couldn't figure out how to program the CNC mill to design the game's apple-shaped board. After struggling to figure it out, he went home; returning the next morning excited to try the idea that had popped into his head overnight.

The nonlinear teaching method utilized by Mr. Thode allows for frequent verification of student work. The students are constantly revising their work and their solutions after they have tested or tried them and found them to fall short of the desired objective or result. I spoke with one student who was trying for the fourth time to build a water-bottle rocket! This particular student had thrice previously tried to use unique fin designs, but each time his rocket failed to reach any desired altitude. Through the refining process of hypothesizing and testing various solutions, the students, in time, discover and execute the best solution. Mr. Thode's nonlinear teaching style is neatly suited to allow the creative process to occur, to varying degrees, in his different classes.

Summarizing the creative press.

The environment is recognized as a very significant (and often overlooked) aspect of creativity (Dawson, 1997). An environment encouraging and supporting of creativity may be either concrete and tangible or subtle and intangible. Mr. Thode's lab clearly promotes creativity on both planes. The physical structure and layout (12 rooms spanning more than 4,000 square feet), the commitment of both students and teachers to safety, and the access students are granted to substantial and extensive resources not typically found in a middle school environment come together, serving to allow creativity to flourish and allowing students to immerse themselves in the specific technology they choose to study. Student projects can be found everywhere, which increases the sense of ownership students have in the tech program and serves as examples to other students.

The Wood River Middle School technology program is *much* more than just cool technological "toys" and gadgets, though. Of greater interest is the intangible environment of Mr. Thode's classes. Many common inhibitors of creativity are notably absent from Mr. Thode's classes or are present to a lesser degree. Time limits and deadlines are extremely flexible. Students are challenged without being inundated or drowned with too much information. Many of the projects build upon the knowledge or skills of other projects, becoming developmentally more challenging (Shallcross, 1981; Dawson, 1997).

Mr. Thode's nonlinear teaching and classroom follow Csikszentmihalyi's (1996*a*) seven elements of the creative environment uncannily (see pp. 28-29). Mr. Thode and Mr. Walrath are both very well prepared and are admirably trained. It is expected (and made clear) that students act with maturity and perform completely. The materials and resources available to students are plentiful and readily available. The creative potential of the students and teachers is acknowledged gratefully. Opportunities are provided to allow students to identify their aspirations and pursue them. Occasions for self-direction are more plentiful in Mr. Thode's classes than can be described. Intrinsic motivation is just as frequent and common as is extrinsic motivation, a phenomenon not commonly found in a system of education where so much emphasis is placed on a letter grade.

The creative environment does not necessarily equate to a chaotic environment, and certainly does not mean that the teacher's authoritative role is abandoned and handed over to the students. Mr. Thode's classes offer a sufficient balance between the students' freedoms and flexibility, and structure and safety provided by the teacher. By giving students the responsibility of their own learning as well as giving them a chance to tailor the direction of their learning, Mr. Thode encourages more and more risk-taking, an oft-mentioned key indicator in the creative environment. Mr. Thode is careful to mix humor with seriousness, going to great lengths to be sensitive to students' feelings and challenges.

The environment created by Mr. Brad Thode in his classes is serious and fun, safe and open. He has coaxed risk-taking out of students immersed in an education system that discourages students from "dissenting", critiquing the curriculum, or doing much of anything that goes against "the flow." His is truly the creative press.

Implications

So what? How is all of this supposed to help change anything? Changing something in the United States as large and complex as public education is bound to be a slow process, at best. In many ways it appears that the typical classroom hasn't changed much philosophically or in practice since it's realization. With the old adage "If you always do what you've always done, you'll always get what you have always gotten" in mind, we cannot expect to see improved results by changing nothing or changing little.

Applying a band-aid solution will do little but mask the problems temporarily. I am not asserting that by infusing creativity into classrooms and curricula across the nation all the problems and challenges facing the world, it's economy, or even education will be resolved. Changing the educational system will take decades and needs to occur on so many different levels, but it is possible to move forward all the same. Mr. Thode represents one instance where exemplary teaching results in an increase of creativity, and a classroom where creativity is fostered and encouraged, not stifled and restrained. Instilling the transferable skill of creativity into education will offer graduating students an additional and necessary edge; so they may be better prepared to meet the demands of a global workplace and be productive members of their communities.

Without support among all the ranks, from the ground up, no lasting changes will be made to enhance creativity in our schools. Creativity needs to be valued at every level of education, and not in word only. From the teachers in the classroom to the administration of schools and districts to school boards to parent or community volunteers, creativity needs to be recognized as a critical component of one's education. With this recognition, the current view of the "model student" also needs to be modified to include behaviors common to the creative person. The current tendency is to esteem and encourage conduct which leads to more conformity in the classroom, not creativity.

Pedagogy we can apply.

So how does Mr. Thode do it? Most notably, he's *passionate* about education and his students. He is committed wholly to ensuring that he helps each student that is willing to be helped and is willing to learn. When comparing research on creativity with the findings of this research, there is a very apparent relationship between Mr. Thode and his nonlinear teaching method and the development of creativity. In all four elements of creativity - person, product, process, and press - Mr. Thode is consciously or unconsciously producing creativity among his students.

He *encourages risk-taking* in an environment that is safe. His *humor* and *love for the students* and for technology education have made that a norm commonly missing in most classes. He *builds personal and appropriate relationships* with his students. The *environment is structured*, but not rigid. Students enjoy a great deal *freedom to manage their learning*, and are expected to do so. This expectation leads to *learning that is student-centered*; which, in turn, allows them additional freedoms to influence and tailor their assignments. Students returning to take additional classes from Mr. Thode find that problems become more and more *ill structured*, and that assignments become more and more long term. By the time they enter the advanced technology classes, they are heavily involved in their own learning, with Mr. Thode taking on a more supporting role of a coach and mentor.

This supports the notion that his students are being *motivated intrinsically*. Assessments in Mr. Thode's classes are *performance-based*. Projects are a manifestation of student creativity, and are therefore appropriate in measuring what a student has understood and retained (Michael, 2001). A student can try and "fail" four or five times before finally accomplishing what he or she set out to do, and what really matters in Mr. Thode's eyes is *not* that the student was finally "successful" but whether or not that student was actually *learning along the way*. Students aren't afraid to try new things or to take the road less traveled because *they see their teacher trying new things*! Mr. Thode *models creativity* in his lectures and assignments and demonstrations.

Knowledge being acquired in Mr. Thode's classes is useable, not simply knowledge for knowledge's sake. His students are learning *how* to learn, how to find answers in books and on the Internet and in Help menus and from each other and from adults in industry. They are taught *divergent thinking*. Students generate multiple possible solutions to complete assignments and solve problems. Sometimes they're right, other times they're wrong. Sometimes their ideas work, and sometimes they don't. No matter what the case may be in any given situation, the students are learning and thinking and going out on a limb to try something a new way. They have plenty of *resources* to work with and work from. The students are *challenged* without being completely overwhelmed.

It is clear that the underlying implication that may be drawn from this research is that the creative process may, to some degree or another, be taught, and therefore increased and supported in our schools. Conscious efforts may be made on various levels of education to strengthen and encourage creativity. There are areas in which individual teachers can improve that will serve to foster more creativity, their person, the products and processes in their classrooms, and the press in and of their classrooms. Administrators of schools or districts can, in the same general areas, also work to develop more creativity among those with whom they work and oversee. Even school boards and volunteers and advisory committees and community partners can work in various forms to increase the creativity in our classrooms. To be sure, different individuals have different propensities and strengths. Like Ford and Harris wrote, “Creativity is a modifiable, deliberate process *that exists to some degree in each of us* [italics added]” (1992, p. 187). Some seem to be endowed with more creativity than others. Creativity will look different to different people and will be interpreted differently by the same! That being mentioned, however, there is room in us all to improve our creative abilities, no matter how that may be.

Recommendations

Risk taking. A structured, safe environment. Student-centered learning. Useable knowledge. Long-term assignments. Modeling creativity. Divergent thinking. Intrinsic motivation. Ill-structured problems. Students in control of their learning. Resources. Performance-based assessment. Students being challenged and learning how to learn. All these are indicators that creativity is occurring in Mr. Thode’s classroom, and more so than in traditional classrooms. This is, in large part, due to the unique, flexible nonlinear teaching method used by Mr. Thode.

To look at all of this and try to incorporate all of it into one’s own teaching methods can be more than a little daunting, overwhelming, or even downright discouraging! It should be clearly understood that Mr. Thode and his technology lab are the result of over thirty years of commitment and extraordinary vision. For an educator looking to promote and develop a little more creativity in his or her classroom, the first step is to make an effort to value creativity and be willing to allow creative behaviors into the classroom. Recognize creative tendencies for what they are and encourage them.

Commit some time to introspection, and identify how you, as an educator, can better model creative behaviors in the classroom.

Choose one element from one of the four general components of creativity you wish to work on, or improve and do it! Maybe you want to work on acquiring more resources to offer your students. Look around for additional funding in the district, or pursue some grants. Maybe you want to work on developing an environment more friendly and open to student-centered learning. Review some of your existing lesson plans or outlines and look for ways to improve the assignment or project. Try and make the assignment more ill-structured; or, try and add some elements that will require higher-order thinking skills. Projects that are long term allow students to build on previously acquired knowledge and put to use the knowledge they've acquired. Commit to trying to intrinsically motivate your students. Focus on trying to assess student work differently, and don't be so quick to utilize assignments, tests, or projects that require convergent thinking. Instead, look for ways to incorporate more divergent thinking in the classroom. Make efforts to step into a role that facilitates more and spoon-feeds less. Take something that is out of your comfort zone and push yourself. This, in and of itself, as a creative act will increase your ability to teach creativity.

As an administrator, encourage creativity among the staff with whom you work. Value and model creative behavior, and be willing to positively acknowledge and allow creative behaviors. Look for ways to encourage divergent thinking around you. Recognize and reward creative behaviors appropriately. Make a note of where the resources are going, and look into reallocating resources to promote creativity in the classrooms. Present those with whom you work challenges or projects that will force them to stretch and grow without overwhelming them. Allow creative behaviors that may not conform to "the norm."

Patterning one's education styles after Mr. Thode and his nonlinear approach to teaching is but *one* valid solution to address the lack of creativity in our schools. It certainly is not the only way. Rather than trying to recreate the nonlinear method of teaching in one's classroom, it may be more reasonable and practical to simply borrow and implement elements and examples from Mr. Thode, his classes, and teaching methods. Any legitimate effort made to increase the creativity in the classroom is a step in the right direction. This study gives us hope and is an example of one way a single teacher of exemplary practice effectively teaches and promotes creativity in his classroom. It provides inspiration for teachers to improve creativity in their classrooms nationwide.

References

Anarella, L. A., (1999). Encouraging Creativity and Imagination in the Classroom. (ERIC Document Reproduction Service No. ED434380)

Berrett, J. (2003). Teaching Technological Literacy Through a Non-Linear Approach: A Case Study of Exemplary Practice at Wood River Middle School. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Bloom, B. (1956). *Taxonomy of educational objectives, handbook I: Cognitive domain*. New York, David McKay.

Brown, R. T. (1989). Creativity: What are we to measure? In J. A. Glover, R. R. Ronning, C. R. Reynolds (Eds.), *Handbook of Creativity* (pp. 3-32). New York: Plenum Press.

Cameron, S. G. (2000). Technology in the Creative Classroom. (ERIC Document Reproduction Service No. ED441260)

Campbell, D. T., & Russo, M. J. (2001). *Social Measurement*. Thousand Oaks, CA: Sage Publications.

Carter, M. (1992). Training teachers for creative learning experiences. *Exchange*, 5, 38-40.

Cho, B., & Kim, J. (1999) The improvement of children's creativity through Korean picture books. *Childhood Education*, 75(6), 337-341.

Cole, D. G., Sugioka, H. L., & Yamagata-Lynch, L. C. (1999). Supportive classroom environments for creativity in higher education. *Journal of Creative Behavior*, 33(4), 277-293.

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. (2nd ed.). Thousand Oaks, CA: Sage Publications.

Cromwell, R. (1993). Creativity is a Key to the Future and to Education: The Importance of Creative Visioning. Paper presented at the Annual Meeting of the American Association of Colleges for Teacher Education, San Diego, CA. (ERIC Document Reproduction Service No. ED356196)

Cropley, A. J. (1999). Creativity and cognition: Producing effective novelty. *Roeper Review*, 21(4), 253-266.

Cross, T. (2003). Rethinking gifted education: A phenomenological critique of the politics and assumptions of the empirical-analytic mode of inquiry. In J. Borland

(Ed.), *Rethinking gifted education* (pp. 72-79). New York: Teachers College Press.

Cross, T., et al. (2003). Phenomenology and its implications for gifted studies research: Investigating the lebenswelt of academically gifted students attending an elementary magnet school. *Journal for the Education of the Gifted*, 26(3), Spring 2003. 201-220.

Csikszentmihalyi, M. (1996a). *Creativity: Flow and the psychology of discovery and invention.* New York: Harper Collins.

Csikszentmihalyi, M. (1996b). The creative personality. *Psychology Today*. Jul/Aug 1996, 29(4), 36-40.

Davis, G. A., Kogan, N., & Soliman, A. M. (1999). The Qatar creativity conference: Research and recommendations for school, family, and society. *Journal of Creative Behavior*. 33(3), 151-166.

Dawson, V. L. (1997). In search of the wild bohemian: challenges in the identification of the creatively gifted. *Roeper Review*. 19(3), 148-152.

Denzin, N. & Lincoln, Y. (Eds.). (2000). *Handbook of qualitative research* (2^{nd} ed.). Thousand Oaks, CA: Sage Publications.

Denzin, N., & Lincoln, Y. (Eds.). (2003). *Collecting and interpreting qualitative materials* (2^{nd} ed.). Thousand Oaks, CA: Sage Publications.

Driver, M. (2001). Fostering creativity in business education: Developing creative classroom environments to provide students with critical workplace competencies. *Journal of Education for Business*. Sept / Oct. 2001, 28-33.

Eisenberger, R., & Cameron, J. (1998). Reward, intrinsic interest, and creativity: New findings. *American Psychologist*, June 1998.

Fleith, D. (2000). Teacher and student perceptions of creativity in the classroom environment. *Roeper Review*, *22*(3), 148-153.

Ford, D. Y., & Harris, J. J., III (1992). The elusive definition of creativity. *Journal of Creative Behavior*. 26(3), 186-198.

Garza, G. (2006). A clarification of Heidegger's phenomenology. *American Psychologist*. April 2006.

Gay, L., & Airasian, P. (2003). *Educational research: competencies for analysis and applications* (7^{th} ed.). Upper Saddle River, NJ: Prentice Hall.

Goree, K. (1996). Creativity in the classroom… Do we really need it? *Gifted Child Today*. *19* (4), 36-37.

Hoepfl, M. C. (1997) Choosing qualitative research: A primer for technology education researchers [Electronic Version]. *Journal of Technology Education*. *9*(1).

Honig, A. S. (2000). Promoting creativity in young children. Paper presented at the annual meeting of the board of advisors for Scholastic, New York, NY. (ERIC Document Reproduction Service No. ED442548)

Houtz, J. C. (1994) Creative problem solving in the classroom: Contributions of four psychological approaches. In M. A. Runco, (Ed.), *Problem finding, problem solving, and creativity*. Norwood, NJ: Ablex Publishing Corporation.

International Technology Education Association (1995). About ITEA. Retrieved December 15, 2006, from http://www.iteaconnect.org/AboutITEA/about.htm

Isaksen, S. G., & Trefffinger, D. J. (1985). *Creative problem solving: The basic course*. Buffalo, NY: Bearly Limited.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, 24(4), Dec. 1979, 602-611.

Kneller, G. F. (1965). *The art and science of creativity*. Austin, TX: Holt, Rinehart, and Winston, Inc.

Kraft, U. (2005). Unleashing creativity. *Scientific American Mind*. April 2005, 16-23.

Lyman, D. H. (1989). Being creative. *Training and Development Journal*. April 1989, 43(4), 44-49.

MacKinnon, D. W. (1978). *In search of human effectiveness*. Buffalo, NY: Creative Education Foundation.

Manzo, A. V. (1998). Teaching for creative outcomes: Why we don't, how we all can. *The Clearing House*. 71(5), 287-290.

Martindale, C. (1989). Personality, situation, and creativity. In J. A. Glover, R. R. Ronning, C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 211-232). NY: Plenum Press.

Meador, K. (1999) Creativity around the globe. *Childhood Education*. 75(6), 324-325.

Michael, K. Y. (2001) The effect of a computer simulation activity versus a hands-on activity on product creativity in technology education [electronic version]. *Journal of Technology Education*. *13*(1).

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Nierenberg, G. I. (1982). *The art of creative thinking*. New York: Simon & Schuster, Inc.

Oppenheimer, T. (1997). The computer delusion. *Atlantic Monthly*, 15 July 1997.

Osborn, A. F. (1957). *Applied imagination: Principles and procedures of creative thinking*. NY: Charles Scribner's Sons.

Perkins, D. N. (1988). Creativity and the quest for mechanism. In R. J. Sternberg & E. E. Smith (Eds.), *The Psychology of Human Thought* (pp. 309-336). New York, Cambridge University Press.

Peters, T. (2005). Leadership. New York: DK Publishing, Inc.

Peterson, R. E., & Harrison, H. L. III (2005). The created environment: An assessment tool for technology education teachers. *The Technology Teacher*, 64(6), 7-10.

Polkinghorne, D. E. (1989). Phenomenological research methods. In R. S. Valle & S. Halling (Eds.), *Existential-phenomenological perspectives in psychology* (pp. 41-60). New York: Plenum Press.

President's Committee of Advisors on Science and Technology (1997, March) *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States*. Education Technology Initiative, Washington DC: U.S. Government Printing Office.

Pritchett, P. (1996) *Mindshift- The employee handbook for understanding the changing world of work*. Dallas, TX: Pritchett & Associates.

Rejskind, G. (1998). TAG teachers: Only the creative need apply. *Roeper Review*. 22(3), 153-157.

Rodd, J. (1999). Encouraging young children's critical and creative thinking skills: An approach in one English elementary school. *Childhood Education*, 75(6), 350-354.

Runco, M. A., Nemiro, J., & Walberg, H. J. (1998). Personal explicit theories of creativity. *The Journal of Creative Behavior*, 32(1), 1-17.

Secretary's Commission on Achieving Necessary Skills (1991). *What work Requires of Schools- A SCANS Report for America 2000*. U.S. Department of Labor, Washington DC: U. S. Government Printing Office.

Shallcross, D. J. (1981). *Teaching creative behavior: How to teach creativity to children of all ages*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Shaughnessy, M. (1991). The Supportive Educational Environment for Creativity. (ERIC Document Reproduction Service No. ED360080)

Sorokin, P. A. (1967). General theory of Creativity. In Nelson, L. & Psaltis, B. (Eds.), *Fostering creativity*. Associated Educational Services Corporation.

Starko, A. J. (1995). *Creativity in the classroom: schools of curious delight*. New York: Longman Publishers.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. Cambridge, MA: Cambridge University Press.

Sternberg, R. J. (2001). What is the common thread of creativity? Its dialectical relation to intelligence and wisdom. *American Psychologist*. April 2001.

Sternberg, R. J., & Lubart, T. I. (1991). Creating creative minds. *Phi Delta Kappan*, 72(8), 608-614.

Sternberg, R. J., & Lubart, T. I. (1993). Creative giftedness: A multivariate investment approach. *Gifted Child Quarterly*, 37 (1), 7-13.

Sternberg, R. J., & Lubart, T. I. (1996). Investing in creativity. *American Psychologist*, July 1996, 51(7), 677-688.

Taylor, C. W. (1964). *Creativity: Progress and potential.* Columbus, OH: McGraw-Hill, Inc.

Taylor, I. (1975). An emerging view of creative actions. In I. A. Taylor & J. W. Getzels, (Eds.), *Perspectives in creativity*. Chicago, IL: Aldine Publishing Company.

Treffinger, D. J. (1986). Research on creativity. *Gifted Child Quarterly*, 30(1), 15-19.

Todd, S. M., & Shinzato, S. (1999) Thinking for the future: Developing higher-level thinking and creativity for students in Japan- and elsewhere. *Childhood Education*, 75(6), 342-345.

Torrance, E. P. (1963). *Creativity*. Washington, DC: National Education Association.

Torrance, E. P. (1969). *Creativity*. San Rafael, CA: Dimensions Publishing Co.

Torrance, E. P. (1970). *Encouraging creativity in the classroom*. Dubuque, IA: Williams C. Brown Company Publishers.

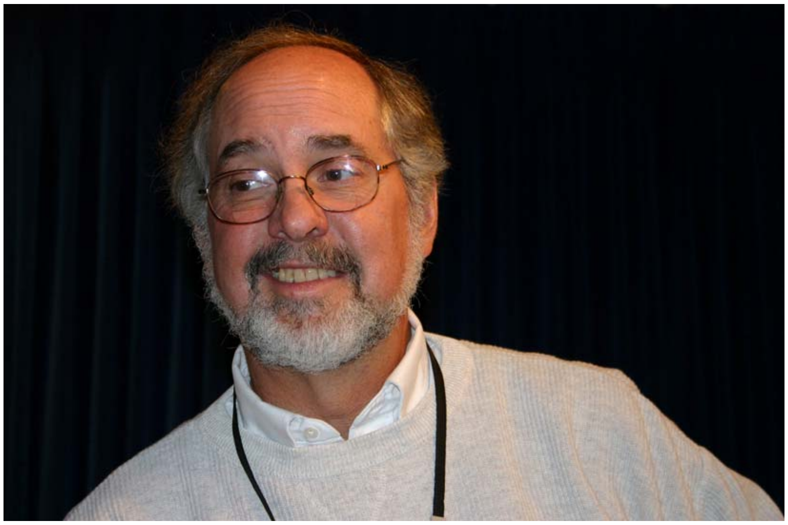
Torrance, E. P. (1971). Are the Torrance tests of creative thinking biased against or in favor of disadvantaged groups? *Gifted Child Quarterly*, 15, 75-80.

Wallace, G. (1926). *The art of thought*. London: Watts.

Walworth, C. (1993, Sept 19). *Interplanetary Kids*. Times-News, Sun Valley, ID, pp. C1-C2.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Appendix

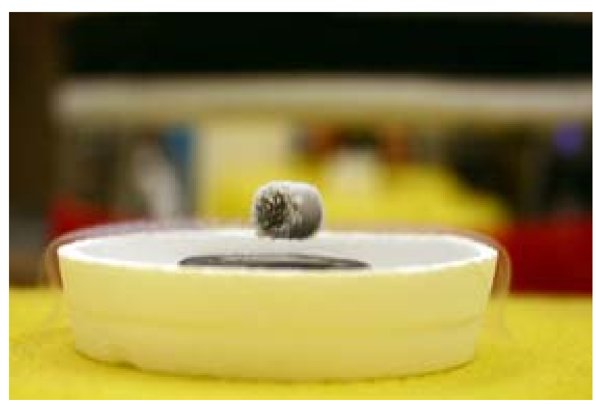


Photograph 1. One of Mr. Thode's typical expressions is a warm smile.

Photograph 2. The demonstration table is set up for a lecture on superconductivity.

Photograph 3. Mr. Thode added liquid nitrogen to his tea to create "iced tea."

Photograph 4. This marshmallow practically exploded when Mr. Thode bit it after submerging it in the liquid nitrogen!

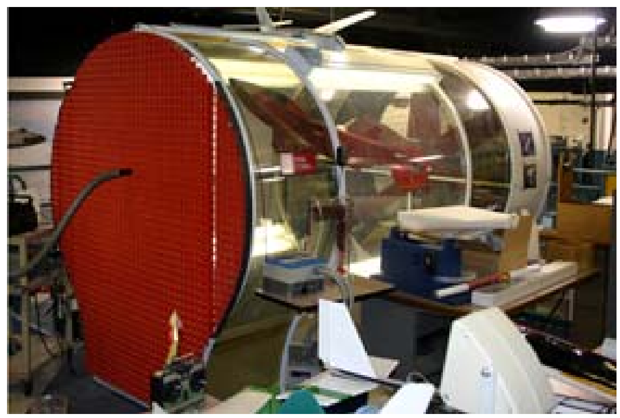


Photograph 5. Superconductivity in action. The effects of the extreme cold cause the magnet to levitate.

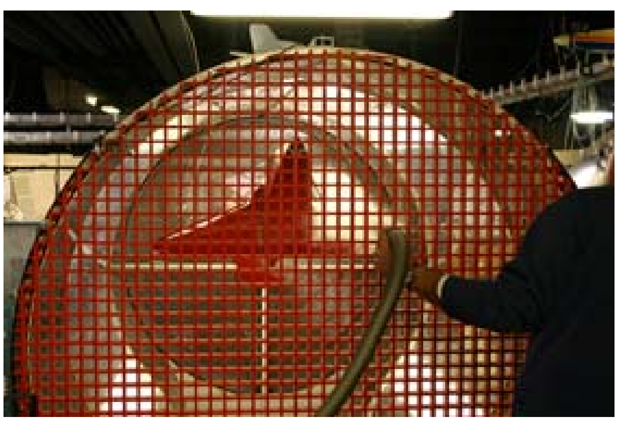
Photograph 6. Looking at the flight simulator. Helmets (bottom left of photograph) are required when using the simulator.

Photograph 7. A second view of the flight simulator.

Photograph 8. Mr. Thode spins a student in the flight simulator during a lunch break.



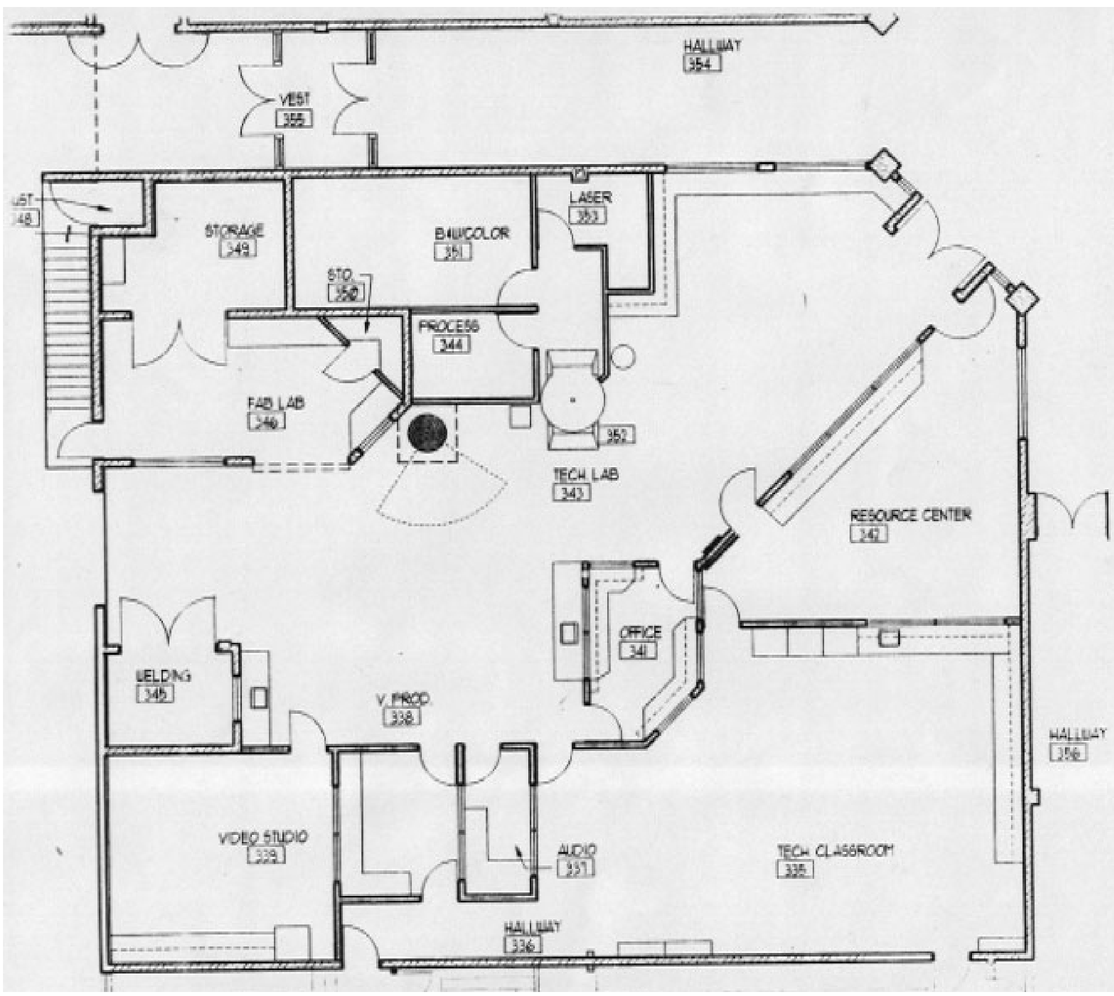
Photograph 9. The human wind tunnel sits on the second floor of the Tech Lab.



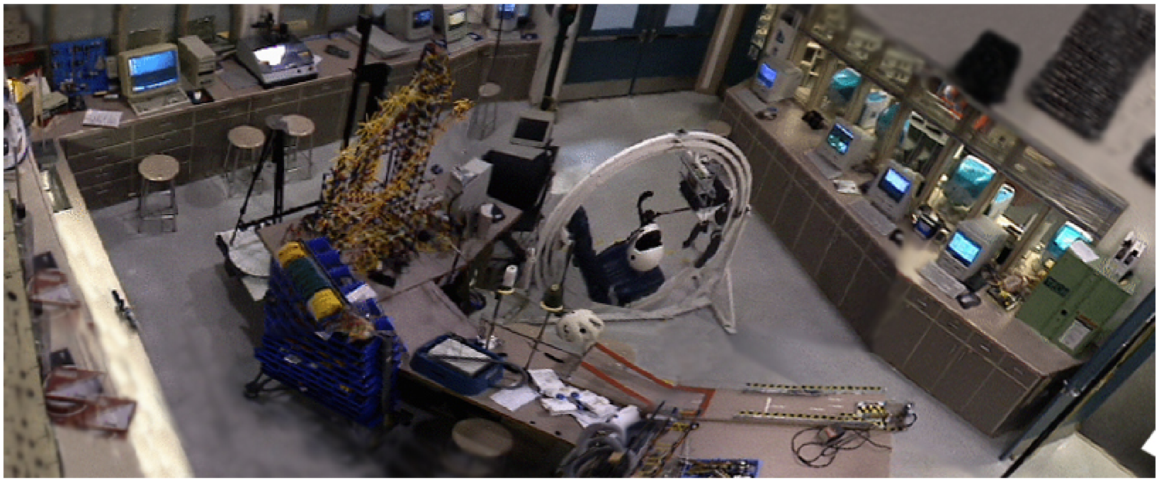
Photograph 10. Mr. Thode stands to the right of the human wind tunnel, demonstrating how it works with a model rocket inside.

Photograph 11. Looking straight on at the Mars rover.

Photograph 12. Students still have a little work to do on the Mars rover.



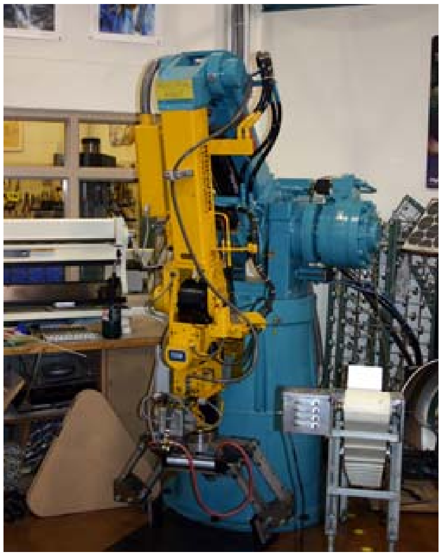
Photograph 13. A detailed floor plan of Mr. Thode's unique physical facilities at Wood River Middle School.



Photograph 14. Looking down from the second floor into the Tech Lab.

Photograph 15. A side view of the hovercraft test track built in Mr. Thode's program.

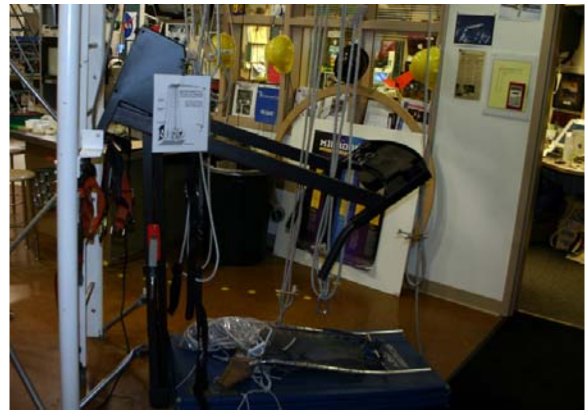
Photograph 16. One of the students was very excited to show me the hovercraft he constructed!



Photograph 17. This industrial robotic arm was donated to Mr. Thode's technology education program.

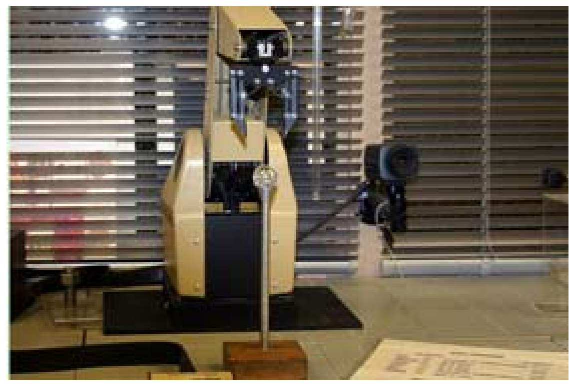
Photograph 18. Looking at the bottom level of the model space station. A ladder connects the two levels.

Photograph 19. Looking across the second floor of the Tech Lab at the upper level of the space station.



Photograph 20. The micro gravity simulator used to be a common treadmill!

Photograph 21. Using this laser-guided straw rocket launcher, students shot their straw rockets across the Tech Lab at the satellite dish by the space station.



Photograph 22. This smaller robotic arm was tasked with picking up the glass sphere in front of it and relocating it.

Photograph 23. A panoramic view of the technology classroom.

Photograph 24. Two students having fun filming for their animation.

Photograph 25. Having already completed the filming, this team of students enjoyed editing as much as filming.

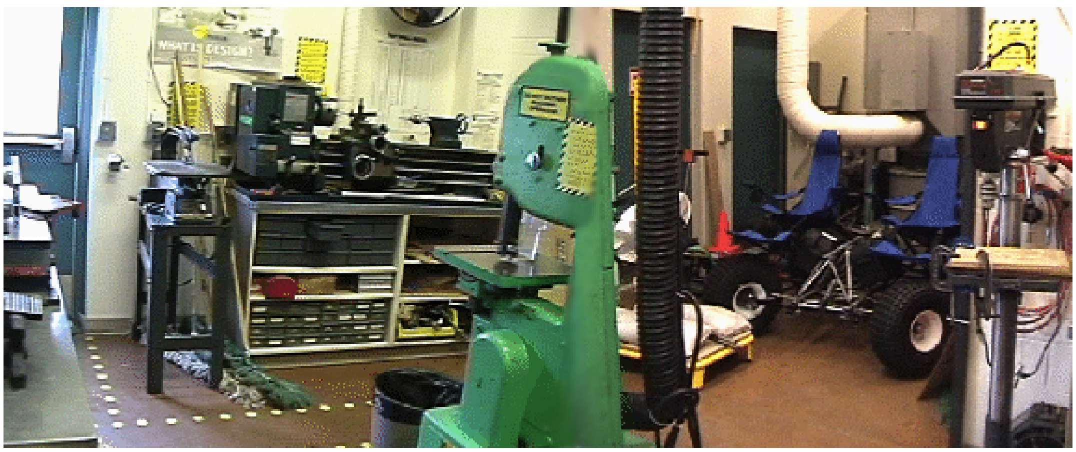
Photograph 26. A snapshot of the audio recording and broadcasting facilities.

Photograph 27. Looking at some of the equipment available to the students involved with video production and the school's video announcements.

Photograph 28. Peering at the other side of the video production facilities.

Photograph 29. Adjacent to the video production facilities, the video studio is where the school's video announcements are filmed.

Photograph 30. The technology education welding equipment.



Photograph 31. The Fab Lab.

Photograph 32. Having dressed appropriately, two students prepare to work on an assignment in the clean room.

Photograph 33. In typical "Thode style," Mr. Thode's office is a good example of managed chaos!

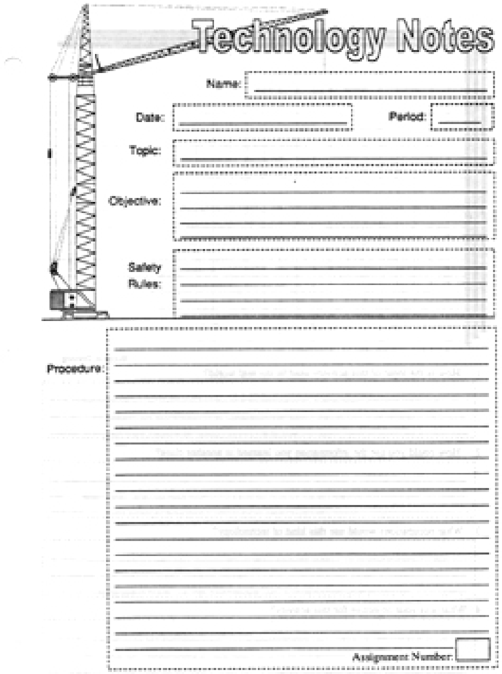
Photograph 34. A model of the Apple Core game board, constructed out of foam core.

Photograph 35. A miniature game board was developed in the preproduction stages of the Apple Core project.

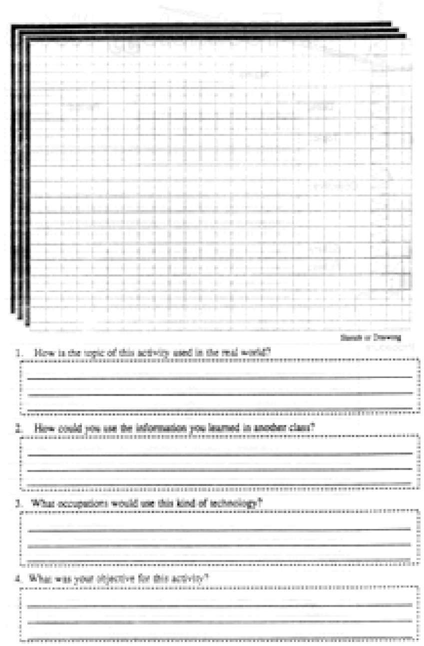
Photograph 36. One of the Apple Core project's trial runs in the production stages.

Photograph 37. The final game board!

Photograph 38. The Tech ID badges must be worn by students at all times while working in the tech facilities.



Photograph 39. Front side of the Tech Notes sheet.



Photograph 40. Back side of the Tech Notes sheet.