2008

Perceptions of Creativity in Art, Music and Technology Education

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Perceptions of Creativity in Art, Music and Technology Education

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

David Russell Stricker

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Dr. Theodore Lewis

June 2008

ACKNOWLEDGEMENTS

No undertaking of this nature is ever accomplished alone. I would like to thank a number of people who have empowered me to complete my dissertation work and doctoral degree.

First, I would like to thank my wife, Shawn, for the unparalleled love and encouragement she provided during my work. From beginning to end, her support has been unconditional and invaluable during this journey. I could not have done it without her. I would also like to thank my parents, Jeff and Karen for their encouragement and support throughout all of my endeavors. Their belief in me and the rewards of diligent work have always provided inspiration. Also, throughout the ups and downs of graduate work, my dearest friend Mauvalyn Bowen has always been a positive spirit and a valued companion.

I could have never completed this dissertation without the support and consultation received from the generous people involved in the National Center for Engineering and Technology Education (NCETE). Their academic, financial, and personal support made this work possible. Thanks to my committee members: Dr. Rosemarie Park, Dr. Jim Brown and Dr. Karl Smith. They have always been available and timely with valuable guidance and insights. Lastly, I'd like to express my sincere gratitude to my advisor, Dr. Theodore Lewis. I have always been able to count on his wisdom and knowledge of the field to guide me through the myriad facets of doctoral work. Dr. Lewis, thank you for your patience and the motivation you've provided me during this process.

DEDICATION

To my daughters,

Madeline and Sydney,

who have been a wonderful source of inspiration.

ABSTRACT

This study was conducted to examine the perceptions of art, music, and technology education teachers with regard to creativity in their respective fields.

The survey used in this study was designed around the themes borne out of creativity literature generally and creativity specific to the fields of art, music, and technology and engineering education. As a result the themes of creative process, products, personal traits, and environment shaped the items contained in the survey.

Although participants from all three subjects perceived the creative process as important to creative work generally, technology education teachers were less interested in the importance of the creative process than the teachers of art and music. In addition, technology education teachers perceived a product's ease of use, practical implications, value to the community, craftsmanship, ability to respond to a need, and general adherence to technical standards as being important features of a creative product in their field when compared to art and music teachers. Art teachers valued creative personality traits significantly more than their peers in technology education. The perception of the importance of group work and competition was significantly higher for technology teachers than for art teachers.

Lastly, of the variables of subject (art, music, or technology education) taught, grade levels taught, years of teaching experience, level of education, and gender, the subject the participants taught was the only significant determinant of creativity perceptions in the study.

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Introduction

Inconsistency exists between the type of capabilities students are required to demonstrate in school and what is expected of them once they leave. With educational standards being adopted and refined for all subjects in many states in the U.S. and the increased usage of standardized test results employed to benchmark individual schools' success, the tendency for teachers to "teach to the test" and students to subsequently learn about the world around them in a rote and myopic fashion can be expected (Ediger, 2000). Ironically, business and engineering communities emphasize the importance of 'outside the box' thinking and the need for creative solutions as a result of competitive market pressures that characterize the true global economy that exists today (Mahboub, Portillo, Liu, and Chandraratna, 2004). As a result, a question arises amid these competing educational paradigms: Where in the curriculum are students allowed to exercise their innate creative urges? More specifically, since it is such a valued skill, how is creativity fostered in students? The more aesthetic subject areas such as art, music, and technology education that not only receive less attention in schools, but emphasize divergent thinking in their curricula, may be the answer (Lewis, 2008). For technology education specifically, with its current curricular efforts focused on the infusion of engineering concepts that inherently demand creative thinking, the topic of providing opportunities for and nurturing creativity is of particular interest to educators at all levels within the field.

Along with the communities mentioned earlier, other motivating factors outside education provide motivation for technology educators to discover the educational power of their subject area. Professionals and the general public think that the type of jobs needed for the problems posed by 21st Century society involve information management skills and critical thinking abilities (Commission on the Skills of the American Workforce, 2006). Teaching children these skills requires different teaching methods, learning materials, school structures and assessment techniques. Simply put, the roles of teachers and students are changing. Many of these changes are focusing attention on the development of higher level thinking skills and the kinds of pedagogical methods used by creative educators: active learning; personal involvement in learning; in depth experience with real life, complex problems; use of technology to aid thinking; information management; and problem solving (Houtz and Krug, 1995). Taught correctly, technology education, using the contemporary engineering infused curriculum, can consistently provide these types of learning experiences for students that encourage and foster creative thinking. Therefore, with problem solving, design and critical thinking at the core of technology education, it is not a large leap to conclude that the role creative thinking plays in each of these domains is crucial. Indeed, the *Standards for Technological Literacy* (International Technology Education Association, 2000) specifically mentions the importance of creativity in technology education: "Creativity, in addition to the ability to think outside the box and imagine new possibilities, is central to the process of invention and innovation. All technological products and systems first existed in the human imagination". (p. 106).

This is not the subject's first claim as a context for fostering creativity by offering unique learning experiences. Indeed, in the 1870's, one of technology education's earliest pioneers and scholars in the U.S., Calvin Woodward, wrote often about the effect *manual training* (technology education of its time) had on students in relation to their experiences with the rest of the classes in the school day. He believed that the importance of manual training was not to just train students for a trade. In addition to being narrow minded, he believed this view underestimated the expansive potential of the subject (Woodward, 1882). Indeed, he commented that "arts are few, the trades are many" and because the arts underlie trades, they represent a stepping stone to exploring and learning about the processes inherent in trades (p. 153). These comments betray the unique potential even early forms of technology education had to provide a way for students to process and experiment with knowledge they had gained from other subjects, as well as their manual training course work. Additionally, Woodward commented on his experience with parents who were often concerned about their students' lack of enthusiasm for a specific vocation. His rebuttal to them was, "The grand result (of being involved in a well rounded manual training education) will be an increasing interest in manufacturing pursuits, more intelligent mechanics, more successful manufacturers, better lawyers, more skillful physicians, and more useful citizens" (Woodward, 1883, p. 89). This lends further support to the truly authentic and encompassing educational power manual training exacted in relation to other subjects.

John Dewey, also a proponent of the subject, contended that, as a result of the massive social changes brought about by the Industrial Revolution, education had become disconnected from society and, in turn, the needs and interests of the individual pupil were being neglected in education. In his opinion, learning and teaching had become disjointed and rote when compared to the reality outside of the school building. He desired to adapt instruction to students' interests and use activities that considered these interests as the engine for education (Cohen, 1998). Much like Woodward, Dewey did not want a child educated to a specific trade or vocation. Rather, a student should develop artistic capacity, scientific ability, effective citizenship and professional and business acumen that were guided by the needs and interests of the child at the time (Dewey, 1916).

The potential for students to uncover unique talents and allow for authentic work not accomplished in other subjects is evident and, as alluded to earlier in *Standards for Technological Literacy,* continues to be a goal today. Indeed, there are several accounts in contemporary literature regarding the powerful and unique learning opportunities modern technology education, specifically with its emphasis on design and engineering, continues to provide. For example, Welch and Lim (2000) contend that while other subjects in the curriculum offer the problem solving approach that assumes there is only one way to find a single solution, technology education presents tasks that have many possible ways to finding different solutions. Further, this opportunity to think divergently provides students with opportunities to apply knowledge to generate and construct meaning. In essence, "it fosters the kind of cognition that combines declarative knowledge, the *what*, with procedural knowledge, the *how"* (p. 34). In light of this brief discussion of the unique and enduring capacity of the technology education curriculum to offer students an opportunity to foster divergent and creative thinking abilities, it is important at this point to examine the historical foundations and subsequent curricular changes that led to the present design and engineering based approach.

Epistemological Foundations of Technology Education

Beginning with the broad consideration of the nature of knowledge itself, technology education as a whole has lacked consensus throughout its history on what type of knowledge the subject is trying to impart. The Aristotelian ideas of phronesis, a knowledge that is practical (Hooley, 2004), and techné, technical rationality in creating craft or art (Parry, 2003) lend themselves well to defining the types of knowledge technology education is specifically able to develop. In other words, these philosophies are of interest because they provide evidence of the idea that technical knowledge is a distinct type of knowing and way of thinking. Further, they apply directly to thought processes inherent through all the historical phases of technology education.

In order to explore and discuss the concepts of techné and phronesis and their use in technology education, clearer definitions are necessary. Aristotle distinguishes between theoretical and practical knowledge. Theoretical (or ultimate) knowledge, termed *episteme*, is characterized by knowledge that should explain events and phenomena in a particular field. Theoretical knowledge is attained through the senses. A person's intellect allows them to process the information from their senses and form generalizations about the witnessed action or scene (Back, 2002). Practical knowledge relates to how a person acts when confronted with a problem or situation. In other words, a person's actions in a given situation are determined to a certain extent on their experience. Arriving at an answer for the situation is a combination of skill (techné) and practical wisdom or experience (phronesis) (Dunne, 1993). Aristotle also contended that each action taken under the guide of a person's own application of techné and phronesis seems to aim at some personal and/or overall good. However, these actions may be ends in themselves or they may produce an outcome or product (Parry, 2003). A good example was provided by Dunne during his discussion of art as a craft and how magic is accomplished as a means not an end. In other words, there is no intended end product in magic. Rather, this art (magic) is designed to evoke emotion through amusement to enjoy the emotions themselves (Dunne, 1993, p. 58). On the other hand, a mechanical engineer for example, enters into the process of building a product not for the experience itself, but for the end product. In this instance, the process may yield some type of emotional satisfaction, but the end result was the motivation for undertaking the construction process. Each paradigm yields a product that is equal in significance; intellectual, physical or both. Considering this, the emphasis of design and engineering within technology education has the ability to offer students unique opportunities to develop and demonstrate phronesis and specific techné. As alluded to above, regardless of the era, this has been an enduring theme of the discipline. In order to solidify this fact, technology education's curriculum genealogy must be considered.

Manual Training

As a method of tool instruction introduced as a part of the Russian exhibit at the centennial exposition held in Philadelphia in 1876, manual training is considered to be the originator of subjects in the U.S. public school curriculum currently known as technology education (Lewis, 1995). However, subjects such as drawing and woodworking can be traced back to around 1855 in America (Barlow, 1967). The birth of manual training in schools parallels the beginning of the Industrial Revolution in the United States; this was no coincidence. New factories fueled by the need for mass produced guns for the Civil War raging at home, as well as many other new products borne of the advent of mass production, called out for aid in the shortage of skilled and semi-skilled workers.

Not long after the centennial exposition was held, Woodward (1889) spoke of the academic and vocational benefits of this type of training:

> "…I have within the past year seen the most unmistakable evidence of its high industrial value. I have never presented the practical side as it can be presented. I do not need it; parents do not need it; they see it even more quickly than I do, and come to me delighted in surprise at the success of their sons in securing good places and earning good salaries." (p. 76)

The claim that manual training could yield educational benefits academically and vocationally would be hotly contested for years to come and remains a point of contention and motivation for technology educators even today. One of the most telling and famous exchanges of the "vocational vs. progressive education" debate in technology education was between David Snedden and John Dewey in 1915 (1977). This conversation is worthy of close review within the context of this paper for two reasons:

1. The significant implications both views had in shaping the field of technology education at the time. Dewey's views nicely represent what would be termed the more progressive "manual training" paradigm of the period. Snedden's ideologies, on the other hand, serve a quintessential example of the "vocational" mind set.
2. Dewey and Snedden's educational theories are a good representation of the distinct philosophical and curricular split which still exists today and will

serve as a backdrop for explaining the metamorphosis of technology education in this paper.

Vocational Education

Dewey was weary of the societal changes underway as a result of the Industrial Revolution. He first made mention of this concern in his book, *School and Society* (Dewey, 1900). He felt that manual training should be taught critically: "We should see what social needs spring out of, and what social values, what intellectual and emotional nutriment; they bring to the child which cannot be conveyed as well in any other way" (Dewey, 1901, p. 195). Dewey's allegiance to liberal education when it comes to industrial/vocational education is obvious. His overall approach to industrial/vocational education was not for the preparation for an occupation or even a range of occupations, but for intellectual and moral growth (Tozer and Nelson, 1989, Dewey, 1977, Dewey, 1916).

David Snedden is often cited as the best example of the philosophical antithesis to Dewey with regard to the motivations underlying industrial/vocational education (see Snedden and Dewey 1977; Drost, 1977; Lewis, 1998, Gregson; 1995; Hyslop-Margison, 1999). Both Snedden and Dewey agreed that manual training should exist in the overall school program, but the motivations behind them created a philosophic divide. Snedden contended that the "common man be educated for a life of practical efficiency through an entirely different program of courses than the elite…training in the trades and business was a legitimate function of public education…Social control…should replace individual choice and prevent the 'immense wastage' resulting from individual trial and error" (Drost, 1977, p. 24).

Along with the growing momentum of industry, the allegiance Snedden formed with agriculture, home economics, and business educators yielded federal funding for Snedden's brand of vocational education in the passing of the Smith Hughes Act in 1917 (Barlow, 1967). The passing of this act forced technology teachers and administrators of the time to decide whether they were going to position their programs to be more vocational in order to court money provided by Smith-Hughes or adhere to manual training and its more progressive educational leanings (Krug, 1960). Not surprisingly, programs gravitated toward funding and the justification for manual training, even as general education had become a matter not of curricular philosophy but of political expediency (Lewis, 1995).

Industrial Arts

The next phase of technology education was brought to the fore as a result of an editorial written in Manual Training Magazine in 1905 by Charles R. Richards. In this editorial, he would make the proposal that the field of manual training be called *industrial art*. "Underlying Richards' advocacy for the leadership of both the industrial arts movement and its counterpart, the vocational industrial education movement, was the idea that the lines between the vocational and liberal aspects of industrial knowledge needed to be sharpened" (Lewis, 1995, p.631). Essentially, Richards had transformed the once all encompassing subject of manual training into two distinct groups: industrial arts would now serve the function of the more progressive form of the subject in the primary grades and the industry focused vocational education would be taught at the high school. Regardless, industrial arts was no longer peripheral to the other subjects in school. It now stood on its own as a separate discipline. This idea represents a clear break from the

Deweyan view of the field. It no longer served just to enhance the primary subjects. This is not to say that industrial arts didn't retain some of its progressive manual training history. Many argued that industrial arts still must address all children, regardless of sex or vocational tendency (see Bonser, 1914 and Russell, 1914). In fact, curricular ideas defined by Russell (1914) at this time consisted of the study not just of materials, but of processes such as production, manufacture, and distribution, which laid the foundation for the next paradigm switch: technology education.

Technology Education

Up to this point, manual training, vocational education, and industrial arts have been guided by the predominant user of technology of the times: industry. Businesses, society and, as a result, trends in technology education quickly moved from this industry and production base to that of the information age. In other words, contemporary society functions by managing knowledge, information, and the proliferation of technologies associated with information (Lauda, 1988). Increasing numbers of technology teacher education universities and colleges, as well as public schools, are embracing the trend. Headings of new technology education competencies included, but were not limited to communication, construction, manufacturing, transportation and biotechnology. (Hanek, 1991). Hanek also noted that the driving force of the content and activities (of technology education) was focused on helping students understand impacts, processes, and outputs of technical subsystems used in industry. One of the first proposals that directly addressed this need for industrial arts to reflect technology in the systems fashion mentioned above was at the American Industrial Arts Association meeting of 1947 (Warner, 1965). Warner stated that contemporary industrial arts curriculum would be based on a socio-economic analysis of technology under the headings of power, transportation, manufacturing, construction, communication, and management. Many also consider the Jackson Mill Industrial Arts Curriculum Theory document (Snyder and Hales, 1981) as the starting point of technology education as well (Wicklein, 2006). The contributors to Jackson Mill defined technology education as being more comprehensive in scope. Along with its social impacts, the thrust of the curriculum would be directed toward the evolution, utilization, and significance of technology and its subsequent relationship with industry, personnel, systems, techniques, resources, and products. (Snyder and Hales, 1981). Devore (1969) also saw the relationship between human beings and technology as being foundational in considering the new technology curriculum. This *problem solving* approach to technology education is a major theme that runs through much of the literature. In particular, Savage and Sterry (1990 a and b) are often cited and their work is viewed as a prime example of the logic behind the technology education curriculum. Problem solving, critical thinking, and evaluation of technological options and impacts are common themes (Lewis, 1995).

Engineering

In the spirit of phronesis, defined at the onset of this chapter, ideally knowledge would not be divided into academic and practical (technical) components. A small number of broadly integrated studies such as the humanities, arts, sciences, technologies and philosophy would be emphasized so that practice and theory can be featured in a comprehensive manner. Each would be designed around work that focused on questions involving both student and community knowledge (Hooley, 2004). As a guiding principle, Hooley believed that children should have an opportunity at school to reflect on their own experience and culture and to be able to draw upon their own practical and theoretical knowledge in order to experience and deal with the problems and ideas of both past and present. Learning should, therefore, take place through practical reasoning instead of imposed academic and vocational truths in technology education.

In defining technological literacy, a mantra and ultimate goal of technology education today, The Standards for Technological Literacy (STL) (International Technology Education Association, 2000) brings the same holistic themes of culture/society in their description: “technological literacy is the ability to use, manage, assess, and understand technology. A technologically literate person understands, in increasingly sophisticated ways that evolve over time, what technology is, how it is created, and how it shapes society, and in turn is shaped by society” (p. 9). The theoretical aspect of technology education that Hooley referred to is also addressed in the STL: “When taught effectively, technology is not simply one more field of study seeking admission to already crowded curriculum …Instead it reinforces and complements the material that students learn in other classes” (p. 6). This reflects a clearer and more defined goal of technology education to again purposefully position itself as an academic and not a vocational pursuit. With the multiple curricular shifts made prior to this point accompanied by its vocational and hobbyist leanings emanating from its past, this will be no easy feat for technology education (Lewis, 1995). Indeed, Wicklein (2006) explains that technology education is still viewed as a non-essential instructional program for three probable reasons:

1. Inadequate understanding by school administrators and counselors concerning technology education.

2. Inadequate understanding by the general populace concerning technology education.

3. Lack of consensus of curriculum content for technology education.

Considering these issues, Wicklein proposed that if the technology education curriculum is organized around engineering design, the goals of technological literacy and creating a well defined and respected framework of study that is understood and appreciated by all can be accomplished.

In their article, *Gaining Support for the Study of Technology*, Bensen and Bensen (1993) also represented the next phase for the subject by suggesting that technology education align itself with engineering for a number of reasons:

1. To gain acceptance by academic subjects.
2. An invitation to the engineering community to collaborate in the schools.
3. The social status of technology education would be enhanced.
4. The subject would be easier to justify in schools' communities.

Because of these foci, they recommended the title of technology education be altered to *Engineering and Technology* education (ETE) in order to represent and signify the essence of the curricular change.

In review, it would appear from the epistemological, historical, and curricular standpoints briefly outlined above that engineering and technology education has an accurate curriculum trajectory that aligns itself well with contemporary educational, societal, and technological needs. It has be argued, however, with math and science already well established in the curriculum, engineering, with its heavy reliance on both of these subjects, may be redundant (Lewis, 2007). Lewis goes on to explain, however, that the math and science curricula may not be able to produce authentic representations of engineering that aptly capture the ill-defined and creative nature of this type of work. In review of its history above, it is clear that technology education has more than one precedent of providing these types of authentic, “real world” experiences. Further, through the use of tools and materials, students have long been able to be active in their learning of concepts within technology education. As Breckon (1995) reiterated, "technology [education] provides that excellent method of learning-learning through doing" (p. 11). In essence, a central theme demonstrated in the nature and philosophy of technology education is that innovative ideas and products are brought to life to solve technological problems. This process often relies on a design process as scaffolding on which the learner is able to build an understanding of how a solution was formed. This concept of newness of constructing a solution through creative thought is thought to be central to technology education (International Technology Education Association, 2000). In fact, when involved in problem solving within technology education, a student is assumed to be engaged in creative thinking (Besemer and Treffinger, 1981; Jane and Robbins, 2004). Interestingly, this idea is not only important to technology educators, but is also valued by institutions where engineers are required to generate creative solutions (Field, 1997), making the partnership of engineering and technology education logical. Indeed, Lewis (2007) commented that “there is much about learning in technology education classrooms and laboratories that amounts to a rehearsal of the aspects of the work of engineers” (p. 849). Additionally, Welch (2007) argued that there are significant parallels between the goals of the field of engineering and technology education.

Clearly, technology educators offer students unique and creative opportunities for students to learn about the designed world around them. With its relatively recent partnership with the engineering community, technology educators are left to contemplate what this relationship will do to enhance or stifle the creativity that has characterized their curriculum since its inception. In essence, does the engineering field and its approach to educating future engineers value creativity to the same degree?

Creativity in Engineering and Engineering Education

Today's engineers are confronted with an ever shrinking and complex world. Because of the growth of global networks and their influence on creating an international marketplace, work has less to do with making goods and is concerned more with control of automation and information (Ihsen, Isenhardt, Sánchez, 1998). The need for structures to withstand harsher environments, be built to greater heights, with greater controllability, and be of greater economy and safety, signals the demand for creativity in engineering practices (Teng, Song, and Yuan, 2004). Tornkvist (1998) found, when examining creativity in the context of engineering, two common questions arose:

1. What are the driving forces behind creativity?
2. What intentions do people have for creative work?

The answers differed with respect to the intentions for creativity:

1. A person is intrinsically motivated to be creative. The fun of the process of creating is to be enjoyed in and of itself, without a need for an outcome necessary.
2. A person must be creative for a purpose. Usefulness of a product is a key indicator of its creative value.

3. Creativity is a factor in being competitive and subsequently successful in the marketplace.
4. Lastly, fame can be a motivator for creative performance. In essence, discovering or producing physical or intellectual property that has never been revealed.

The pressure on engineering educators therefore, is to develop ways to foster and assess creativity in engineering students in order to answer the demands of contemporary society and industry that are impacting the engineering profession worldwide (Mitchell, 1998). In the last two decades, engineering education has indeed focused on enhancing students' creativity to meet these various needs (Cropley and Cropley, 2000). This change has necessitated a shift away from traditional engineering curriculums focused on the basic sciences such as physics, math, and mechanics. Industry now requires engineers to possess problem solving ability (Grimson, 2002). In addition, manufacturing has changed significantly and demands that engineering majors study disciplines such as finance, management, economics, organizational psychology, and communication (Moses, 1994). When students do become engineers, many find projects out in the work place to be fragmented and the flow of information chaotic (Chan, Yeung, and Tan, 2004). This may be due to the fact that many engineering students have the preconception that engineering should be intellectual in nature and involve only deductive reasoning. Because of this approach, students are severely restricted in their thinking when presented with open ended design problems that require creative thought (Court, 1998). Indeed, Chan, et. al. (2004) found that a newly hired engineer, educated under the traditional engineering curricular paradigm, can take as much as six to twelve months to become professionally competent. As a result, there is an obvious need for universities to provide training for students in order to assist them to think creatively and look at problems in new ways.

One of the most common approaches to training engineering students to think creatively is presenting them with complex, open ended design problems. These types of problems are designed to represent “real” scenarios or issues and have many possible solutions (Lewis, 2004). The curriculum Roth (1996) identified in his study to understand the process of designing, Engineering for Children: Structures (EFCS), provides such an experience for students to construct engineering knowledge in the realm of structures. However, Roth is careful in pointing out that these activities, whose core goal is to have students construct bridges as part of an ongoing engineering competition for constructing a link between two sections of a city, are not designed specifically to “transmit legitimated and canonical engineering knowledge” (p. 130). Rather, like the motivation for posing open ended problems generally, these activities provide students with opportunities to explore issues critical to designing, learn to manage the complexity of open ended design challenges, and gain knowledge of how to work with the group dynamics inherent in ill-structures design situations. There are several approaches used to engage students in these concepts, however. For example, students may be asked to design a robot to accomplish a specific task only using a certain amount or type of materials. ROBOLAB has been found to be a powerful tool for a range of students studying engineering concepts. The students are provided with a central unit or LEGO “brick” that contains several input and output devices on which they can attach touch, light, temperature, and rotation sensors. The open ended problem posed within this framework, for example, can be to design a bumper car that can be used by a restaurant to serve meals in a limited area (Erwin, Cyr, and Rogers, 2000). The use of unusual materials to construct model artifacts as solutions to problems, such as building a bridge out of ice cream sticks or spaghetti (ASCE, 2003), or using concrete to construct a boat (Johnson, 1999) have also been used as scenarios to encourage creativity in problem solving. Also, rather than suggesting unusual materials, atypical parameters have be used to create authentic open ended problems. For example, at the University of Liverpool, students were asked to design a house to reflect a piece of music (University of Liverpool, 2003). Lewis (2004) suggested that an advantage to this activity was its ability to force students to engage different senses in a creative way.

Creativity

Even with the innovative use of open ended problem solving as a representation of a more dynamic approach to engineering education today, on the surface it would appear from the examples above that engineering is still chiefly concerned with only the making of products or, at most, the unique manipulation of materials. In fact, definitions concerned with creativity in engineering that were developed in the past during the subject's rigid approach to math and physics seem to focus chiefly on the making of products and effective exploitation of energy and materials to suit human needs as well (see Gregory and Monk, 1972).

Creativity cannot obviously be confined to the making of products. Taylor (1988), after extensive work on the nature of creativity itself, produced six classes of definitions for creativity:

1. Gestalt or perception: stresses the unique combination of ideas.

2. End product or innovation: emphasizes the process that yields a new idea or product.
3. Aesthetic or expressive: focuses on the creativity inherently present in authentic forms of self expression.
4. Psychoanalytic or dynamic: suggests that creativity is linked to personality.
5. Solution thinking: emphasizes the value of general intellectual thought with special consideration to divergent thinking during the creative process.
6. Varia: provides a category for creativity activity not easily defined by the definitions above.

These definitions are consistent with literature concerned with creativity generally. Indeed, these themes of creativity being evident in the *process* of creating, the *product* created, and in the *personality traits* of the person doing the creative act are also dominant in the seminal works that characterize research in creativity (i.e. Guilford, 1950; Sternberg, 1985; Eisner, 1962; Getzels and Csikszenthmihalyi, 1976). Ironically, after the limited definition of creativity in engineering mentioned above, Gregory and Monk, lament later in their book *Creativity and Innovation in Engineering* that engineers should not confine themselves to creativity associated to products only. Instead, they suggest that engineers should broaden their definition of engineering creativity to include, along with products, the creative process, creative persons, and the environment in which creativity is encouraged. This notion of the environment's ability to affect creative work is also prominent in creativity literature (see Amabile, 1983; Gardner, 1993).

Creativity in Art and Music

Hudson (1967) identified long ago that there is a tendency to classify scientists as convergent thinkers and artists as divergent thinkers. Students that possess inherent creative finesse will tend to be persuaded to find success in the arts and not in engineering because of the perceived deductive nature of the course work (Court, 1998). It is not surprising that subjects such as music and art arise in a discussion regarding design, creativity and the goal of fostering divergent thought in problem solving. Indeed, Kersting (2003) acknowledged that there are possible similarities and differences in creativity as it related to people in the sciences and artist: “Science has to be constrained to scientific process, but there is a lot less constraint on artists. Many artists come from more chaotic environments, which prepares them to create with less structure” (p. 40). Larson, Thomas, and Leviness (1999) commented that although the opportunity may exist for creativity to exist in both the arts and sciences, there is a possibility that creativity in engineering might be different from creativity in the arts: “A distinguishing feature is that the engineer has an eye on function and utility. Therefore, there may be a creative engineer versus a creative sculptor, painter, poet or musician” (p. 2). Gardner (1999) appeared to support this idea of domain specific creativity as well: “People are creative when they can solve problems, create products, or raise issues in a domain in a way that is initially novel, but is eventually accepted in one or more cultural settings” (p. 116).

Basic to contemporary art education, whose foci are on visual culture that emphasizes creative experiences, are these same issues of creative and critical thinking skills, as well as, problem solving (Freedman, 2003). Specifically, today’s art educators’ aim is to have students understand the visual arts as an openly expressed creative social action. By approaching curriculum as a creative activity, art educators of today aim to "emphasize concepts as well as skills of analysis, critique, and synthesis in expressive artmaking, writing, and speaking" (Freedman, 2007 p. 209). Design is also a major theme addressed in art education. According to Zande (2007):

> "The approaches to teaching about the creation of art and the creation of functional design may be similar. In both, activities may be associated with generating a message through a unique way to view the natural and human-made environments, an involvement of deeply felt perceptions, a personal emotive expression, an aesthetic exploration of materials and compositional elements, and/or the use of a creative process" (p. 48).

The curricular goals of general creative and critical thinking along with problem solving, and creating products within a certain social construct are demonstrated in music education as well. In fact, Webster (1987a, 1987b, 1989), developed a model of creative thinking specifically for music which consisted of the following factors:

- *Musical Extensiveness*: The time in seconds that involved in a musical response.
- *Musical Flexibility*: The extent a person can move freely between the extremes of the parameters of high/low, soft/loud, and fast/slow.
- *Musical Originality*: The degree of musical manipulation a person can accomplish in a unique fashion.

- *Musical Syntax*: The extent a person can manipulate music in a logical and "inherently musical" manner with regard to the entire response (Webster, 1987c).

Upon review of this model, it is obvious that aspects of the design process run through these factors. Many researchers considered the crucial development of both creative thinking and aptitude with regard to music needed to occur at a young age. This early experience in music aided in children's musical and intellectual growth (Henry, 1996).

Technology education is not the only discipline, therefore, to declare that their curriculum champions creativity. Indeed, both art and music lay claim to many of the same types of intellectual rigor in creativity to which the engineering -focused technology education curriculum seems assert to have a monopoly upon. In light of this, since creativity is a cornerstone of engineering education currently embraced by technology education, scholars and practitioners of the discipline must determine if the engineering -focused technology education curriculum pushes students to explore creativity not only unique to technology education, but in a way that is not attainable in art or music education.

Problem Statement

Technology education has partnered with the engineering community in an effort to infuse engineering principles into their curriculum. Although technology education has had an established record of providing opportunities for students to uncover talents untapped in other subject areas, the new technology education curriculum lays claim to providing an opportunity for further fostering their creativity. However, art and music also have a rich history of providing creative opportunity to students as well. In essence, does the technology education curriculum, with its emphasis of engineering and design principles, offer students an avenue to explore their creative potential in a way that art and music education cannot?

Research Questions

1. Do technology, art and music teachers differ in their perception of the creative process?
2. Do technology, art and music teachers differ in their perception of the creative product?
3. Do technology, art and music teachers differ in their perception of creative personal traits?
4. Do technology, art and music teachers differ in their perception of the creative environment?
5. Are their predictors of the creativity perceptions among art, music, and technology education teachers?

Chapter II

Review of Literature

This study examines the perceptions art, music, and technology teachers have regarding creativity in their fields. This chapter reviews literature that provides the key theoretical concepts that form the framework for the study of creativity's place in education and its subsequent relationship with art, music and technology education. Specifically, an international perspective on the evolution of technology education will be presented in order to identify forces behind contemporary technology education programs and their resulting emphasis on creative endeavors. Next, the nature of creativity itself will be explored. Also, with creativity's place already firmly established in engineering the technology education curriculum in Chapter 1, its place in the disciplines of art and music will be reviewed.

As has been reviewed in Chapter I, the origins of technology education in United States were rooted in the pedagogy of manual training and vocational education. The motivations of the time were straight forward: allow students to accentuate their school experience with manual training coursework and engage them in a vocational interest that would allow them to become a major driver of the economy at the turn of the 20th century: industry (see Mays, 1918; Richards, 1906; Snedden, 1916). The German style of apprenticeship was considered at the time to be a main conduit for students to enter into industry and employment. Although this method proved to be ineffective in attaining its goal of instilling *industrial intelligence* (the ability to see beyond immediate hand skills and recognize events that affect industry in general (Richards, 1906)), it represents the significance foreign models had on technology education in the United

States. In light of this, the discussion of how the United States arrived at the present engineering-focused technology education curriculum is incomplete without an examination of how other countries have developed their approaches to modern technology education as well.

A Global Perspective on Technology Education

During a relatively short period of maturation, technology education in Britain has moved from being a nonessential subject intended only for students with marginal abilities, to being at the heart of the National Curriculum (NC) (Kimbell, 1995). The 1988 Education Reform Act established a minimum entitlement National Curriculum of England and Wales of ten subjects that all children ages 5 to 16 are legally required to complete (Layton, 1993). These subjects consisted of core subjects (mathematics, English, and science) and foundational subjects (technology, history, geography, music, art, physical education, and a foreign language). Technology was introduced in 1990 for primary school children ages 5 to 11 and secondary school children ages 11-14 (p. 17).

Prior to the passing of the 1988 Education Reform Act, technology education had not been a specific subject of the school curriculum. In the primary grades, technology education was covered in a thematic way involving cross curricular and practical activities like making models (p. 17). The secondary school technology curriculum, however, consisted of various pedagogical approaches that varied in rigor and scope. The first was typical craft subjects of wood and metal work. Next, emphasis was placed on the process of design. According to Layton (1993), “This gave intellectual status to the construction of artifacts and systems, and the subject was strongly supported by those urging a greater emphasis on design in industry and in public life generally” (p. 18).

Influenced heavily by science, other teachers attempted to convey the principles of engineering design through their form of technology education. Highly reflective of the curriculum change being suggested in the United States today, these teachers wanted to encourage students to examine engineering and science in preparation for university programs. Indeed, approaching electronics, structures, energy transfer, feedback and control, pneumatic systems, and aerodynamics from a conceptual standpoint speaks to the similarities between British technology education and modern U.S. programs.

Finally, by the beginning of the 1980's, Craft, Design and Technology (CDT) curriculum also emerged in an attempt at culminating the approaches mentioned above. Less emphasis was put on applied science and more on work shop activity (Kimbell, 1995). In other words, for much of the work done in CDT classes, it was sufficient for students to have a functional understanding of devices rather than a fundamental grasp of the underlying physics (Layton, 1993). CDT, more often referred to as *design and technology* in the U.K., represents Britain's technology education curriculum approach and is specifically mentioned in the National Curriculum in England and Wales. Layton explains that a Working Group on Design and Technology was formed to advise the achievement targets and programs of study. The group's terms of reference also serve as an example of the curricular goals of technology education in Britain today: "to view technology as that area of the curriculum in which pupils design and make useful objects or systems, thus developing their ability to solve practical problems" (p. 20).

Interestingly, there is also a reference to creativity in the National Curriculum Importance Statement that states that students studying design and technology "learn to think creatively" and become "creative problem solvers as well" (Department for Education and Employment, 1999).

As of late, teachers of design and technology in England have been driven to improve the sub-skills of designing, such as creativity, through the newly introduced Design and Technology Framework (Department for Education and Skills, 2004). An example of this drive for change is the "Young Foresight" initiative that aims to develop communication and collaboration skills in students as they worked in groups to design future products. Barlex (1999) introduced these activities as *design without make* assignments. In fact, Barlex and Trebell in 2007 aimed to determine what sort of designing students did in *design without make* and what teacher's and student's attitudes were regarding this approach. In essence, students, based on the Young Foresight initiative mentioned above, were asked to design, but not make future products and services; use new and emerging technologies in design proposals; write their own design briefs; work in groups; and finally present their proposals to peers, teachers, mentors, and adult audiences at innovation conferences. Specific activities such as improving cooking pans, making a sculpture, using CAD (computer aided drawing), and developing food products were used in preparation for the design without make activity in order to help the students focus developing creativity through conceptual design.

Aimed at students nearing graduation, *A-level* examinations within a course of study provide students in the U.K. an opportunity to create work that demonstrates their mastery within a particular. Along with Design and Technology, these subjects typically consisted of English, Mathematics, Science, Information and Communication Technology, a Foreign Language, Physical Education and Citizenship (Engineering

Council and the Engineering and Technology Board, 2003/4). Until 1987, children in the UK were assessed in two separate systems at sixteen years of age: the General Certificate of Education (GCE) and the Certificate of Secondary Education (CSE) examinations (Atkinson ,1990). The GCE was for the top 20% of students while CSE was designed to cater to the next 60% of students. To consolidate and simplify these measures, the *General Certificate of Secondary Education* (GCSE) was introduced. In essence, assessment was no longer to be by examination alone. At least 20% of students' grades would be derived from coursework, either in the form of project work or by continuous assessment of pupils' regular classroom activities (Atkinson ,1990). Lewis (2001) pointed out that, because of the changing landscape in industry and engineering, and the resulting new focus of design and technology, the subject is a major force in the school curriculum. He added that there had been a significant increase in the number of candidates for A Level design and technology because of weight they carried at colleges and universities after graduation.

This focus on uncovering students' unique creative talents through problem solving in contemporary technology education is not unique to just Britain. Barak (2004) contends that technology teacher education must embrace these types of teaching methodologies along with new technologies because of the significant change technology education is undergoing in many countries. Problem solving and Problem Based Learning (PBL), regarded as "…an orientation towards learning that is flexible and open and draws upon the varied skills and resources of faculty and students" (Feletti, 1993, p. 146), have become central themes that run through the subject not only in the U.S. and the U.K., but in other nations' approach to present-day technology education as well.

Indeed, contemporary technology education curricula worldwide have begun to center themselves on the topics of problem solving, design, and construction methods (Rasinen, 2003). The reliance this approach to technology education has on fostering creativity and subsequent creative work is significant. Since the late 1990's for example, an increasing amount of Israeli senior high school students have been preparing problem based final projects in technological areas such as electronics, robotics and computer sciences. Students are required to take matriculation exams relating to these types of final projects that are required of the subjects they study to receive a *Bagrut* certificate. This certificate is viewed as imperative for entry into post secondary education (Barak, 2005). Barak discusses in the same article that recent studies in Israeli high schools have revealed that problem based learning contributes to students' creative thinking, problem solving abilities and teamwork.

In the 1980's, technology educators in Australia, recognized the need for change in their field as well (Gardner, 1996). These perceptions were reinforced by societal factors operating in Australia at the time and would serve to bring about substantial change in the educational system in general and technology education in particular. They included:

1. Increasing trends towards globalization of economic and educational systems.
2. Increasing demands for technological development in order to strengthen the national economy.
3. Changes in the role of technology in the workplace, coupled with beliefs that education in the post-compulsory years should help prepare students for the world of work.

4. Increasing retention rates in the post-compulsory years.
5. Perceptions that technological awareness is important in modern society, that education ought to help raise that awareness amongst all students, irrespective of their career intentions (p. 10).

Although it could be said that these factors are universally recognized as guidelines for current technology education programs worldwide, it is important to use them as a backdrop for the conceptualization of the current technology education curriculum in Australia. *A Statement on Technology for Australian schools* (Curriculum Corporation, 1994), the national framework that guides current technology education curriculum nationally, states that technology involves "the purposeful application of knowledge, experience and resources to create products and processes to meet human needs" (p. 3). Further, Australian technology education is made up of interdependent "strands" in the national curriculum (Gardner, 1996):

1. Designing, making and appraising: this strand is concerned with activities and processes concerned with investigating, devising, producing, and evaluation.
2. Information: focuses on the importance of information storage, retrieval and communication in various media.
3. Materials: focuses on natural and synthetic resources.
4. Systems: concerned with combinations of elements that work together to achieve specified outcomes (p. 16).

Stein, McRobbie, and Ginns (2002) contend that the strands mentioned provide an overall framework for the planning, teaching and assessment of design and technology education. While the students are involved in these experiences, they are able to use their knowledge of materials, tools, machines, and overall systems to solve problems and produce an end technological process, product or artifact.

In summary, whether it is through curricula initiatives such as technology education with an engineering focus, PBL, or design and technology, it would seem that the U.S. is not the only country where technology education has been undergoing transformation. This focus on real world problem solving and design using the type of tacit knowledge featured above is being demonstrated in the countries mentioned previously, but in Canada (Welch, 2007) and Columbia (Carulla, Duque, Molano, Hernández, 2007). In Columbia these types of curricular initiatives spark the interest and encourage participation of a variety of social groups including central and local governments, area engineering schools, science museums, industrial and commercial companies and national agencies such as the National Science Academy (Carulla et al., 2007). These new curricula focus on dynamic themes such as design, engineering and technical problem solving in order to better suit students' current and future needs in a world that not only expects technical prowess, but demands creative acumen.

Creativity

Industry in the United States has moved away from the production of goods and services and concentrates instead on the production of ideas and knowledge. Matheson (2006) points out that the "creative" industries have become the subject of an increasing amount of research. Indeed, President George W. Bush (2002) believes "the strength of our economy is built on the creativity and entrepreneurship of our people" (p. 1). It has been argued that these professions that covet creativity are driving more than just economic growth. By placing the creative industries at the center of civic and commercial life, they encompass social and cultural development as well; (Matheson, 2006; Gans, 1999; Kunzman, 1995; Volkerling, 2000). Indeed, in *The Rise of the Creative Class,* Florida (2002) describes how these industries are leading the way to a new economy with social, cultural, and environmental issues and priorities at its center. For example, high level information and communication technologies are rapidly evolving. Industry is profoundly influenced by these technologies and has required engineering curriculum, which has been traditionally dominated by physics, math, and other basic sciences, to embrace creative problem solving (Pate-Cornell, 2001). Oddly enough, as mentioned in Chapter 1, one of the common requirements of engineering programs is that students should have strong analytical and deductive skills borne of competence in math and physics (Lewis, 2004). This type of training tends to direct these students to think in a convergent rather than a divergent manner. It is these divergent thinkers who are believed to have a natural instinct for creativity (Dyson, 1997). Open ended design problems have been a common curricular strategy to encourage engineering students to think in a more divergent manner (see Court, 1998; Erwin, et. al., 2000; Johnson, 1999; Lewis, 2004). This shift in curricular emphasis to creative endeavors needs to occur because of the increase of societal and human issues rather than just technical conundrums. It is the combination of these two paradigms that lie at the heart of today's engineering problem solving process (Grimson, 2002). In light of this, Joel Moses, the former Dean of Engineering at MIT, urged graduates to develop their communication prowess not only on the technical level, but put specific emphasis on interpersonal communication with non-technical people (Moses, 1994).

Definitions of creativity itself have proven to be multifaceted. Torrance (1974) offered a comprehensive definition of creativity and the creative process that bears a striking resemblance to the problem solving models offered by Garmire (2002/2003) and Savage and Sterry (1990 a and b). He stated that creativity is a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies; being able to identifying difficulty; search for solutions, making guesses at and testing formulated hypotheses, and finally being able to communicate the results.

This *creative process* has been represented in various models (see Hayes, 1990; Stein, 1974; Taylor, 1959; Torrance 1963, 1966). Hinton (1968) created the notion of *creative problem solving* by combining the creative process and the problem solving process believing that creativity would be better understood if placed within a problem solving structure. Indeed, Parnes (1987) believed creativity could even be encouraged and developed through the use of steps in the creative problem solving process.

It is important to differentiate between the creative *process* or creative *problem solving* and *attributes* of creativity or the *sub processes* of creativity (Lubart, 2000-2001). A creative process, as the name implies, is a sequence of steps a student would progress through in order to arrive at solution to a problem or the production of a product. Wallas (1926) developed a model to represent such a process that was comprised of four stages:

1. *Preparation* – defining the problem and drawing on knowledge and personal aptitude with regard to analytical skills.
2. *Incubation* – On the surface, a person may be taking a break from the problem, but unconsciously the person is forming connections that will be revealed in the next stage.

3. *Illumination* – This stage is characterized by a sudden realization of a refined idea that can be described as a "flash" of enlightenment.
4. *Verification* – Conscious work takes place after the realization of a possible solution.

This model has endured and can be identified in modern literature on the creative process as well. For example, Amabile (1996) integrated a version of the four stage model in her description of the creative process. She identified five phases that included problem/task identification, preparation, response generation, response generation, response validation and communication, and, lastly, proposed a final phase of decision making about further work.

There are factors that have been found to impede this process as well. Duncker (1945) in his seminal work on this issue of problem solving found that *functional fixedness,* or the tendency to use objects in their usual or expected ways, can stand in the way of creative problem solving. One of the methods he used to investigate this phenomenon was asking participants to attach a candle to a wall and light it. Materials including matches, a candle and a matchbox filled with thumbtacks were supplied. The solution required subjects to use the matchbox as a holder for the candle by fastening it to the wall with the thumbtacks. Interestingly, the participants were more likely to solve the problem if the matchbox is given empty, with the thumbtacks separately, thus leading them to think about the materials made available in atypical ways.

Creative attributes or personality traits, on the other hand, are factors that influence the creative problem solving process. In other words, a creative process involves steps the problem solver progresses through, while creative attributes are the abilities the problem solver may (or may not) possess while working through the creative process. Guilford (1950) provides an excellent example of these two notions by suggesting that there was "considerable agreement that the complete creative act involves four important steps" (p. 451). Described as preparation, incubation, illumination and verification, these "steps" characterize the creative process. In the same article, goes on to identify certain abilities or personality traits that may be involved in creativity: sensitivity to problems; a capacity to produce many ideas (fluency); an ability to change one's mental set (flexibility); an ability to reorganize; an ability to deal with complexity; and ability to evaluate. Guilford's ideas not only provide a clear explanation of these pivotal concepts, they helped to form the basis for much of the creativity research for years to come (Lubart, 2000-2001). Additionally, he suggested that the creative process may be effectively studied by examining the sub processes that play a role in creative work (Guilford, 1950).

Identifying and assessing creative products has also been a concern of some researchers (Michael, 2001). Eisner (1962), in an effort to study different types of creativity, used the characteristics of boundary pushing or inventing, boundary breaking, and aesthetic organization as criteria for rating art products. Getzels and Csikszenthmihalyi (1976) also conducted a longitudinal study of problem finding in art in their book *The Creative Vision*. A portion of the study involved determining how art is evaluated. Their procedure involved four groups: *artist-critics*, established artists whose work is represented in museums and galleries; *artist-teachers*, all taught full time at an art school; *doctoral students in mathematics*; *and graduate business students*. Each judge was asked to rate each drawing on *craftsmanship* (technical skill of the work), *originality* (imaginativeness) and *overall aesthetic value.* Among other valuable findings, Getzels and Csikszenthmihalyi found that the *artist-critics* group of experts appeared to base their evaluation of a work of art more on its originality than on its technical skill. The authors explained this discrepancy as "a symptom of a larger misunderstanding between artists and the public values about art. For the public, a valuable piece of work is one that is technically accomplished. But experts take skill for granted, and must look for other qualities; in our times the foremost of these is 'originality' "(Getzels and Csikszenthmihalyi, 1976). Some technology teachers using "product" based curriculum may argue that technology educator assessment would be better compared with the *artist-teachers* group of experts or may agree that an exceptional piece of student work is *technically accomplished*. In fact, this may be a valid argument since Getzels and Csikszenthmihalyi had them unknowingly evaluating their own students work. This group rated each piece with very high consistency when compared to one another, especially in the craftsmanship category. The context of creativity in an educational setting, the *skill* alluded to above that is taken for granted, could also be considered to be the technology itself and/or the students' competent use of the technology in the classroom. Indeed, Peterson and Harrison (2005) stated that the technology of creativity includes tools and processes that allow a person or group to develop a solution that is original and has purpose. In other words, the mere fact a student can demonstrate the ability to competently use tools, no matter the degree of preciseness, should not qualify as a measure of creativity in a teacher's evaluation of their work. In fact, Gardner (1993) believed there is tension between creativity and expertise to the extent that an individual could perhaps be an expert without being creative.

Amabile (1983) stated that when all the social and environmental factors that might influence creativity are considered, most can be found in the classroom. She categorized environmental factors into areas that included peer influence, teacher characteristics and behavior, and the physical classroom environment. Grouping of students in heterogeneous groups; having a teacher that is intrinsically motivated and believes in student autonomy and self directed work; and being in a cue-rich and therefore cognitively stimulating classroom were all examples of environmental factors influencing student creativity.

Although a variety of environmental variables have been identified that may influence creativity, *climate* is also an important consideration in the discussion (Hunter, Bedell, and Mumford, 2007). At the individual level, climate represents a cognitive interpretation of a situation and has been labeled *psychological climate* (PC) (James, James, and Ashe, 1990). PC theory supposes that individuals respond to cognitive representations of environments rather than to the actual environments (James and Sells, 1981). In essence, the climate of a classroom is a more global view of environmental influences on creativity. Most of the classroom research has focused on the distinction between "open" and traditional classrooms climates (Amabile, 1983, p. 205). *Openness* is most often considered a style of teaching that involves flexibility of space, student selected activities, richness of learning materials, combining of curriculum areas, and more individual or small-group than large-group instruction (Horwitz, 1979). In contrast, traditional classrooms consist of examinations, grading, an authoritative teacher, large group instruction, and a carefully prepared curriculum that is carried out with little variation (Ramey and Piper, 1974). As might be anticipated, most evidence regarding creativity favors open classrooms (Amabile, 1983).

Upon review, four major themes consisting of the creative process, creative products, creative personality traits, and the creative environment emerge. In fact, these themes are found time and again in creativity literature (see Amabile, 1996; Bear, 1993, Plucker, Beghatto, and Dow, 2004; Sternberg and Lubart, 1999). As a result, the following definition from Plucker, Beghatto, and Dow (2004) will be used as a reference point and a building block of the construct of this study as it accurately encompasses these themes with relative parsimony: Creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context.

This is not the first study to be concerned with creativity between subjects based in scientific inquiry (like technology and engineering) and the arts. Nearly a half century ago, Snow (1959) saw that scientists and artists can act like they are from two distinct cultures even though there are commonalities between them. He stated "there seems to be no place where the cultures meet" (p. 17). As it turns out, what brings the two groups together is problem solving (Weisburg, 2006). What will be demonstrated in the literature review that follows is how people involved in technology and engineering, as well as artists (specifically, visual art and music) demonstrate creativity within problem solving in different ways. Although differences between the groups are evident, similarities also appear. To this point, Caper (1996) succinctly stated that, "Artistic creation and scientific investigation become hard to distinguish in their essence" (p. 867). Therefore, since creativity in technology and engineering has been demonstrated and reviewed (see Chapter 1), it is important to establish the same perspective for the disciplines of art and music.

Creativity in Art

Creativity in technology education and engineering is not unlike creativity in art, where individuals perform in relation to a well designed open ended problem. However, unlike the *design process* often referred to in technology and engineering education as literal interpretation of the cognitive processes used to solve problem, people in the field of art refer to the processes of *problem finding* and *problem solving* as generalized headings that categorize the phases of creating art (Getzels and Csikszenthmihalyi, 1976). *Problem finding* (i.e., searching, choosing, and/or manipulating of the concepts to be used in the work) and *problem solving* (the production of the expressed problem) are interdependent and responsive in nature (Mace, 1997). These processes have been mirrored in more contemporary literature regarding learning and concept development within art-making as well. Marshall and Vashe (2008) identified and implemented a series of three exercises in their study of how to convey concepts in art education that bore a resemblance to *problem finding* and *solving*. The first, named *mining* referred to closely examining and deriving meaning and ideas inherent in images and objects. The second, *bridging*, focused on finding the connections between ideas, images and objects and subsequently breaking them down into concepts. Lastly, the third exercise was *making*, or the actual visual representation that embodied the concepts formed previously. In either case, it is evident that in the event of art-making, the act is inherently cyclical and the relationship between the stages is deeply complex by nature. Beardsley (1965) articulates this point:

"Once the work is underway, with a tentative commitment to an idea, the creative process is kept going by tensions between what has been done and what might have been done. At each stage there must be a perception of deficiencies in what now exists, plus the sense of unrealized possibilities of improvement" (pp. 298-299).

How do these stages of the creative process manifest themselves in making art? Parker (2005) considered the stages through which the painter Howard Hodgkin progressed to be an excellent example of this process. She explained that Hodgkin, after forming an idea for his work, would "undertake a period of incubation and illumination which interlock and overlap until the moment of verification is reached" (p. 191). Poincaré (1952) is often cited for his work involving this significant subconscious activity of the incubation process in problem solving. He explained that solutions or ideas essentially come to mind with "characteristics of brevity, suddenness, and immediate certainty" (p. 54).

Overall, the creative process described above reflects the four stage model proposed by Wallas (1926) and Amabile (1996) in general creativity literature discussed earlier in this chapter.

Out of this explanation, another question arises: of all the artistic problems that exist, how does a creative person choose one that suits? In explaining this process, Zou (1998) found that *aesthetics* play a role in the decision and offers accounts of well known creative scientists' ability to identify research problems that had the greatest potential of discovery. For example, Darwin experienced *tension* between the Biblical version of creationism and scientific findings that revealed the earth experienced gradual change over millions of years. It is this sense of tension that is felt in the presence of new information that does not match with existing knowledge that signals a particular sensitivity to the problem in creative people generally. Stein (1988) wrote that this aesthetic sensitivity can also be expressed as lacking "emotional satisfaction with the existing state of affairs" (p. 53). The significance of emotion and issues with contentment regarding a problem or its solution, such as delaying the definition of a problem or being satisfied with a piece of work are also identified as significant characteristics of creative artmaking (see Mace, 1997). Also, it has been found that for highly creative people, the restraints a problem has and the more criteria a solution to a problem has to satisfy, the more appealing a problem becomes (Ochse, 1990). Paradoxically, the significance of a solution to this type of problem is based on its ability to solve it simply and elegantly (Zuo, 1998). Sternberg (1988) contended that a creative analogy that is remote enough to be unique, yet near enough to be recognizable, is a way to demonstrate such an answer. Metaphor theory (Lakeoff and Johnson, 1980) and cognitive theory (Bransford, Brown, and Cocking, 2000; Efland, 2002) have also been employed in an effort to demystify thinking and general creative work in art by identifying the most basic of conceptual processes: connection making. For example, Ricoeur (1981), in his theory of metaphor, claimed that concepts are generated by connecting one tangible item, idea, or experience to another. In essence, creativity is rooted in finding or making these unexpected connections between previously unassociated entities (Koestler, 1990). From this, creativity and learning takes place in identifying the idea that connects them.

With an emphasis on making unique connections that define creativity in art, it is not surprising that creative and critical skills and concepts in art education have as much to do with the creativity of audiences as of artists. As opposed to the past, where student artistic work was considered therapeutic self-expression, contemporary art curriculum emphasizes the development of cultural and personal identity (Freedman, 2007). More specifically, current art education reform is focused on visual culture that emphasizes creative experiences based on teachers' knowledge of student interests, socioeconomic conditions, fine art and popular culture (Freedman, 2003). Freedman (2007) contends that art education has moved far beyond the ideas of only teaching the basics of line, shape and color: essentially the skills of art-making. She declares: "What is basic to art education also has to do with questions of *why* people make art, how they *use* art, and how they *value* art" (p. 211). This point is not lost on art educators. In fact, Zande (2001) declared that art educators are not demonstrating the same interest in design education as is reflected in national standards, publications, and enrichment programs created outside of art education. This drive toward focusing on style and functional design is borne out of art educators' response to consumerism and how it relates to product selection in the United States. Indeed, Meikle (2005) stated that *design* has become big business and, in turn, contributes significantly to the U.S. economy. A continuous flow of new styles including clothing fashions, architecture, furniture, and advertisements are examples of a visual culture that characterizes this consumer-driven society (Zande, 2007). Zande goes on to point out, however, the subtle but significant difference between art and other subjects such as technology education that claim to address functional design:

> "Most of what of what is being addressed about functional design in other subject disciplines and organizations is closely related to engineering and culture. They

> are not teaching aesthetics and meaning-making aspects of design that reach deeply into the human spirit. This is the domain of art education" (pp. 46-47).

Therefore, it would appear to be naïve to claim that the subjects of technology and art education give equal opportunity for students to be creative. A more accurate appraisal would surely take into consideration what has been identified as the existential and extremely personal nature of art-making as opposed to the specific parameters and inherent desire for social acceptance that characterizes creativity in the modern lessons and subsequent products of contemporary technology education. Indeed, it is popular to believe that to make art is to be creative, when in actuality it is possible to make art without the resulting work to be considered creative (Mace, 1997). As demonstrated above, this axiom does not tend to hold true for work in technology education or engineering. To this point, Solso (1994) illuminates this unique connection between art and mind:

> "Art is a reflection of the inner structures and the perceptions of the mind of the artist and the art viewer… For in art, especially art that appeals to universal principles of perception and cognitive organization and resonates sympathetically with the inner neurological structures of the brain, we can discover the salient facts necessary to formulate general laws of the mind and the often elusive relationship with the external world" (p. 49).

As a result of art being in a location where subjective and cultural interpretation are most openly celebrated and practiced (Efland, 2002), it is obvious that this unique approach to creativity in art and art education enables the subject to offer a distinctive opportunity for students to at least explore if not eventually foster a type of creativity offered nowhere else in education.

Creativity in Music

The National Standards for Arts Education were published in 1994 in the U.S. as a part of the efforts of music educators to ensure the arts were included in the Goals 2000: Educate America Act. Specific to music education, these comprehensive standards include the creative activities of *improvisation* and *composition* as curricular objectives for music students in grades K-12 (Hickey, 2001 a and b). On a grander scale, the terms of improvisation and composition are used generally in the field of music to describe creative work.

Kernfeld (1997) contended that although it is present in many forms of music, improvisation is frequently viewed as a central aspect of *jazz*. By definition, jazz is a rhythm based form of music founded on the *blues* and other popular music (Gioia, 1997). Created by lowering the pitch of several notes in a major scale, transforming them into "blue" notes, a much broader range of emotional expression was generated (Ward and Burns, 2000). This idea of emotion being a key element in music that is, from the standpoint of the listener and the composer, considered to be creative is significant and also establishes a parallel with creativity in art as well. Research suggests that the ability to perceive and enjoy music generally is an inborn trait and both pleasant and unpleasant emotions can be produced through certain types of music (Solusa, 2006). These findings would also suggest that, as in art, music making and listening is an endeavor that reflects individual preferences. This fact is also important to music educators. Hickey and

Webster (2001) suggest that music teachers concerned with encouraging their students to think creatively should persuade students to *imagine sound*.

> "Creative thinking in sound can occur when a teacher asks students to imagine sound as a key to all musical activities. What is so exciting about this very simple idea is that, in creating experiences for students that encourage thinking in sound, teachers ask them to exercise cognitive abilities that are central to music as art" (p. 21).

Additionally, Hickey and Webster stated that by being taught to imagine sound and applying this skill to their work in listening, performing, composing and improvising, students experience *musical personality*. This would imply that students imagining in sound while listening or producing music would be able to formulate ideas about the certain musical piece. Indeed, Jacobs (1999) proposed that in order to establish a listener's taste in music, the related idea of *musical aesthetic* could be investigated. Requesting that students improvise or compose in a music class, "a teacher can see evidence of students' divergent and convergent thinking in sound… Asking students to imagine and manipulate sounds in both divergent and convergent ways should naturally lead to aesthetic decision making" (Hickey and Webster, 2001, p. 22). Webster (1990), in his attempts to measure creative aptitude in his music students, sought to identify these divergent and convergent thinking skills in music using musical tasks in game-like contexts. For example, he describes a measure he developed using an amplified voice, a round sponge ball with a piano, and a set of temple blocks to engage children in musical imagery. The tasks begin very simply and progress to higher levels of difficulty in terms of divergent thinking.

In the first section of the activity, the author is familiarizing the students with the basic “instruments” needed to complete a creative product. Although some room for interpretation exists (i.e. manipulation of parameters) for the student, the tasks are still defined by the author. No product is produced in this section, but the foundation is created for the evaluation of the students’ performance throughout the task. This part of the evaluation is basically designed to help children become familiar with the instruments used and how they are arranged. The students explore the parameters of "high/low", "fast/slow", and "loud/soft" in this section and throughout the measure. One of the bases for scoring is the way they manipulate the parameters (p. 22). The middle section asks students to essentially create a product by using the skills they have learned in the first section. “Children enter into a kind of musical question/answer dialogue with the mallet and temple blocks, and they create songs with the round ball on the piano and with the voice and the microphone” (p. 22). During the last section of creative evaluation the student is set free of any teacher imposed parameters and asked to develop a creative product (tell a space story with a beginning, middle, and end). This measure, and others like it, yields scores for such factors as musical originality, extensiveness, and flexibility, as well as musical syntax. Webster uses measurement strategies based on the careful analysis of video or audio tapes of children actually engaged in the activities. Objective criteria as well as rating scales are used to musical extensiveness, originality of the final product (Webster, 1990).

The idea that music educators concerned with fostering creativity in their curriculum should encourage divergent as well as convergent thinking in their students is noticeably different than the motives of both technology and art educators discussed previously who focused primarily on divergent thought.

In a related study where Hickey and Webster (2001) suggested activities such as extending an improvisation by employing a motive used earlier by another improviser. They also asked students to determine the “color” of a complex musical work after listening to it a second or third time in order to elicit creativity. The authors defined these as examples of *aesthetic decision making* in music. Although it could be said that these activities demand higher skill mastery and cognitive functioning than in the previous study by Webster, they are similarly open ended in nature. In any case, it would appear that convergent and divergent thinking, as well as decision making with regard to aesthetics are significant concepts pursued by teachers concerned with creativity in music.

These types of decisions being made during listening to or making creative music can be linked to ideas in the use of metaphor in music as well (see Kramer, 2004; Spitzer, 2004). Spitzer (2004) contended that the relationship is reciprocal within music listening and production: "With reception, theorists and listeners conceptualize musical structure by metaphorically mapping from physical bodily experience. With production, the illusion of a musical body emerges through compositional poetics-the rhetorical manipulation of grammatical norms" (p. 4). Said differently, music creates thought and thought creates music. This obviously correlates with literature reviewed earlier in this chapter that explained the significance of metaphor in creative work in art as well.

Studies within the area of improvisation in jazz, however, have revealed that creativity associated with composing music is often found to be a group phenomenon rather than just an individual one suggested above. For example, Monson (1996) studied many examples of musical collaboration in jazz. Through transcribed musical data, she was able to demonstrate how musicians converse with one another during improvisation. She concluded, “There is a great deal of give and take in such improvisational interaction, and such moments are often cited by musicians as aesthetic high points of performances” (p. 80). The idea of aesthetics being a significant part of satisfying improvisational music among group members suggests that creativity can be a group phenomenon in music as well as an individual one. In fact, Sawyer (2006), based on his research in music and theater, as well as his own experience as a jazz pianist, has identified three characteristics of group creativity in music:

- Improvisation: creativity happens “in the moment of encounter” (p. 148) and performers are not just interpreters, but creative artists.
- Collaboration: all members of a group contribute and the dynamic of their interaction results in the performance.
- Emergence: describes the performance that only results from a collaborative effort and is a phenomenon that is inherently and wholly unpredictable.

These characteristics of group musical creativity distance the discipline from creative work in art and, at the same time, make connections to technology education and the field of engineering with regard to the effectiveness of groups working collaboratively to creatively solve a problem.

In summary, it would appear that music and music education hold a unique position with regard to their stance on creativity when compared with technology/engineering and art. Specifically, music education’s approach to offering open ended activities with an emphasis on generating a very personal product via a process couched in emotional and physical exploration of the students' environment, promotes a unique creative learning opportunity indeed. Unlike the fields of technology education and art, music may possess few creativity characteristics that it can organically call its own. Rather, the subject offers students a hybrid of creative opportunities that do not exist anywhere else in their school day. It would be easy to say that from a sensory standpoint, music education has a monopoly on offering a unique creative opportunity. Upon closer examination however, a more accurate synopsis of music education's curricular capabilities would include its ability to cover concepts such as the personality, aesthetics, and metaphors in and of creative artistic expression; being able to nurture both convergent and divergent thinking; and encouraging creative performance in both an individual and group environment. When compared to the other subjects in this study, music educators have the power to expose creative ability in students that may only be ephemeral in the curriculum of other courses.

Assessment of Creativity

Assessment of student learning is not only desired by educators in order to determine if their students have gained the knowledge they meant to impart, but it is often mandated by government (i.e. No Child Left Behind). As a result, an important question to ask at this juncture is: Considering the complexity of its components, how can creativity be assessed? The general purpose of assessment of creativity can be to seek understanding of the phenomenon in question or to exploit it for commercial or educational gain (Feldhusen and Goh, 1995). Treffinger (1987) suggested that, because of the lack of a single theory regarding creativity, assessment could identify broad categories. This indicates a concerted effort to produce an assessment tool designed to encompass the many facets of creativity. However, as pointed out previously, the themes of person, product, process and environment are demonstrated in creativity literature generally. To this point, Feldhusen and Goh stated "The Four P's conception – person, product, process, and (environmental) press – seems a more profitable framework for assessment as reflected in current theoretical conception of creativity" (p. 235). Dacey (1989) reviewed several assessment approaches to creativity and categorized them as test oriented, personality oriented, or product oriented. However, most efforts made to assess creativity have been found to focus on a person's cognitive abilities, personality, motivation, or background experience (Feldhusen and Goh, 1995).

Taylor (1975) also presented a creativity assessment model that focused on product making: the Creativity Product Inventory. He suggested seven criteria:

- Generation – the power the product has to stimulate ideas.
- Reformulation – the extent the product produces change.
- Originality – the uncommonness of the product.
- Relevancy – the extent the product solves a problem or fills a need.
- Hedonics – the popularity of the product.
- Complexity – the degree of intricacy of information involved in the making of the product.
- Condensation – the ability of the product to simplify or integrate ideas.

Amabile (1990), based on her belief that creativity can be seen as a property of products, developed a successful strategy called the *Consensual Assessment Technique* for the assessment of creativity. She contended that a product is creative to the extent that the observers, familiar with the particular field of activity, agreed it was creative. This technique that focuses assessment not only within a content area, but on the task as well is well supported in the literature (see Baer, 1994; Plucker and Runco,1998).

It would seem fair to assume then, that to be creative; a person must perform in a particular domain. In other words, creativity cannot be abstract or without context. However, the word "creativity" embodies many diverse elements and, at the same time, suggests a common strand among them (Bear and Kaufman, 2005). Some researchers (see Proctor and Burnett, 2004) now propose an approach to creativity theory and training that focuses on all aspects of creativity be encompassed in some manner.

Technology Education

Historically, technology educators have chosen the creation of products or artifacts as a means to teach technological concepts (Knoll, 1997). Taking a broader view, Lewis (1999) stated that technology is a manifestation of human creativity. An important way students can understand creative work would be through engaging in activities focused on technological creation. As reviewed in Chapter 1, much of the new design-focused curriculum is focused on open ended engineering design problems that yield an end product as a solution. Often this product is meant to embody the learning process students progressed through and, as a result, is used by teachers to assess the learning and creative work that has hopefully taken place. In essence, as Michael (2001) stated, it is this creative product that personifies the very essence of technology.

Moss (1966), in an effort to identify and assess creative products, concluded that unusualness and usefulness (terms that are also evident in Taylor's model earlier) were defining characteristics of a creative product produced by industrial arts students of the time and defined them as follows:

> 1. *Unusualness*: To be creative a product must have some degree of unusualness. The quality of unusualness may, theoretically, be measured in terms of probability of occurrence; the less the probability of its occurrence, the more unusual the product.
>
> 2. *Usefulness*: While some degree of unusualness is a necessary requirement for creative products, it is not a sufficient condition. To be creative, an industrial arts student's product must also satisfy the minimal principle requirements of the problem situation; to some degree it must function. Completely ineffective, irrelevant solutions to teacher imposed or student initiated problems are not creative.
>
> 3. *Combining Unusualness and Usefulness*: When a product possesses some degree of both unusualness and usefulness it is creative. But, because these two criteria are variable, the degree of creativity among products will also vary.

Technological problems, like the ones being used in more contemporary technology education classes to evoke creative work require students to often work in groups and wrestle with the iterative nature of the engineering design process.

The characteristics of technical problems and the engineering design process often employed to illustrate the steps engineers and designers use to solve technical problems provide a scaffolding for students to document their work. Custer (1999) classifies technical problems as having to do with invention, development, and use of objects and tools for human purposes. His categorization of technological problems is important to note:

Invention: Occurs when abstract ideas are transformed into physical objects or processes.

Design: Concentrates on using sets of established principles and practices within certain constraints to accomplish an intended purpose.

Trouble shooting: Usually is reactive in nature – when things go wrong.

Procedures: Centered around planning or following instructions (p. 27).

"All four kinds of problems are addressed professionally by engineers and designers, but there are also aspects of each that should be a part of the technological literacy of all students" (p. 28).

In order to better understand the vital place creativity holds in solving technical problems, as well as its subsequent assessment, it is important to examine the problem solving model proposed in the engineering curriculum within technology education: *the engineering design process*. Cougar (1996) declared after examining design processes like the one featured below, students "apply these processes deliberately, they speed up their creative processes and experience greater creative productivity" (p. 93). An example of this engineering design process is the subject of Elsa Garmire's article *The Engineering Design Method* (2002/2003). Justifications for using this model as an example are as follows:

1. When the following example is followed, all of the content standards for

technology education listed in the STL: Content for the Study of Technology (International Technology Education Association, 2000) under the sections Design and Abilities for a Technological World can be met.

2. This method makes the assumptions that "all design is a compromise" and "engineering design involves teamwork" which are too often mentioned as being merely peripheral to the process or not at all.

   a. *all design is a compromise* – Garmire explains that all designs have compromises as well as cultural biases. Often time cultural values will determine the direction of the compromise. Time and money are also limiting so students must understand the influence of both of them.

   b. *engineering design involves teamwork*– Teamwork is an important skill that students should acquire. As outlined above, the cultural bias that is inherent in design must be assumed and teased out by either by arranging groups to be eclectically blended in terms of race, gender, and/or ethnic background or by allowing groups to be homogeneous and let the designs reveal their biases when finished. To this point, Miller (1999) declared that creativity is as much of a group phenomenon and an individual one.

Even though the following design process steps are used in a course designed for first and second year engineering students in the Thayer School of Engineering at Dartmouth College, it can translate very easily to both junior and high school (Garmire, 2002/2003). This statement is accurate when compared with literature concerned with the engineering design process in technology education (see ITEA, 2000). The Dartmouth Design Process is characterized by the following steps:

1. Define the problem
2. Restate the problem
3. Develop constraints/criteria/specifications
4. Brainstorm ideas
5. Research alternatives
6. Analyze alternatives by a trade-off matrix
7. Identify a potential solution
8. Research in detail the potential solution
9. Design a potential solution
10. Construct a prototype
11. Evaluate prototype
12. Reiterate if necessary
13. Simplify if possible

Savage and Sterry (1990), referred to in Chapter 1 as two of the vanguards of the technology education curriculum movement, identified a problem solving process that, in essence, encompasses some of the same developmental stages as the Dartmouth Design Process featured previously:

1. *Defining the problem*: Analyzing, gathering information, and establishing limitations that will isolate and identify the need or opportunity.
2. *Developing alternative solutions*: Using principles, ideation, and brainstorming to develop alternate ways to meet the opportunity or solve the problem.

3. *Selecting a solution*: Selecting the most plausible solution by identifying, modifying, and/or combining ideas from the group of possible solutions.
4. *Implementing and evaluating the solution*: Modeling, operating, and assessing the effectiveness of the selected solution.
5. *Redesigning the solution*: Incorporating improvements into the design of the solution that address needs identified during the evaluation phase.
6. *Interpreting the solution*: Synthesizing and communicating the characteristics and operating parameters of the solution.

Neither a product nor a standardized test can always communicate the creative work involved in short to long-term tasks and multistaged projects inherent in modern technology education. Wiggins and McTighe (1998) in their book *Understanding by Design* not only recommend open ended problem posing as a way to help students to think about big concepts in more depth, but offer guidelines for their assessment:

- Feature a setting that is either real or simulated and involves constraints, background noise, incentives, and opportunities an adult would encounter in the same situation.
- Require the student to address an audience.
- Are based on a specific purpose that relates to the audience.
- The student should have an opportunity to personalize the task.
- Tasks, criteria, and standards are known in advance and guide the student's work.

Assessments that require a production or performance such as the ones recommended by Wiggins and McTighe of take the shape of paper reports, electronic prototypes, or the display of a poster have been use to showcase and enable teachers to “see” the creative work (i.e. Schultz and Christensen, 2004). Not surprisingly, considering the type and caliber of problems being posed to students in engineering-focused technology education, in 2005 the International Technology Education Association (ITEA) introduced new addenda to the technological literacy standards documents that included recommendations for standards based assessment that was founded on the work of Wiggins and McTighe (ITEA, 2004).

Art

There have been many studies that have measured various types of human aptitude through visual art: Getzels and Csikszenthmihalyi (1971) used still-life drawings to research behavior in artists; Sobel and Rothenburg (1980) researched artistic creation after viewing images; Sterberg and Lubart (1995) examined drawings made after verbal stimuli describing a special time perspective. Indeed, of the disciplines involved in this study, the ability to demonstrate a person's individual observations and reflections of the world around them is a reasonably distinctive characteristic of visual art. However, these performances, particularly the creative ones, are hard to measure objectively. As Dewey (1934) points out, this does not stop us from employing various criteria to judge the qualities we appreciate in a painting, essay, scientific experiment, or essay.

Lindström (2006) identified seven criteria for evaluating creative performance for Sweden's National Agency for Education in 1998. He explained that the following criteria were based on objectives in the national curricula, qualities appreciated in the art world and research of the creative process:

1. The visual work communicates the intention behind the picture.

2. Elements such as color, form and composition were used to achieve the desired effect.
3. Craftsmanship or mastery of materials and techniques.
4. Persistence in pursuing a problem is demonstrated. Through this process, the student is challenged rather than discouraged.
5. Experimenting with new solutions, risk taking and general inventiveness is evident.
6. The ability and willingness to use models.
7. Ability to self assessment and reflect on different aspects of the work.

All the students in Lindström's study had assembled portfolios of their art work as a part of their educational requirement. These folders we independently assessed using a rubric for each criteria above by the student's teacher and a teacher at the same grade level from another school. Lindstrom found high rates of agreement between the two sets of teacher assessors with regard to the creative criteria. These results suggest that with the proper criteria, creativity in visual art which is considered to be too intrinsic or personal to assess, is indeed assessable.

Chen, Kasof, Himsel, Greenberger, Dong, and Xue (2002), in a study concerning the assessment of creativity in drawings across two cultures (European American and Chinese), considered Amabile's (1983) Consensual Assessment Technique. This technique, as mentioned earlier in the chapter, contends that a small group (6 to 12) of experts from a given field can provide reliable assessment of the level of creativity in a product. Chen found that judges agreed not only within their own groups, but across the groups as well.

These studies would suggest that even though art is considered to be an individual endeavor that reflects the a person's perspective and emotion in relation to their perception of the world, creative work in this field can be assessed.

Music

According to Hickey (2001a), music teachers, like technology teachers, have traditionally viewed the products made in music education as means for assessing success in learning. She cites ratings at musical festivals to gauge group performances as well as individual performance ratings at solo and ensemble events to indicate an individual student's success. Along with paper and pencil exams, Hickey claimed that these sorts of assessments do serve a function in an overall educational philosophy that endorses creative thinking.

As discussed with regard to the assessment of student performance in using the engineering design process to solve technical problems in technology education, music educators concerned that their students are thinking in sound, making aesthetic decisions in music and generally using their skills in creative applications have to look for alternative measures.

Currently, Webster's (1994) Measurement of Creative Thinking in Music-II (MCTM-II) is the most well-known measure of creative musical potential and, like the Torrance's TTCT, it measures divergent thinking and convergent factors of musical syntax. In addition to Hickey (2001b) noting that these paper-and-pencil tests have myriad validity problems, she states that these types of assessments do not capture the greater and more complex instances of real-life creative works.

The use of consensual assessment originated by Amabile (1983, 1996) for measuring musical creativity has also been suggested here as well. In fact, in her research of the reliability of this assessment method, Hickey (2001b) found that the Consensual Assessment Technique was a moderately reliable method for measuring the creativity of children's compositions. Interestingly, out of the teachers, experts and children she used in the study as judges, the music teachers were most able to come to an agreement consistently regarding the degree of creativity in the children’s musical work.

Other authentic assessments also are available. Much like the alternative modes of assessment suggested in technology education, Hickey (2001a) suggested, for example, that students maintain folders as a means to organize products produced by completing creative tasks. By writing about changes in their composition and improvisational performance over time, students can document and reflect on their progress.

Summary

It would appear that the subjects of art, music and technology education all have legitimate claims to fostering creativity in their curricula. What has become evident, however, is the fact that each subject has the ability to allow students the opportunity to uncover different facets of the broad spectrum of creativity. Creative work in art, on one hand, is very personal in nature and has been demonstrated to require the service of emotions and the elegant use of metaphor in order to cultivate divergent thought. Creativity in musical work is uniquely characterized by its ability to utilize, like art, the personality of the creator’s sensitivity to aesthetics and metaphor. However, the creative work in this subject not only embraces individual endeavors, but group efforts as well. Additionally, although divergent thinking is valued in creative musical work, convergent thought is also encouraged. Lastly, there seems to be no doubt that creativity and problem solving, the flagship activity of the engineering-focused technology education curriculum, are inextricably intertwined. In fact, Guilford (1976) stated that, "Problem solving is creative; there is no other kind." This realization is especially significant for technology educators as they attempt to infuse engineering into the curriculum. With divergent thinking being brought about both individually and more commonly in groups of students through the use of open ended problems, it appears that creativity in technology education shares a great deal with the development of creative work in art and music.

Concerning technology education specifically, by understanding creativity and its unique and vital place within their classroom, technology educators will be better equipped to deliver and assess informed, innovative, and focused curriculum that defines contemporary technology education.

Chapter III

Methodology

Identification of creative aspects inherent to the design and problem solving activities being suggested by the new engineering-focused technology education curriculum is still a fledgling area. The primary purposes of this study, therefore, were to identify specific aspects of creativity shared by the subjects of art, music, and technology education and to determine if there are creativity aspects unique to technology education. To examine these perceptions, a quantitative research method was employed. Specifically, a survey instrument was designed to collect data to answer the research questions. This survey, along with a random sampling of Minnesota Technology Education Association (MTEA), Art Educators of Minnesota (AEM), and Minnesota Music Education Association (MMEA) members were utilized because information about the entire population of teachers in the fields of art, music, and technology education in the state of Minnesota could be inferred from the responses of an appropriate sample size. Indeed, McMillan and Schumacher (1997) stated, "surveys are used frequently in educational research to describe attitudes, beliefs, opinions, and other types of information" (p. 38). The data gathered by these means will help answer the following questions:

1. Do technology, art and music teachers differ in their perception of the creative process?
2. Do technology, art and music teachers differ in their perception of the creative product?

3. Do technology, art and music teachers differ in their perception of creative personal traits?
4. Do technology, art and music teachers differ in their perception of the creative environment?
5. Are there predictors of the creativity perceptions among art, music, and technology teachers?

Upon close examination, identification of attributes inherent in the creative process and/or product produced by students of art, music, and technology education is a significant vein that runs through the questions above. Plucker and Runco (1998) stated that creativity has lately been considered to be content specific and both theoretical and empirical evidence has been provided to make this claim. In addition, Baer (1994) said the assessment of creativity should not only be content specific, but task-specific within content areas. These statements lend additional support to the legitimacy of efforts of this study to identifying attributes of creativity independently addressed by the three disciplines considered in this study.

Before an investigation of these specific attributes is considered, identifying whether a general agreed upon group of attributes believed to be common to all creative endeavors is fundamental in establishing a starting point for this inquiry. Using these concepts, the development of a survey instrument will be discussed along with the sampling approach. Lastly, this chapter will conclude by describing how the data were be gathered by the above instrument and subsequently analyzed.

Instrumentation

A seventy-nine item questionnaire was developed for this study. The items contained in the survey were sectioned into five categories: one addressing demographic information and four dealing with the nature of creativity consistent with the literature: creative process; creative product; creative personal traits; and the creative environment. The categories and the number of items contained in each of them, seminal authors, and common indicating terminology embedded in the literature and therefore used to compose the items in the survey, are found in Table 3.0.

Table 3.0
Components of the Survey Instrument

Categories	Seminal Author(s)	Example Indicators
Process (16 items)	Lubart (1999, 2000-2001), Torrance (1966), Sternberg (1985)	ability to transform things, observation, risk taking, flexibility, flow, synthesis, inventive use of an idea, act in a systematic manner
Product (14 items)	Getzels and Csikszenthmihalyi, (1976), Eisner (1962)	originality, completeness, novelty, technical quality, expressive power, aesthetic quality
Personal Traits (29 items)	Torrance (1963), Guilford (1950, 1976), Millar (2002)	humor, playfulness, ability to fantasize, ability to delay closure, tenacity, sensitivity to beauty, awareness of feelings/senses
Environment (15 items)	Amabile, T.M. (1983, 1990).	time management, sensory input, individual work, teamwork, knowledge, aptitude, technology

Pilot Instrument

After the instrument was developed, a pilot study was conducted. The instrument was delivered in person to three technology teachers, three art teachers, and two music teachers. All but two of the teachers involved in the pilot held a master's degree, with the two exceptions technology educators who had earned a doctorate. Instructions were given, orally and written, to review the statements and the overall format of the instrument. Modifications were made, based on their feedback, to clarify the wording of a few creative process related items.

Participants rated via a seven point Likert-type scale with 7 indicating "extremely important" and one indicating "not important" the extent of the importance of each item relative to their particular field. The participants were also asked five demographic questions related to the subject and grade level they taught, how long they had been teaching their subject, current level of education, and gender. The survey instrument is included in full in Appendix A.

Once data were derived, Cronbach's alpha reliabilities were determined for each category, as well as the instrument as a whole. Cronbach's alpha is a numerical coefficient of reliability or consistency. Calculation of alpha is based on the reliability of a test relative to other tests with same number of items and measuring the same area of interest (Hatcher, 1994). These findings are listed is Table 3.1. An overall reliability score of .91 was calculated for the entire pilot survey.

Table 3.1
Cronbach's Alpha Scores for Survey Instrument

Variable	Cronbach's Alpha	Number of Items
Total	.91	74
Process	.83	16
Product	.81	14
Personal Traits	.89	29
Environment	.66	15

Process= Creative Process; Product= Creative Product;
Personal Traits= Creative Personal Traits; Environment= Creative Environment
n=8

Population and Sample

Art, music, and technology education where the main subjects of interest in this study, therefore, members of the Minnesota Technology Education Association (MTEA), Art Educators of Minnesota (AEM), and Minnesota Music Educators Association (MMEA) were chosen as the populations from which to sample. The positions educators hold in these associations range from elementary to post secondary and administrative with many employed particularly at the middle and high school levels. After receiving prior approval from the Institutional Review Board (Appendix C), the researcher contacted association officials seeking access to the membership lists. After access was granted and the lists obtained, Microsoft Access was used to generate a random sample of teachers from the list of 289 MTEA, 422 AEM, and 1786 MMEA members. As a result, using tables referenced from Krejcie and Morgan (1970), surveys were sent via email to 208 AEM members and 169 MTEA members according to the addresses supplied by the association lists. Because of a privacy agreement, no email addresses accompanied the MMEA membership list. Therefore, 317 paper surveys were mailed to members via the accompanying school addresses supplied by the association list. Both online and paper forms of the survey followed identical formats. Each contained a letter of consent that was comprised of a page preceding the survey for web based surveys and a separate heading for paper surveys (Appendix B). Follow-up emails and paper mailings including an incentive of a chance to win one of fifteen $10 Amazon.com gift cards were used to encourage respondent participation. A listing of the response rates for each group of educators is listed in Table 3.2.

Table 3.2
Response Rates of Art, Music, and Technology Education Teachers

Group	Sample	n	% Response
Technology Education	169	42	25
Art	208	75	36
Music	317	126	40
Overall	694	243	35

Demographic Data

Demographic data comprised of what subject the participants taught, grade level they were currently teaching, years of teaching experience, level of education, and the gender of respondents was collected from the respondents in an effort to determine if any of these variables could be predictors to perceptions of creativity.

Grade Level: The largest group of respondents for both Art and Music educators were those that chose the category of "other" in relation to grade level. This would imply that these respondents could either be educators at the elementary or post secondary levels or hold administrative positions. The technology educators had the largest category of respondents at the high school level and the smallest to report themselves to be in the "other" category. Music educators had the highest level of middle school members responding to the survey. Table 3.3 displays the age groups to which the educators belonged.

Table 3.3: Grade levels taught by respondents.

Grade level	Art N	Art %	Music N	Music %	Technology N	Technology %	Total N
Middle/Junior High	12	16.2	44	38.9	10	25.6	66
High School	28	37.8	24	21.2	25	64.1	77
Other	34	45.9	45	39.8	4	10.3	83
Total	74	100.0	113	100.0	39	100.0	226

Teaching Experience: From within each discipline, Art educators had the highest percentage of respondents that had been teaching from 1 to 10 years. Table 3.1 displays the years of experience each of the respondents had obtained. Art educators again had the highest percentage of their respondents at the 11 to 20 year experience category. Music educators had the highest percentage of respondents at the 21 to 30 year experience category with technology education and art coming in second and third respectively. The percentages for the 31 or more category were the lowest for all three subject areas.

In summary, the largest percentage of art, music and technology education educator respondents had 1 to 10 years of teaching experience. Table 3.4 displays the levels of experience to which the educators belonged.

Table 3.4: Years of experience teaching their subjects.

Years	Art N	Art %	Music N	Music %	Technology N	Technology %	Total N
1-10	30	40.0	40	31.7	14	33.3	84
11-20	23	30.7	34	27.0	11	26.2	68
21-30	13	45.9	35	39.8	9	10.3	57
31 or more	9	12.0	17	13.5	8	19.0	34
Total	75	100.0	126	100.0	42	100.0	243

Level of education: The highest percentage from within each discipline for all subjects with regard to current level of education was that of a masters degree. Technology education had the highest within subject percentage of 66.7% with Art reporting 65.3% along with Music educators at 54.4%. Even though the percentages were quite low (art = 1.3%; music = 5.6%; technology education = 7.1%), there were teachers in each discipline that held a doctoral degree as well.

In addition, 40.0% of music educators reported having a bachelor's degree along with 33.3% of art educators and 26.2% of respondents in technology education. Table 3.5 displays the level of education to which the educators belonged.

Table 3.5: What is your current level of education?

Level of Education	Art		Music		Technology		Total
	N	%	N	%	N	%	N
Bachelors degree	25	33.3	50	40.0	11	26.2	66
Masters Degree	49	65.3	68	54.4	28	66.7	77
Doctorate	1	1.3	7	5.6	3	7.1	83
Total	74	100.0	113	100.0	39	100.0	226

Gender: Music educators were relatively split: 56% female, 44% male. In contrast, female respondents dominated art at 82.7% while technology education respondents were dominated by males at 90.5%. Table 3.6 displays the descriptive data for gender.

Table 3.6: Gender

	Art		Music		Technology		Total
Gender	N	%	N	%	N	%	N
Male	13	17.3	55	44.0	38	90.5	106
Female	62	82.7	70	56.0	4	9.5	136
Total	75	100.0	125	100.0	42	100.0	242

Data Analysis

In light of the five research questions guiding this study, it was imperative to determine how the perceptions of the items used to comprise the creative process, making of a creative product, creative personality traits, and working in a creative environment varied between art, music, and technology education. The researcher, using the Statistical Package of the Social Sciences (SPSS), analyzed the data after coding in accordance with the research questions. Descriptive statistics including means and standard deviations were used on the data garnered from all questions including demographics. Mean comparison and rankings were conducted to determine if one subject area perceived certain creative items as more important when compared to another subject.

In an effort to identify any predictors associated with the educators' creativity perceptions, participants were asked to identify demographic information. It was appropriate to compare these variables using a multivariate analysis of variance (MANOVA). Using this analysis enabled the researcher to test the dependent variables as a combined set of attributes concerning the creative process, products, personality traits, or environment and whether the independent variables perceive them differently. Specific to this study, MANOVA tested these dependent variables as a combined set of attributes, concerned with each respondent's total score added across all the items used to indicate the level importance and whether the demographic data interacted differently with them. Separate ANOVAs were conducted if significant relationships were found.

Chapter IV

DATA ANALYSIS AND FINDINGS

The purpose of this chapter is to present the findings of the survey which examined the perceptions of art, music, and technology education teachers with regard to the creative process, products, personality traits, and environment in relation to their respective fields of study and practice. The teachers participating in this study held positions that range from elementary to post secondary with many employed particularly at the middle and high school levels. They were asked to rate each creativity item by the degree to which they deemed it important in relation to their field of study.

Research Questions

The five research questions set forth were:

1. Do technology, art and music teachers differ in their perception of the creative process?
2. Do technology, art and music teachers differ in their perception of the creative product?
3. Do technology, art and music teachers differ in their perception of creative personal traits?
4. Do technology, art and music teachers differ in their perception of the creative environment?
5. Are their predictors of the creativity perceptions among art, music, and technology education teachers?

Findings for each are now reported in turn.

Research Question 1

Do technology, art and music differ in their perception of the creative process?

In this section of the survey, subjects were asked to indicate the level of importance of sixteen statements related to the creative process in their particular field. These statements were derived from the art, music, technology education, engineering, and creativity literature with particular attention paid to literature focused on the process of creating (see Sternberg, 1985; Torrance,1963, 1966; and Lubart, 2000-2001). The extent of the importance of each item was rated via a seven point Likert-type scale with seven indicating “extremely important” and one indicating “not important”. The data were analyzed using one-way analysis of variance (ANOVA). Mean ratings from art, music and technology education were compared. Scheffé post hoc comparison tests were used if there were significant differences for particular items.

As shown in Table 4.1, the analyses revealed four items for which the group ratings were significant different at the .01 level: item (Q13) “The creative process sometimes requires taking a break from the problem or challenge at hand to allow ideas to incubate”; item (Q15) “Metaphors and analogies are useful aids in creative thinking”; item (Q16) “The act of creating sometimes involves reformulation of the initial problem or challenge as one becomes engaged in the work”; item (Q17) “The creative process may begin even though the final product may not be formed in the “mind’s eye”.

Scheffé post hoc analysis revealed significant differences between technology education on one hand, and music and art teachers on the other for items 13 and 15. For both items, technology education had a lower mean (5.38 and 5.33 respectively) than both music (5.99 and 5.86 respectively) and art (6.29 and 5.93 respectively).

Specifically, technology education teachers were less interested in the importance of incubation during the creative process than the teachers of art and music. For item 16, art had a significantly higher mean than both technology education (5.62) and music (5.57). Lastly, for item 17, art had a significantly higher mean (6.32) than technology education (6.02). The last two findings indicate that art teachers placed higher importance than technology education teachers on the ability to essentially begin work without a definite final product in mind and being able to reformulate the initial challenge once work has begun.

Table 4.1 – Mean Comparison of the Creative Process Items

	Items/Statements	Art		Music		Technology		
		Mean	SD	Mean	SD	Mean	SD	p
Q6	Having relevant knowledge of prior products or solutions is an important aspect of creative work.	5.39	1.29	5.38	1.16	5.26	1.45	.856
Q7	To produce creative work a person must be familiar with standards for acceptable solutions.	4.57	1.60	5.00	1.49	4.95	1.43	.143
Q8	The creative process requires the ability to generate a number of exploratory ideas or solutions.	6.32	.83	6.02	.93	6.10	1.10	.082
Q9	Finding or identifying challenging problems is a critical dimension of the creative process	5.61	1.26	5.37	1.34	5.19	1.25	.206
Q10	Creativity includes the ability to find gaps, inconsistencies or flaws in existing solutions.	5.57	1.14	5.13	1.38	5.26	1.33	.070
Q11	Generating a representation of the problem or challenge is part of the creative process.	5.33	1.10	4.88	1.32	5.26	1.08	.024
Q12	Seeking out reactions to possible solutions is an important dimension of the creative process.	5.16	1.34	4.94	1.52	5.14	1.20	.487
Q13	The creative process sometimes requires taking a break from the problem or challenge at hand to allow ideas to incubate.	6.29	.90	5.99	1.18	5.38	1.41	.000*

N Art = 75, n Music = 127, n Technology =42,
*sig. p

Table 4.1 – Mean Comparison of the Creative Process Items (cont.)

	Art		Music		Technology		
Items/Statements	Mean	SD	Mean	SD	Mean	SD	p
Q14 Creative solutions sometimes come to mind as a "flash" or sudden awareness	6.23	.97	6.08	1.08	5.79	1.07	.093
Q15 Metaphors and analogies are useful aids in creative thinking.	5.93	1.26	5.86	1.08	5.33	1.05	.015*
Q16 The act of creating sometimes involves reformulation of the initial problem or challenge as one becomes engaged in the work.	6.08	.88	5.57	1.04	5.62	.96	.001*
Q17 The creative process may begin even though the final product may not be formed in the "mind's eye".	6.32	.83	6.06	.98	5.76	.91	.007*
Q18 The creative process often includes gathering and drawing upon all resources that can be helpful in completing a task.	6.08	1.00	5.81	1.03	6.02	1.00	.151
Q19 The possession of relevant knowledge is an important aid to the creative process.	5.76	1.05	5.82	1.11	5.52	1.09	.319
Q20 Creativity is improved if a person that is familiar with technical rules.	4.93	1.48	4.79	1.57	4.83	1.64	.823
Q21 Creativity is improved if a person is familiar with relevant principles or theories.	5.04	1.34	5.08	1.40	5.31	1.12	.548

N Art = 75, n Music = 126, n Technology =42,
*sig. p

Overall Rankings

Table 4.2 displays the results of not only how teachers of each subject ranked the items, but the overall level of importance of the 16 items. The top five items, listed in descending order, across the three subjects were item 8 – The creative process requires the ability to generate a number of exploratory ideas, item 17 – The creative process may begin even though the final product may not be formed in the "mind's eye", item 14 – Creative solutions sometimes come to mind as a "flash" or sudden awareness, item 13 – The creative process sometimes requires taking a break from the problem or challenge at hand to allow ideas to incubate, and item 18 – The creative process often includes gathering and drawing upon all resources that can be helpful in completing a task.

When comparing these items with the rankings of the individual subjects, only a few differences arose. Art teachers ranked items 8 and 17 (virtually the same ranks as overall) equally as the highest rank item, item 13 as the third, item 14 as the fourth, and items 16 (The act of creating sometimes involves reformulation of the initial problem or challenge as one becomes engaged in the work), and item 18 tied for fifth highest rank.

Music teachers considered item 14 of the highest importance, followed by item 17 (same rank as overall), item 8, item 14 (same rank as overall), and item 15 (metaphors and analogies are useful aids in creative thinking) respectively.

Technology teachers selected item 8 (same as overall) as first rank, then items 18, 14, 17, and 16 respectively. Overall, with the exceptions of items 15 from music and 16 from technology education, the top five items from each subject area matched well with the top five overall rankings across the independent variables with means above 5.62.

Table 4.2 – Rank of the Creative Process Items

	Items/Statements	Art		Music		Technology		Overall	
		Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Q6	Having relevant knowledge of prior products or solutions is an important aspect of creative work.	11	5.39	9	5.38	11	5.26	10	5.36
Q7	To produce creative work a person must be familiar with standards for acceptable solutions.	16	4.57	13	5.00	15	4.95	15	4.86
Q8	The creative process requires the ability to generate a number of exploratory ideas or solutions.	1.5	6.32	3	6.02	1	6.10	1	6.12
Q9	Finding or identifying challenging problems is a critical dimension of the creative process	9	5.61	10	5.37	13	5.19	9	5.40
Q10	Creativity includes the ability to find gaps, inconsistencies or flaws in existing solutions.	10	5.57	11	5.13	11	5.26	11	5.28
Q11	Generating a representation of the problem or challenge is part of the creative process.	12	5.33	15	4.88	11	5.26	13	5.07
Q12	Seeking out reactions to possible solutions is an important dimension of the creative process.	13	5.16	14	4.94	14	5.14	14	5.03
Q13	The creative process sometimes requires taking a break from the problem or challenge at hand to allow ideas to incubate.	3	6.29	4	5.99	7	5.38	4	5.98

N Art = 75, n Music = 127, n Technology =42

Table 4.2 – Rank of the Creative Process Items (cont.)

	Items/Statements	Art Rank	Art Mean	Music Rank	Music Mean	Technology Rank	Technology Mean	Overall Rank	Overall Mean
Q14	Creative solutions sometimes come to mind as a "flash" or sudden awareness	4	6.23	1	6.08	3	5.79	3	6.08
Q15	Metaphors and analogies are useful aids in creative thinking.	7	5.93	5	5.86	8	5.33	6	5.79
Q16	The act of creating sometimes involves reformulation of the initial problem or challenge as one becomes engaged in the work.	5.5	6.08	8	5.57	5	5.62	8	5.74
Q17	The creative process may begin even though the final product may not be formed in the "mind's eye".	1.5	6.32	2	6.06	4	6.02	2	6.09
Q18	The creative process often includes gathering and drawing upon all resources that can be helpful in completing a task.	5.5	6.08	7	5.81	2	6.02	5	5.93
Q19	The possession of relevant knowledge is an important aid to the creative process.	8	5.76	6	5.82	6	5.52	7	5.75
Q20	Creativity is improved if a person that is familiar with technical rules.	15	4.93	16	4.79	16	4.83	16	4.85
Q21	Creativity is improved if a person is familiar with relevant principles or theories.	14	5.04	12	5.08	9	5.31	12	5.11

N Art = 75, n Music = 127, n Technology =42

Research Question 2

Do technology, art and music teachers differ in their perception of the creative product?

In this section of the survey subjects were asked to indicate the level of importance of fourteen statements related to creative products in their particular field. Statements were derived from the art, music, technology education, engineering, and creativity literature and considerable focus was placed upon work focusing on defining what attributes of products make them creative (see Eisner, 1962; Getzels and Csikszenthmihalyi, 1976). Means were compared using oneway analysis of variance (ANOVA). Scheffe' post hoc comparison tests were conducted if any significant differences among mean scores were detected.

The analysis revealed several items that were significant at the .01 level or less. When examined, common themes such as a product's ability to be revolutionary and break with tradition, novel or generally unusual, practical, easy to use and of value to the community, and well made were points of contention.

Specifically, post hoc analysis (Scheffe') revealed significant differences between Music and Art with regard to a creative product's ability to be revolutionary and break with tradition, novel or generally unusual, and easy to use. Specifically, with the exception of a ability to be easy to use, art educators rated a creative product's ability to be revolutionary and novel significantly higher than music educators.

Of more interest to this study, technology education educators rated items dealing with quality, practicality, ease of use, and value to the community, significantly higher than music and art educators with regard to their perceptions of creative product. Of the items where a significant difference was found, teachers of the three subjects rated half of the items above 4.00, which would demonstrate general support for the ideas the items were based upon. The others rated below 4.00 were: item (Q26) "A creative product follows the accepted and understood rules of the discipline"; item (Q27) "A creative product has clear and practical implications"; item (Q28) "To be considered creative, a product in my field must be of value to the community at large"; item (Q32) "A creative product in my field is easy to understand, interpret, or use"; item (Q33) "The craft component of completed works is critical in determining how creative they are"; item (Q34) "To be deemed creative, a product in my field must be revolutionary in some way; and item (Q35) "A creative product in my field must conform to acceptable technical requirements". Upon closer review, all the items just mentioned that were rated below 4.00 as a mean score, were rated above 4.00 by technology education teachers with only Music also rating item (Q32) at 4.01 as well. This demonstrated, again, the significant difference in how technology education teachers view creative products when compared with their peers in art and music with respect to valuing general ease of use, quality, and community perceptions. Indeed, the difference between the ratings of the technology education teachers and the art and music teachers is dramatic. With respect to the items concerned with valuing a product's ease of use, practical implications, value to the community, craftsmanship, ability to respond to a need, and general adherence to technical standards (items 25, 27, 28, 32, 33, 35), means ranged from 4.45 to 5.00 for technology education teachers while means for art and music ranged from 2.72 to 4.11.

Interestingly, the mean ratings for all three subjects regarding items concerned with the creative process were higher than for items about creative products.

Table 4.3– Mean Comparison of the Creative Product Items

Items/Statements	Art Mean	Art SD	Music Mean	Music SD	Technology Mean	Technology SD	p
Q22 In my field, a creative product must posses a high degree of novelty.	4.64	1.49	3.95	1.51	4.10	1.69	.009*
Q23 A creative product is likely to influence or suggest additional future creative products.	5.67	1.16	5.06	1.28	5.07	1.35	.003*
Q24 A product is considered creative if it is unusual or seen infrequently in the category to which it belongs.	4.88	1.65	4.13	1.44	4.24	1.46	.003*
Q25 The degree to which a product responds to a need or problem determines its level of creativity.	4.05	1.58	3.57	1.59	4.74	1.29	.000*
Q26 A creative product follows the accepted and understood rules of the discipline.	3.48	1.48	3.55	1.63	4.00	1.25	.183
Q27 A creative product has clear and practical implications.	2.95	1.43	3.63	1.69	5.00	1.23	.000*
Q28 To be considered creative, a product in my field must be of value to the community at large.	2.72	1.43	3.31	1.73	4.60	1.27	.000*
Q29 A creative product breaks with the tradition from which it emerges.	4.55	1.79	3.92	1.50	4.93	1.35	.000*

N Art = 75, n Music = 127, n Technology =42
*sig. p

Table 4.3– Mean Comparison of the Creative Product Items (cont.)

Items/Statements	Art Mean	Art SD	Music Mean	Music SD	Technology Mean	Technology SD	p
Q30 Products are creative if they combine elements in unusual ways.	5.57	1.25	5.01	1.17	4.98	1.24	.003*
Q31 A product is creative if it commands the attention of a person using, listening to, or viewing it.	5.25	1.41	5.18	1.41	4.86	1.35	.316
Q32 A creative product in my field is easy to understand, interpret, or use.	3.19	1.52	4.07	1.47	4.93	1.22	.000*
Q33 The craft component of completed works is critical in determining how creative they are.	3.49	1.56	4.11	1.38	4.45	1.19	.001*
Q34 To be deemed creative, a product in my field must be revolutionary in some way.	4.00	1.69	3.53	1.47	4.24	1.30	.014*
Q35 A creative product in my field must conform to acceptable technical requirements.	3.24	1.45	3.54	1.67	4.88	1.35	.000*

N Art = 75, n Music = 127, n Technology =42
*sig. p

Overall Rankings

Table 4.4 displays the results of not only how teachers of each subject ranked the items, but the overall level of importance the 14 items garnered. The top five items, listed in descending order of ranking, across the three subjects were item 23 – A creative product is likely to influence or suggest additional future creative products, item 30 – Products are creative if they combine elements in unusual ways, item 31 – A product is creative if it commands the attention of a person using, listening to, or viewing it, item 24 – A product is considered creative if it is unusual or seen infrequently in the category to which it belongs, and item 29 – A creative product breaks with the tradition from which it emerges.

When comparing these items with the rankings of the individual subjects, Art teachers also ranked items 23, 30, 31, and 24 as their most important aspects of creative products (the same rank order as overall). To round out the top five, art teachers selected item 22 – In my field, a creative product must possess a high degree of novelty, with a mean score of 4.64. This was unique to that group. In fact, although music teachers ranked this item as seventh out of the fourteen items (mean score of 3.95), technology teachers ranked it a very low 13 with a mean score of 4.10.

Music teachers considered item 31 of the highest importance, followed by items 23, 30, item 24 respectively. Item 33 was ranked fifth (The craft component of completed works is critical in determining how creative they are) with a mean of 4.11 which was unique to this group. Indeed, the Art group placed item 33 as ninth on the list of fourteen, with a mean of 3.49, and the technology education group selected it as tenth with a mean of 4.45.

Technology education teachers were quite different in their rankings when compared to the patterns demonstrated by the art and music teachers above. Although they found 23 to also be their top ranked item and item 30 to be the third in line, this group identified 27, A creative item has clear and practical implications, as the second ranked item with a mean of 5.00. Art and music teachers ranked them thirteenth and ninth with means of 2.95 and 3.63 respectively. Items 29 (A creative product breaks with the tradition from which it emerges) and 32 (A creative product in my field is easy to understand, interpret and use) were ranked equally at 4.5 with equal means of 4.93. Art and music teachers ranked item 29 as sixth and eighth with means of 4.55 and 3.92 respectively and item 32 as eleventh and twelfth with means of 3.24 and 3.54 respectively. Again, this indicated a significant difference in how technology education teachers view creative products when compared with their peers in art and music with respect to valuing general ease of use and community perceptions.

Table 4.4 – Rank of the Creative Product Items

Items/Statements	Art Rank	Art Mean	Music Rank	Music Mean	Technology Rank	Technology Mean	Overall Rank	Overall Mean
Q22 In my field, a creative product must posses a high degree of novelty.	5	4.64	7	3.95	13	4.10	6	4.18
Q23 A creative product is likely to influence or suggest additional future creative products.	1	5.67	2	5.06	1	5.07	1	5.23
Q24 A product is considered creative if it is unusual or seen infrequently in the category to which it belongs.	4	4.88	4	4.13	11.5	4.24	4	4.38
Q25 The degree to which a product responds to a need or problem determines its level of creativity.	7	4.05	10	3.57	8	4.74	9	3.92
Q26 A creative product follows the accepted and understood rules of the discipline.	10	3.48	11	3.55	14	4.00	13	3.60
Q27 A creative product has clear and practical implications.	13	2.95	9	3.63	2	5.00	12	3.66
Q28 To be considered creative, a product in my field must be of value to the community at large.	14	2.72	14	3.31	9	4.60	14	3.35
Q29 A creative product breaks with the tradition from which it emerges.	6	4.55	8	3.92	4.5	4.93	5	4.28

N Art = 75, n Music = 127, n Technology =42

Table 4.4 – Rank of the Creative Product Items (cont.)

Items/Statements	Art Rank	Art Mean	Music Rank	Music Mean	Technology Rank	Technology Mean	Overall Rank	Overall Mean
Q30 Products are creative if they combine elements in unusual ways.	2	5.57	3	5.01	3	4.98	2	5.18
Q31 A product is creative if it commands the attention of a person using, listening to, or viewing it.	3	5.25	1	5.18	7	4.86	3	5.14
Q32 A creative product in my field is easy to understand, interpret, or use.	12	3.19	6	4.07	4.5	4.93	8	3.94
Q33 The craft component of completed works is critical in determining how creative they are.	9	3.49	5	4.11	10	4.45	7	3.97
Q34 To be deemed creative, a product in my field must be revolutionary in some way.	8	4.00	13	3.53	11.5	4.24	10	3.79
Q35 A creative product in my field must conform to acceptable technical requirements.	11	3.24	12	3.54	6	4.88	11	3.67

N Art = 75, n Music = 127, n Technology =42

Research Question 3

Do technology, art and music differ in their perception of creative personal traits?

For this section of the survey, particular attention was given to work focused on creative personalities and behavior (see Guilford, 1950; Millar, 2002). In addition, statements were also derived from the art, music, technology education, engineering, and other creativity literature as well.

This portion of the survey was comprised of 29 items. A high mean reflected a high level of importance. As shown in Table 4.5, means and standard deviations were calculated for each of the items. The analysis revealed that several of the items showed significant differences between the subject areas. Mainly, the items the three groups of educators differed on dealt with a person's ability to tap into their emotions, fantasize and employ their senses; be humorous and playful in their creative pursuits; and having the flexibility of mind to produce unique responses and assemble novel ideas often in usual settings.

Post hoc analysis (Scheffe') revealed significant differences between Music and Art for item 39 with Art having the higher mean of 6.25. Art also had significantly higher mean ratings (6.15 and 6.21 respectively) than technology education (5.57 and 5.64 respectively) with regard to items 37 and 45. For item 51, music had a significantly higher mean (5.34) than technology education (4.29). Concerning items 43, 44, 46, 47, and 50, significant mean differences were found between all subjects with music possessing the highest mean for item 43 (6.05) and art having the highest mean for items 44 (6.00), 46 (5.88), 47 (6.45), and 50 (6.16). Of special note, technology education possessed the lowest composite means of the three subject areas analyzed in the items just mentioned: 43 (3.86), 44 (5.00), 46 (5.05), 47 (5.79), and 50 (5.31).

With means ranging from 4.10 to 6.36, there was general support of the creative personal traits items from technology education teachers, with the obvious exception of item 43 (Creative people in my subject area tap into their emotions in order to generate ideas or solutions to a problem or challenge) and item 58 (Creativity in my field is really a gift that cannot be taught) that received a mean rating of a 3.86 and 3.71: the lowest two ratings of this section of the survey. This would indicate a significant difference between the perceptions of art teachers and technology education teachers. Specifically, technology education teachers do not appear to value creative personality traits to the same degree as their peers in art.

Table 4.5– Mean Comparison of the Personal Trait Items

	Art		Music		Technology		
Items/Statements	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**p**
Q36 A creative person in my field can generate a large number of ideas that are relevant to the problem at hand.	5.71	1.28	5.21	1.28	5.57	1.15	.020
Q37 Creative people in my subject area have an ability to produce uncommon or unique responses.	6.15	.82	5.70	.93	5.57	1.17	.001*
Q38 The ability to develop and elaborate upon ideas is a trait that creative people in my field possess.	6.21	.91	5.94	.98	5.90	1.10	.112
Q39 A creative person considers a variety of types of information when thinking about a problem.	6.25	.90	5.74	1.11	6.05	.94	.002*
Q40 Being open minded is an important trait one must possess to be considered creative in my field.	6.33	1.06	5.87	1.36	6.29	.74	.013*
Q41 When faced with a problem or challenge a creative person is able to distinguish clearly between relevant and irrelevant information.	4.99	1.34	5.16	1.30	5.45	.97	.163
Q42 The ability to resist the impulse to accept the first solution that comes to mind and to explore all possible ideas would be a trait of a creative person in my field.	5.71	1.39	5.14	1.43	5.67	1.28	.010*
Q43 Creative people in my subject area tap into their emotions in order to generate ideas or solutions to a problem or challenge.	5.81	1.01	6.05	.995	3.86	1.59	.000*
Q44 A creative person has the ability to put together ideas into novel and pleasing combinations.	6.00	.97	5.85	1.10	5.00	1.36	.000*

N Art = 75, n Music = 127, n Technology =42,
*sig. p

Table 4.5– Mean Comparison of the Personal Trait Items (cont.)

Items/Statements	Art Mean	Art SD	Music Mean	Music SD	Technology Mean	Technology SD	p
Q45 A creative person has the ability to fantasize and go beyond concrete reality.	6.21	.87	5.99	1.18	5.64	.96	.021
Q46 A creative person seeks out ways to stimulate more than one of their senses to increase their flow of ideas.	5.88	1.12	5.75	1.27	5.05	1.38	.002*
Q47 A creative individual may look at everyday objects and see something novel and exciting.	6.45	.70	5.85	1.22	5.79	1.03	.000*
Q48 A creative person in my field is interested in looking beyond exteriors; exploring the inner workings of an object, problem or idea.	6.07	.95	5.70	1.25	5.81	1.09	.093
Q49 The degree to which a person is able to look past the task at hand and visualize the systems it functions in is a characteristic of a creative person.	5.68	.99	5.28	1.32	5.62	1.08	.045
Q50 Creative people in my field have the ability to see peculiarity and have the ability to combine ideas or images in unusual ways that evoke surprise.	6.16	.87	5.58	1.19	5.31	1.07	.000*
Q51 In my field the ability to be humorous or playful is an indicator of a creative person.	5.03	1.57	5.34	1.46	4.29	1.66	.001*
Q52 A key component of a creative person in my field is a concern for the future, and a desire to be a part of its shaping.	4.69	1.48	4.82	1.61	5.40	1.23	.042
Q53 Creative people in my field usually show unusual interest in their particular pursuit.	5.49	1.29	5.94	1.11	5.52	1.13	.014*

N Art = 75, n Music = 127, n Technology =42,
*sig. p

Table 4.5– Mean Comparison of the Personal Trait Items (cont.)

Items/Statements	Art Mean	Art SD	Music Mean	Music SD	Technology Mean	Technology SD	p
Q54 Creative people in my field have great tolerance for vagueness.	4.48	1.66	3.84	1.56	4.10	1.78	.028
Q55 Creative people in my field possess great knowledge of the principles and theories relating to their area of interest.	5.37	1.30	5.38	1.29	5.55	1.06	.733
Q56 Creative people in my field are known for the persistence that they bring to their work.	5.79	1.20	5.92	1.21	5.81	.80	.692
Q57 Creative people in my field have the ability to improvise.	6.43	.81	6.48	.87	6.36	.73	.675
Q58 Creativity in my field is really a gift that cannot be taught.	3.73	1.70	4.38	1.70	3.71	1.73	.013*
Q59 Creative people are seldom satisfied with their work and would rather not bring quick closure to a task.	4.61	1.43	4.87	1.42	4.55	1.42	.315
Q60 Creative people display flexibility of mind; they are capable of changing their mental set easily.	5.45	1.15	5.06	1.17	4.86	1.34	.018*
Q61 Creative people can manipulate many related ideas at the same time.	5.71	1.04	5.48	1.19	5.19	1.33	.072
Q62 Creative people possess high intrinsic motivation for their work.	5.95	1.10	6.00	1.31	5.55	.99	.066
Q63 Creative people tend to have novel ideas relating to their subject.	5.81	1.15	5.78	1.13	5.38	.854	.087
Q64 Creative people have high sensitivity to problems: they can see challenges in situations where others are oblivious to them.	5.64	1.07	5.56	1.13	5.64	.96	.856

N Art = 75, n Music = 127, n Technology =42,
*sig. p

Overall Rankings

Table 4.6 displays the results of not only how teachers of each subject ranked the items, but the overall level of importance the 29 items measured across the three independent variables. The overall top five items, listed in descending order of ranking, across the three subjects were item 57 – Creative people in my field have the ability to improvise, item 40 – Being open minded is an important trait one must possess to be creative in my field, item 47 – A creative individual may look at everyday objects and see something novel and exciting, item 38 – The ability to develop and elaborate upon ideas is a trait that creative people in my field possess, and item 45 – A creative person has the ability to fantasize and go beyond concrete reality.

Comparing these items with the rankings of the individual subjects, art teachers ranked item 47 as first with a mean of 6.45. In addition, item 57 was second, item 40 third, item 39 (A creative person considers a variety of types of information when thinking about a problem) was fourth, and items 38 and 45 were tied for the ranking of 5.5 with means of 6.43, 6.33, 6.25, and 6.21 respectively. With the obvious exception of item 39, which was sixth in overall rankings, the top five ranks of the art group essentially mirrored that of the overall rankings. Interestingly, the art group scored all of their top five items well above 6.00, ranging from 6.45 to 6.21. Music means ranged from 6.48 to 5.94 and technology education means ranged from 6.36 to 5.81.

The rankings of items 57 as first, 45 as fourth, and 38 at a rank of 5.5 by Music teachers are very similar to the overall rankings of these traits with respective means of 6.48, 5.99 and 5.94. However, a striking difference between music and the other two groups appeared when the ranking of item 43 (Creative people in my subject area tap into their emotions in order to generate ideas or solutions to a problem or challenge) as second, item 62 (Creative people possess high intrinsic motivation for their work) as third, and item 53 (Creative people in my field usually show unusual interest in their particular pursuit) in a tie for the rank of 5.5 were demonstrated with means of 6.05, 6.00 and 5.94 respectively.

Like the overall rankings, technology education teachers also ranked item 57 as first and item 40 second. Item 39 was third and item 38 was, like the overall ranking, fourth. Interestingly, items 48 (A creative person in my field is interested in looking beyond exteriors; exploring the inner workings of an object, problem or idea) and 56 (Creative people in my field are known for their persistence that they bring to their work) were tied for the ranking of 5.5. In comparison, art teachers ranked item 48 at ninth, music teachers at a distant 14.

Table 4.6 – Rank of the Personal Traits Items

Items/Statements	Art Rank	Art Mean	Music Rank	Music Mean	Technology Rank	Technology Mean	Overall Rank	Overall Mean
Q36 A creative person in my field can generate a large number of ideas that are relevant to the problem at hand.	17	5.71	22	5.21	12.5	5.57	20	5.43
Q37 Creative people in my subject area have an ability to produce uncommon or unique responses.	8	6.15	14.5	5.70	12.5	5.57	10	5.82
Q38 The ability to develop and elaborate upon ideas is a trait that creative people in my field possess.	5.5	6.21	5.5	5.94	4	5.90	4	6.01
Q39 A creative person considers a variety of types of information when thinking about a problem.	4	6.25	13	5.74	3	6.05	6	5.95
Q40 Being open minded is an important trait one must possess to be considered creative in my field.	3	6.33	8	5.87	2	6.29	2	6.07
Q41 When faced with a problem or challenge a creative person is able to distinguish clearly between relevant and irrelevant information.	25	4.99	23	5.16	17	5.45	23.5	5.14
Q42 The ability to resist the impulse to accept the first solution that comes to mind and to explore all possible ideas would be a trait of a creative person in my field.	17	5.71	24	5.14	8	5.67	21.5	5.40
Q43 Creative people in my subject area tap into their emotions in order to generate ideas or solutions to a problem or challenge.	13.5	5.81	2	6.05	28	3.86	17	5.59
Q44 A creative person has the ability to put together ideas into novel and pleasing combinations.	10	6.00	9.5	5.85	23	5.00	11	5.75

N Art = 75, n Music = 127, n Technology =42

Table 4.6 – Rank of the Personal Traits Items (cont.)

Items/Statements	Art Rank	Art Mean	Music Rank	Music Mean	Technology Rank	Technology Mean	Overall Rank	Overall Mean
Q45 A creative person has the ability to fantasize and go beyond concrete reality.	5.5	6.21	4	5.99	9.5	5.64	5	6.00
Q46 A creative person seeks out ways to stimulate more than one of their senses to increase their flow of ideas.	12	5.88	12	5.75	22	5.05	15	5.65
Q47 A creative individual may look at everyday objects and see something novel and exciting.	1	6.45	9.5	5.85	7	5.79	3	6.03
Q48 A creative person in my field is interested in looking beyond exteriors; exploring the inner workings of an object, problem or idea.	9	6.07	14.5	5.70	5.5	5.81	9	5.82
Q49 The degree to which a person is able to look past the task at hand and visualize the systems it functions in is a characteristic of a creative person.	19	5.68	21	5.28	11	5.62	19	5.46
Q50 Creative people in my field have the ability to see peculiarity and have the ability to combine ideas or images in unusual ways that evoke surprise.	7	6.16	16	5.58	20	5.31	14	5.70
Q51 In my field the ability to be humorous or playful is an indicator of a creative person.	24	5.03	20	5.34	26	4.29	25	5.05
Q52 A key component of a creative person in my field is a concern for the future, and a desire to be a part of its shaping.	26	4.69	27	4.82	18	5.40	26	4.87
Q53 Creative people in my field usually show unusual interest in their particular pursuit.	21	5.49	5.5	5.94	16	5.52	12.5	5.72

N Art = 75, n Music = 127, n Technology =42

Table 4.6 – Rank of the Personal Traits Items (cont.)

	Art		Music		Technology		Overall	
Items/Statements	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean
Q54 Creative people in my field have great tolerance for vagueness.	28	4.48	29	3.84	27	4.10	28	4.09
Q55 Creative people in my field possess great knowledge of the principles and theories relating to their area of interest.	23	5.37	19	5.38	14.5	5.55	21.5	5.40
Q56 Creative people in my field are known for the persistence that they bring to their work.	15	5.79	7	5.92	5.5	5.81	8	5.85
Q57 Creative people in my field have the ability to improvise.	2	6.43	1	6.48	1	6.36	1	6.43
Q58 Creativity in my field is really a gift that cannot be taught.	29	3.73	28	4.38	29	3.71	29	4.05
Q59 Creative people are seldom satisfied with their work and would rather not bring quick closure to a task.	27	4.61	26	4.87	25	4.55	27	4.74
Q60 Creative people display flexibility of mind; they are capable of changing their mental set easily.	22	5.45	25	5.06	24	4.86	23.5	5.14
Q61 Creative people can manipulate many related ideas at the same time.	17	5.71	18	5.48	21	5.19	18	5.49
Q62 Creative people possess high intrinsic motivation for their work.	11	5.95	3	6.00	14.5	5.55	7	5.89
Q63 Creative people tend to have novel ideas relating to their subject.	13.5	5.81	11	5.78	19	5.38	12.5	5.72
Q64 Creative people have high sensitivity to problems: they can see challenges in situations where others are oblivious to them.	20	5.64	17	5.56	9.5	5.64	16	5.60

N Art = 75, n Music = 127, n Technology =42

Research Question 4

Do technology, art and music differ in their perception of the creative environment?

In this part of the survey, participants from the three subjects were asked to indicate the level of importance of statements related to the creative environment in their particular field. The data were analyzed via one way analysis of variance (ANOVA). Scheffé post hoc comparison test was used if there were significant differences detected among the means.

This portion of the survey was comprised of 15 items. As shown in Table 4.7, the analysis revealed three items that showed significance at the .01 level: item 65 (Q65) "Creativity is enhanced when people work in groups"; item 70 (Q70) "An atmosphere of competition tends to have a positive effect on creative work"; item 71 (Q71) "Creativity is aided in environments that offer rewards for such work."

Post hoc analysis (Scheffé) revealed significant differences between the mean score of technology education and that of art for item 65; with technology education having a mean of 5.14 and Art 4.03. The mean scores for items 70 and 71 for technology education were significantly higher at 5.14 and 5.55 respectively when compared to both art (3.97 and 4.17 respectively) and music (3.75 and 4.37 respectively). These results would indicate that technology education teachers perceive group work, competition, and reward for creative work to be significantly more important in the production of creative work than art and music teachers.

Table 4.7– Mean Comparison of the Creative Environment Items

Items/Statements	Art Mean	Art SD	Music Mean	Music SD	Technology Mean	Technology SD	p
Q65 Creativity is enhanced when people work in groups.	4.03	1.66	4.45	1.71	5.14	1.42	.002*
Q66 Creativity is enhanced in environments that allow risk taking.	6.41	.89	6.16	1.14	6.07	.95	.144
Q67 Creative people in my field tend to be more productive when they work by themselves.	4.63	1.45	4.39	1.51	4.10	1.61	.186
Q68 In my field work environments that are open and offer flexibility are aids to creative work.	6.05	1.13	5.74	1.26	5.60	1.28	.105
Q69 Classrooms that offer structure can be beneficial to the development of creativity.	5.12	1.40	4.97	1.39	4.93	1.26	.688
Q70 An atmosphere of competition tends to have a positive effect on creative work.	3.97	1.55	3.75	1.63	5.14	1.34	.000*
Q71 Creativity is aided in environments that offer rewards for such work.	4.17	1.54	4.37	1.52	5.55	.92	.000*
Q72 Creativity is aided in environments that offer feedback about a person's work.	5.83	1.19	5.48	1.24	5.64	1.01	.137
Q73 Being able to work within constraints is a measure of creativity.	4.69	1.78	4.53	1.72	4.83	1.36	.559
Q74 Creativity is fostered when people are encouraged to pursue activities that are of interest to them.	6.09	1.04	6.25	.89	5.95	.85	.172

N Art = 75, n Music = 127, n Technology =42,
*sig. p

Table 4.7– Mean Comparison of the Creative Environment Items (cont.)

Items/Statements	Art Mean	Art SD	Music Mean	Music SD	Technology Mean	Technology SD	p
Q75 Creativity is more likely to be achieved when one's activities are aimed towards a goal.	5.24	1.21	5.64	1.14	5.69	1.07	.034
Q76 Creative environments are usually messy or chaotic.	3.63	1.60	3.90	1.61	4.00	1.56	.377
Q77 In the classroom creativity is aided if the teacher provides guidelines for how the work should proceed.	5.01	1.36	5.09	1.30	4.64	1.27	.163
Q78 In the classroom students are more likely to be creative when the teacher allows them freedom to work in their own way.	5.12	1.30	5.14	1.26	5.26	1.23	.832
Q79 Students are more likely to produce creative work if they receive sound instruction in the knowledge and principles relating to their work.	5.65	1.16	5.78	1.18	5.43	1.25	.250

N Art = 75, n Music = 127, n Technology =42,
*sig. p

Overall Rankings

Table 4.8 displays the results with of not only how teachers of each subject ranked the items, but the overall level of importance the 15 items. The top five items, listed in descending order of ranking, across the three subjects were item 66 – Creativity is enhanced in environments that allow risk taking, item 74 – Creativity is fostered when people are encouraged to pursue activities that are of interest to them, item 68 – In my field work environments that are open and offer flexibility are aids to creative work, item 79 – Students are more likely to produce creative work if they receive sound instruction in the knowledge and principles relating to their work, and item 72 – Creativity is aided in environments that offer feedback about a person's work.

The rankings of items 74 as first, 66 as second, 79 as third, and 68 as fourth by Art teachers were also very close to the order of the overall top four ranking order. Music teachers ranked item 75 (Creativity is more likely to be achieved when one's activities are aimed toward a goal) as fifth which only bettered the overall and Art ranking by only one (6) while technology education teachers ranked it as a close three.

Similar to the overall rankings, technology education teachers ranked item 66 as first and item 74 as second. Item 75, as mentioned previously, was third and item 72 was fourth along with item 68 as fifth. Overall, with the exceptions of item 75 from music and technology education, the top five items from each subject area matched well with the top five overall rankings across the independent variables.

Table 4.8 – Rank of the Creative Environment Items

	Items/Statements	Art Rank	Art Mean	Music Rank	Music Mean	Technology Rank	Technology Mean	Overall Rank	Overall Mean
Q65	Creativity is enhanced when people work in groups.	12	4.03	11	4.45	9.5	5.14	12	4.43
Q66	Creativity is enhanced in environments that allow risk taking.	1	6.41	2	6.16	1	6.07	1	6.22
Q67	Creative people in my field tend to be more productive when they work by themselves.	10	4.63	12	4.39	14	4.10	13	4.40
Q68	In my field work environments that are open and offer flexibility are aids to creative work.	3	6.05	4	5.74	5	5.60	3	5.82
Q69	Classrooms that offer structure can be beneficial to the development of creativity.	7.5	5.12	9	4.97	11	4.93	8	5.02
Q70	An atmosphere of competition tends to have a positive effect on creative work.	13	3.97	15	3.75	9.5	5.14	14	4.06
Q71	Creativity is aided in environments that offer rewards for such work.	11	4.17	13	4.37	6	5.55	11	4.51
Q72	Creativity is aided in environments that offer feedback about a person’s work.	4	5.83	6	5.48	4	5.64	5	5.61
Q73	Being able to work within constraints is a measure of creativity.	9	4.69	10	4.53	12	4.83	10	4.63
Q74	Creativity is fostered when people are encouraged to pursue activities that are of interest to them.	2	6.09	1	6.25	2	5.95	2	6.14

N Art = 75, n Music = 127, n Technology =42

Table 4.8 – Rank of the Creative Environment Items (cont.)

Items/Statements	Art Rank	Art Mean	Music Rank	Music Mean	Technology Rank	Technology Mean	Overall Rank	Overall Mean
Q75 Creativity is more likely to be achieved when one's activities are aimed towards a goal.	6	5.24	5	5.64	3	5.69	6	5.52
Q76 Creative environments are usually messy or chaotic.	14	3.63	14	3.90	15	4.00	15	3.84
Q77 In the classroom creativity is aided if the teacher provides guidelines for how the work should proceed.	8	5.01	8	5.09	13	4.64	9	4.99
Q78 In the classroom students are more likely to be creative when the teacher allows them freedom to work in their own way.	7.5	5.12	7	5.14	8	5.26	7	5.16
Q79 Students are more likely to produce creative work if they receive sound instruction in the knowledge and principles relating to their work.	5	5.65	3	5.78	7	5.43	4	5.68

N Art = 75, n Music = 127, n Technology =42

Research Question 5

Are their predictors of the creativity perceptions among art, music, and technology education teachers?

To determine predictions of respondent's ratings of the importance of creativity in the study, multivariate analysis of variance (MANOVA) was used. MANOVA, in this instance, tested the dependent variables as a combined set of attributes concerning the creative process, products, personality traits, or environment and whether the independent variables perceive them differently (Cooley and Lohnes, 1971, pp. 227-228). Specifically, a value that represented each respondent's overall score for every item in the survey needed to be fashioned. This was accomplished by creating a "total score" for each of the respondents of the study by adding each of the ratings the participants selected for the 74 items in the survey. These "total scores" for all of the 244 respondents served as the dependent variable in the MANOVA analysis and were analyzed with the demographic data (subject taught, grade level currently teaching, years of experience, level of education, and gender) to determine if they interacted with one another in ways that were significant in any way. Doing this permitted the analysis to take into account that the total score for each person was a reflection of each participant's overall perception of the importance of creativity in their field. Separate ANOVAs were conducted if significant relationships were found. Scheff post hoc test was conducted to identify the specific reason of the significant difference.

There were significant main effects for only the independent variable "subject" ($F(4, 199) = 5.99$; $p<.001$). Because the main effects for subject were significant, these were further examined to determine which dependent variables specifically affected them

(Table 4.9). Upon doing this, there were found to be significant main effects of subject on the total scores of creative products ($F(1, 201) = 7.21$; $p<.01$) and creative personal traits ($F(1, 201) = 6.47$; $p<.01$).

One way analyses of variance were run as post hoc tests in order to identify specific conditions of the dependent variables identified above. As depicted in Table 4.95, with respect to creative products, there were significant differences in total product scores between technology education and both art and music with technology education holding the highest mean of 65.20 and art and music having means of 57.74 and 56.86 respectively. Inversely, technology education had a significantly lower mean of 154.48 than art (163.80) when comparing total personal trait scores.

These findings indicate that when comparing the determining independent variables of subject, grade, experience, education, and gender, the subject the participants teach is the only significant determinant of creativity perceptions. Specifically, technology education teachers have a significantly higher total product score than either art or music teachers. This subsequently would represent a significantly higher level of importance these teachers are placing on the qualities of creative products when compared to art and music teachers' perceptions of creative products.

Lastly, as indicated above, art teachers had a significantly higher total score when compared to the technology education teachers considering creative personal traits. This would imply that technology education teachers value creative personal traits significantly less than art teachers.

Table 4.9 Results of MANOVA

	Total Process		Total Product		Total Personal Traits		Total Environment	
Source	Mean Square	F	Mean Square	F	Mean Square	F	Mean Square	F
Intercept	70797.35	555.03	23986.24	195.39	212995.04	713.59	45751.76	627.87
Subject	407.73	3.20	885.47	7.21**	1931.21	6.47*	64.23	.88
Grade Level	581.76	4.56*	88.48	.72	1715.55	5.75*	112.31	1.54
Years Experience	32.96	.26	4.77	.04	703.66	2.36	7.58	.10
Level of Education	7.83	.06	114.76	.94	117.47	.39	93.28	1.29
Gender	251.39	1.97	16.14	.131	808.85	2.71	111.48	1.53

**p< 0.01, *p<.05

Table 4.95 Results of Post Hoc ANOVA

	Total Process			Total Product			Total Personal Traits		
Source	**Mean**	**p**	**N**	**Mean**	**p**	**N**	**Mean**	**p**	**N**
Subject									
Art	95.75		75	57.74		74	163.80		75
Music	91.71	.06	117	56.86	.86	119	159.66	.27	121
Music	91.71		117	56.86		119	159.66		121
Technology Ed.	92.00	.99	42	65.20	.00	41	154.48	.25	42
Technology Ed.	92.00		42	65.20		41	154.48		42
Art	95.75	.23	75	57.74	.00	74	163.80	.02	75

Summary of Findings

This study examined the perceptions of art, music, and technology education teachers with regard to the creative process, products, personality traits, and environment in relation to their respective fields of study and practice. This chapter included a description of the findings from the study. Summarized, these findings are as follows:

a. Technology education teachers were less interested in the importance of incubation during the creative process and the use of metaphor in creative work than the teachers of art and music. Also, art teachers placed higher importance than technology education teachers on the ability to essentially begin work without a definite final product in mind and being able to reformulate the initial challenge once work has begun.

b. There was a significant difference in how technology education teachers view creative products when compared with their peers in art and music. Specifically, items focusing on the themes of valuing a product’s ease of use, practical implications, value to the community, craftsmanship, ability to respond to a need, and general adherence to technical standards were main points of difference.

c. Technology Education teachers did not appear to value creative personality traits to the same degree as their peers in Art.

d. Technology Education teachers perceive group work, competition, and reward for creative work to be more important in the production of creative work than Art and Music teachers.

e. When considering the variables of subject, grade, experience, education, and gender, the *subject* the participants teach is the only significant determinant of creativity perceptions. Also, Technology Education teachers had a significantly higher total product score than either Art or Music teachers. This finding would suggest the significant level of importance these teachers are placing on the qualities of creative products when compared to Art and Music teachers' perceptions of creative products.

Chapter V

Discussion

The primary purpose of this study was to identify specific aspects of creativity shared by the subjects of art, music, and technology education and to determine if there are creativity aspects unique to technology education. A survey comprised of statements regarding the creative process, creative products, creative personality traits, and the creative environment relative to the fields of art, music and technology education was developed and sent to educators belonging to associations aligned with these subjects. A total of 226 participants responded to the survey which yielded data that was subsequently analyzed in an effort to answer the five research questions of this study. This chapter describes the findings from this study. In addition, conclusions, limitations of the study, and recommendations for future practice and research based on the study will be presented.

Research Question 1

Do the teachers for each subject area differ in their perception of the creative process?

As described in Chapter 4, analyses of items pertaining to the creative process revealed four items to be significant at the .01 level or less: item 13 “The creative process sometimes requires taking a break from the problem or challenge at hand to allow ideas to incubate”; item 15 “Metaphors and analogies are useful aids in creative thinking”; item 16 “The act of creating sometimes involves reformulation of the initial problem or challenge as one becomes engaged in the work”; item 17 “The creative process may begin even though the final product may not be formed in the “mind’s eye”.

Specifically, post hoc analysis revealed that technology educators rated the importance of these items pertaining to taking a break from the problem to allow ideas to incubate and using metaphors and analogies as useful aids significantly lower than both music and art teachers. This finding suggests that technology educators do not support general reflection or theoretical constructs for thought during the creative process to the same extent as art and music teachers. Literature pertaining to engineering students is reflective of this finding. Lewis (2004) commented that this type of creative, or divergent thinking, has not been what engineering students have been trained to do, let alone been noted for generally. On the other hand, metaphor and analogy are viewed as an important aspect of creativity work in art (Lakeoff and Johnson, 1980; Ricoeur, 1981) and music (Kramer, 2004; Spitzer, 2004) literature.

The possibility of technology educators valuing consistent progress over iterative reflection when compared to the other subjects was also demonstrated by the fact that art educators rated the importance of reformulating a problem after beginning work significantly higher than technology educators. Indeed, the fact that art educators believed that the creative process could begin even though an end product hadn't been determined was significantly more important to them when compared to technology educators lends additional support to this finding. These findings are consistent with the literature pertaining to creativity assessment and the creative process in both art and technology education. Soep (2005) believes artists are continually involved in assessment of their work by constantly revising, designing, applying standards for themselves and their work. She insists that an artist cannot progress without formulating these types of judgments during the creation of their work or upon its completion (p. 40).

Also, the importance placed on the incubation process by people in art also lends credence to this finding (see Parker, 2005).

Conversely, regarding technology education's value of diligence, this finding is supported in the literature pertaining to product invention. For example, Henderson (2004) found in her interview of product inventors that they spoke often about how much they enjoyed their innovation work but admitted that inventing work was indeed demanding and required persistent effort without immediate reward.

Research Question 2

Does each subject differ in their perception of the creative product?

Analysis of the responses to the items dealing with creative products revealed multiple items as being perceived differently in their level of importance to educators. Common themes dealing with a product's ability to be revolutionary and break with tradition, degree of novelty, practicality, ease of use, general value to the community, and technical quality were points of disagreement among the educators of the three subject areas.

The majority of the differences found dealt with the fact that technology educators rated items dealing with quality, practicality, ease of use, and value to the community significantly higher than both music and art educators. This demonstrated the significant difference in how technology education teachers view creative products when compared with their peers in art and music. This finding speaks not only to the motivation behind technology generally, but the unique parameters the subject of technology education has the ability to inherently create as a teaching and learning archetype when compared to art and music. Indeed, the centuries old Aristotelian ideas of phronesis, a knowledge that is practical (Hooley, 2004), and techné, technical rationality in creating craft or art (Parry, 2003) lend themselves well to defining the types of knowledge technology education is able to develop (see Chapter 1).

Additionally, the defining characteristics of *technology* itself may also provide some insight into the finding that technology educators valued product qualities such as practicality, technical quality, ease of use, and public value. Devore (1985) contends that, if a problem is defined as human or social within a certain environment, the activity is deemed technological. Specifically, engineering design relies on the principles of science to manufacture useful products to satisfy human needs (Court, 1998). Therefore, a technological product must, by definition, solve an existing problem or fulfill a specific need of a certain community of people. It is this community that can determine whether the technological product does indeed fulfill its purpose to solve the problem at hand, therefore determining the designer's success or failure. As a result, people involved in technology education tend to be most concerned with solving real world problems and providing concrete experiences. As Kimbell, Stables, Wheeler, Wosniak, and Kelly (1991) pointed out, "there [is] general agreement on certain basic tenets of [technology education]. It is an *active* study, involving the *purposeful* pursuit of a *task* to some form of *resolution* that results in *improvement* (for someone) in the made world" (p. 17). In essence, a product created in technology education needs to be useful in order to be considered creative. Evidence of creativity in technology being a social construct is played out in the economy as well with one out of 540 ideas result in a marketable product and eight out of 6000 new gadgets surviving their first year in the market place (Tornkvist, 1998).

This differs from literature dealing with creative products in art education, for example. Even though art teachers are concerned with functional design, issues such as *style* and *appealing to the human spirit* are coveted (Zande, 2007). Moreover, Bailin (2005) noted that works of art are generated from an artist's imagination and are a reflection of an artists "inner being" (p. 258). Also, as a paradox to the often specific parameters placed on technological problems, Bailin believes that "external constraints on the imagination of the artist are inhibiting and that she should be free to express her feelings and emotions" (p. 258). Not only does this illuminate the unique standards technology educators have for creative products in their field, it foreshadows another finding of this study; art and technology educators rate the importance of creative personal traits in their field differently.

Research Question 3

Does each subject differ in their perception of creative personal traits?

Analysis revealed that several of the items showed significant differences between the subject areas in how educators in art, music and technology education rated the importance of creative personal traits in their field. Specifically, the majority of the differences found were between art and technology educators. Items pertaining to a person's ability to tap into their emotions; fantasize; employ their different senses; be humorous and playful; and having the flexibility of mind to produce unique responses and assemble novel ideas in common settings were the main points of contention. This finding would indicate that people in technology education do not appear to value creative personality traits to the same degree as their peers in art. This finding is supported in the engineering education literature. As alluded to above, people in technology and engineering fields are expected to work to certain codes, specifications and legal constraints instead of being able to have unbridled freedom to create as seen in other fields. In essence, they must be very rational in their approach to their work. As a result, engineers are generally thought of as dull and non-creative (Blicblau and Steiner, 1998). This notion is being played out in universities as well where people whose personality types indicate high levels of creativity are leaving engineering programs at higher rates than other subject areas (Ogot and Okudan, 2006). The explanation of the difference between art and technology education found in this study may lie in how rational thought, valued by technology educators, and emotional thought, coveted by art educators, are explained in brain research. Specifically, Goleman (1995) in his book *Emotional Intelligence,* explained that basically people have a thinking mind and a feeling mind and each is significant in how people learn and develop. “From the most primitive root, the brainstem, emerged the emotional centers… The fact that the thinking brain grew from the emotional reveals much about the relationship of thought to feeling; there was an emotional brain before a rational one” (p. 10). Superficially, Goleman’s explanation may appear to pit art and technology educators against one another. Rather, this would indicate that both art and technology education have unique aspects to their curricula that allow students to explore both their emotional and rational thinking capabilities.

Research Question 4

Does each subject differ in their perception of the creative environment?

Participants from the three subjects were asked to indicate the level of importance of statements related to the creative environment in their particular field. Although art educators generally supported the idea of creativity being enhanced when people work in groups, technology educators ranked it significantly higher in importance. As noted above in the discussion of findings for the research questions pertaining to perceptions of creative products and personal traits, the process of art making appears to be an intensely personal endeavor (see Zande, 2007 and Bailin, 2005) and lends support to this finding as well. The fact that technology educators perceived group work as being more important to their field than art educators is reflective of the types of activities used to deliver the problem solving and design concepts that are common in contemporary curriculum. Super mileage vehicle competitions (Thompson and Fitzgerald, 2006), the West Point Bridge Design Contest, FIRST Robotics Competition, FIRST LEGO League, and the Science Olympiad (Wankat, 2007) are all team based activities designed to encourage students to work together to solve problems with specific technical parameters. In addition, these types of activities are competitive by design which speaks to the higher level of importance technology educators demonstrated toward the ideas competition's ability to have a positive effect on creative work.

Research Question 5

Are there predictors of the creativity perceptions among art, music, and technology teachers?

When analyzing the data to determine if the independent variables of subject, grade, experience, education, and gender were predictive of perceptions of creativity, the subject the participants taught was the only significant predictor. Specifically, technology education teachers had a significantly higher total score pertaining to items concerned with creative products than either art or music teachers. This finding lends additional support to the significant differences between technology education and both art and music discussed above and represents the high level of importance these teachers are placing on the qualities of creative products.

Also, reflective of the findings discussed above regarding the teacher's perceptions the importance of creative personal traits, art teachers had a significantly higher total score when compared to technology teachers. This again lends support to the finding that technology educators value creative personal traits significantly less than art teachers.

Conclusions

a. Technology educators value consistent progress toward a predetermined end product over iterative reflection and working without a defined end in mind.
b. Art educators believe that the iterative nature of the creative process is important and can begin without the need for a predetermined end product.
c. Technology educators believe that in order to be creative, a product in their field needs to be practical, easy to use, of value to the community, and possess a high degree of craftsmanship.
d. Art educators value the ability a person in their field has to tap into their emotions; fantasize; employ their different senses; be humorous and playful; produce unique responses and assemble novel ideas in common settings significantly more than their peers in technology education.
e. Technology educators perceive group work as being more important to an environment supporting creative work their field than art educators.

f. Technology educators perceive competition to be significantly more important in the environment where creative work takes place when compared to both art and music educators. Indeed, both art and music educators tended not to support competition or reward generally.

g. There were significant differences found between the subjects in all of the four categories of the survey pertaining to the creative process, creative products, creative personality traits and the creative environment.

h. The only predictor of perceptions of creativity among art, music and technology education was the subject an educator taught.

Limitations

Limitations to this study were identified and will be discussed below. These limitations are considered because of their ability to reduce the generalizability of the findings of this study to a larger population.

a. Only art, music and technology educators belonging to education associations in Minnesota were included in the study. This population, however, did include educators from rural, suburban and urban areas; males and females; varying education levels (bachelors to doctoral degrees); and a wide range of experience levels.

b. Both electronic and paper surveys were used in the effort to collect data from participants. Specifically, music educators in the study were only accessible via paper mailing while the art and technology educators were accessed via web survey. Although the format for the items remained the same for each type of survey, the different delivery and interface systems may have resulted in different response rates.

c. An incentive accompanied two series of reminder messages sent to encourage completion of the survey. This offer was not extended to the initial sample. This may have effected the reason for response and, subsequently, the quality of data collected from these surveys.

Implications

Evidence regarding the implementation engineering curriculum has been encouraging. For example, Yaşar, Baker, Robinson-Kurpius, Krause, and Roberts (2006) found teachers were supportive of the idea of infusing design and technology into the curriculum. However, Yasar's et al. research also revealed that these teachers had negative perceptions of engineers generally. As demonstrated in the engineering and engineering education literature, creative thinking is the foundation to successful design within a contemporary technology curriculum. Being that the perceptions of technology education teachers found in this study were significantly different with regard to items focused on a variety of creativity characteristics, this may foreshadow difficulty in the full acceptance of the engineering-focused technology education curriculum in the field of technology education. Said differently, these perceptions of, for example, a product's ease of use, practical implications, value to the community, craftsmanship, ability to respond to a need, and general adherence to technical standards may temper technology education teachers' thinking about the actual capability of their field of study.

The results of this study should be used to initiate a dialog regarding the capability of the field of technology education to embrace the types of creativity valued by the art and music fields. For example courses of study in areas such as industrial design, engineering design, graphic communication, and architecture that demand divergent thinking should be explored.

Recommendations

In consideration of the findings of this study, the following suggestions are proposed:

a. It has been established in the literature pertaining to technology and engineering education that creativity and divergent thinking are key elements to success in education and subsequent employment (e.g. Lewis, 2004). An important curricular ingredient to creativity, as demonstrated in art education, is emotion. In fact, Henderson (2004) comments that without seriously considering the effect of emotions, creativity can no longer be fully understood. As demonstrated in this study and in the literature (e.g. Blicblau and Steiner, 1998; Ogot and Okudan, 2006) technology teachers do not perceive emotion as being an important part of their curriculum. It is suggested that effective technology teachers should generate technical problems that are either inherently motivational (i.e. profit generating, high profile for the students' school and/or community) or controversial (nuclear energy, robots in manufacturing) to evoke a certain amount of emotional tension. Peterson and Harrison (2005) included these emotional and motivational influences as well as environmental characteristics in their assessment of the factors associated with highly creative technology education classrooms.

b. Although contests of design and other competitive events have been very effective in delivering engineering concepts to students, these activities are chiefly extracurricular in nature (see Wankat, 2007). The absence of support for competition from both art and music educators in this study could suggest to technology teachers that diversity related to the intrinsic and extrinsic motivations and emotions of students must be considered. Indeed, the engineering components of successful programs reviewed in this chapter (West Point Bridge Design Contest, FIRST Robotics Competition, FIRST LEGO League, and the Science Olympiad) should be considered in the general technology education curriculum and made available to the overall student body. The issue of clarifying important components of engineering education has also been raised in engineering education literature. Lewis (2007) points out that despite efforts to infuse (engineering) into schools, efforts to systemize engineering in a way that is translatable in schools have lacked focus. To do otherwise would imply that the type of creativity demanded in solving problems posed by the programs above is not important for students experiencing the mainstream technology education curriculum and must be pushed into the realm of co-curricular activities.
c. Technology educators should examine the benefits art educators have wrought from valuing the iterative and reflective nature of the creative process in their work. Although results of this study suggest technology teachers, as opposed to their peers in art, value consistent effort toward a decided end goal, invention literature supports a more reflective approach. Henderson (2004)

proclaimed that if students properly motivated and supported, they can experience the “positive pole of inventing”: in essence, the experience of tension, excitement, and pleasure associated with working on a difficult task. It has been argued that this tension is triggered when a person encounters a product, process, or event that is unexpected, puzzling, or annoying (Runco, 1994).

d. Educational administrators need to recognize the unique ability the subjects of art, music, and technology education have with regard to covering the multiple facets of creative thought and work.

e. A qualitative research design should be assembled to validate the finding of this study. Little qualitative research exists that explores creativity in technology or engineering education (Lewis, 2005). The phenomenon of witnessing the creative experience displayed by people in the fields of art, music, and technology education could also be researched, for example, via individual unstructured interviews. Max van Manen (1990) considers the aim of phenomenology to be to transform lived experience into a textual expression of its essence. Additionally, he felt a written account of a lived experience has the possibility of conveying a unique meaningful inquiry that may not otherwise be possible in other forms of research. Indeed, the multifaceted nature of creativity and perceptions may be better explored through qualitative methods.

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Appendix A

Perceptions of Creativity in Art, Music and Technology Education

Consent Form

You may decline to answer any questions, and you are free to withdraw from the survey at any time.

This research survey is part of a dissertation project and subsequent publications intended to gain insight into how you feel creativity is approached in your field. Your response will be compiled for data analysis with the goal of assessing how Art, Technology, and Music teachers view the creative process, creative products, creative environment, and personality traits of creative people relative to their subject. All responses of the 682 participants in this study will be kept confidential and no individual participant will be identified in the research process.

There are no foreseeable risks and no direct benefits for your participation in this survey. All of the responses will be kept confidential and each potential participant has been assigned a unique code only for the purposes of data analysis and eliminating your name from future contacts to complete the survey. The data from the survey will be kept by research staff at the University of Minnesota for only research related to the objectives of this project.

Again, we want to stress that your identity will be kept confidential and only results of collective data analysis may be used for publication. **Your participation is voluntary and no loss of benefits or rights will be endured if you choose not to participate.**

If you have any questions about this research project, please contact David Stricker at 612-624-6204 or via email stri0026@umn.edu or you may contact Dr. Theodore Lewis at 612-624-6204 or via email lewis007@umn.edu. If you have questions regarding your rights as a participant, please contact the University of Minnesota Institutional Review Board (IRB) office at 612-626-5654 or irb@umn.edu for assistance.

Directions: Under each of the four sections found below, you will find specific directions that guide you in how to complete the survey. Art, Technology, and Music teachers will be responding to this survey and particular items may be more familiar or relevant to each field.

Demographics

This section of the questionnaire deals with background information relating to you and your school (Mark only one response for each item).

1. **What subject do you currently teach?**
   - ◯ Art
   - ◯ Music
   - ◯ Technology Education

2. **What grade level do you currently teach?**
   - ◯ Middle/Junior High
   - ◯ High School
   - ◯ Other

3. **How many years have you been teaching your subject?**
   - ◯ 1-10
   - ◯ 11-20
   - ◯ 21-30
   - ◯ 31 or more

4. **What is your current level of education?**
   - ◯ Bachelors degree
   - ◯ Masters Degree
   - ◯ Doctorate

5. **Gender:**
   - ◯ Male
   - ◯ Female

Process

This section of the questionnaire asks you to evaluate the extent to which each of 16 statements relating to processes involved with creative work are consistent with the way teachers in your field think about creativity. Please fill in the number (*1 = not important, 7 = extremely important*) you feel best reflects how essential these statements are to the creative process in your subject area.

Statement	Not Important … Extremely Important
1. Having relevant knowledge of prior products or solutions is an important aspect of creative work.	① ② ③ ④ ⑤ ⑥ ⑦
2. To produce creative work a person must be familiar with standards for acceptable solutions.	① ② ③ ④ ⑤ ⑥ ⑦
3. The creative process requires the ability to generate a number of exploratory ideas or solutions.	① ② ③ ④ ⑤ ⑥ ⑦
4. Finding or identifying challenging problems is a critical dimension of the creative process.	① ② ③ ④ ⑤ ⑥ ⑦
5. Creativity includes the ability to find gaps, inconsistencies or flaws in existing solutions.	① ② ③ ④ ⑤ ⑥ ⑦
6. Generating a representation of the problem or challenge is part of the creative process.	① ② ③ ④ ⑤ ⑥ ⑦
7. Seeking out reactions to possible solutions is an important dimension of the creative process.	① ② ③ ④ ⑤ ⑥ ⑦
8. The creative process sometimes requires taking a break from the problem or challenge at hand to allow ideas to incubate.	① ② ③ ④ ⑤ ⑥ ⑦
9. Creative solutions sometimes come to mind as a "flash" or sudden awareness.	① ② ③ ④ ⑤ ⑥ ⑦
10. Metaphors and analogies are useful aids in creative thinking.	① ② ③ ④ ⑤ ⑥ ⑦
11. The act of creating sometimes involves reformulation of the initial problem or challenge as one becomes engaged in the work.	① ② ③ ④ ⑤ ⑥ ⑦
12. The creative process may begin even though the final product may not be formed in the "mind's eye".	① ② ③ ④ ⑤ ⑥ ⑦
13. The creative process often includes gathering and drawing upon all resources that can be helpful in completing a task.	① ② ③ ④ ⑤ ⑥ ⑦
14. The possession of relevant knowledge is an important aid to the creative process.	① ② ③ ④ ⑤ ⑥ ⑦
15. Creativity is improved if a person that is familiar with technical rules.	① ② ③ ④ ⑤ ⑥ ⑦
16. Creativity is improved if a person is familiar with relevant principles or theories.	① ② ③ ④ ⑤ ⑥ ⑦

Product

This section of the questionnaire asks that you to evaluate the extent to which each of 14 statements relating to the nature of creative products are important in your field. Please fill in the number (*1 = not important, 7 = extremely important*) you feel best reflects how essential statement is to the creative products in your subject area.

Statement	Not Important … Extremely Important
1. In my field, a creative product must posses a high degree of novelty.	① ② ③ ④ ⑤ ⑥ ⑦
2. A creative product is likely to influence or suggest additional future creative products.	① ② ③ ④ ⑤ ⑥ ⑦
3. A product is considered creative if it is unusual or seen infrequently in the category to which it belongs.	① ② ③ ④ ⑤ ⑥ ⑦
4. The degree to which a product responds to a need or problem determines its level of creativity.	① ② ③ ④ ⑤ ⑥ ⑦
5. A creative product follows the accepted and understood rules of the discipline.	① ② ③ ④ ⑤ ⑥ ⑦
6. A creative product has clear and practical implications	① ② ③ ④ ⑤ ⑥ ⑦
7. To be considered creative, a product in my field must be of value to the community at large.	① ② ③ ④ ⑤ ⑥ ⑦
8. A creative product breaks with the tradition from which it emerges.	① ② ③ ④ ⑤ ⑥ ⑦
9. Products are creative if they combine elements in unusual ways.	① ② ③ ④ ⑤ ⑥ ⑦
10. A product is creative if it commands the attention of a person using, listening to, or viewing it.	① ② ③ ④ ⑤ ⑥ ⑦

Product (continued)

	Not important … Extremely important
11. A creative product in my field is easy to understand, interpret, or use.	① ② ③ ④ ⑤ ⑥ ⑦
12. The craft component of completed works is critical in determining how creative they are.	① ② ③ ④ ⑤ ⑥ ⑦
13. To be deemed creative, a product in my field must be revolutionary in some way.	① ② ③ ④ ⑤ ⑥ ⑦
14. A creative product in my field must conform to acceptable technical requirements.	① ② ③ ④ ⑤ ⑥ ⑦

Personal Traits

This section of the questionnaire asks you to evaluate the extent to which each of 29 statements relate to personal traits creative people in your field posses. Please fill in the number (*1 = not important, 7 = extremely important*) you feel best reflects how essential these statements are to personal traits of creative people in your subject area.

	Not important … Extremely important
1. A creative person in my field can generate a large number of ideas that are relevant to the problem at hand.	① ② ③ ④ ⑤ ⑥ ⑦
2. Creative people in my subject area have an ability to produce uncommon or unique responses.	① ② ③ ④ ⑤ ⑥ ⑦
3. The ability to develop and elaborate upon ideas is a trait that creative people in my field possess.	① ② ③ ④ ⑤ ⑥ ⑦
4. A creative person considers a variety of types of information when thinking about a problem.	① ② ③ ④ ⑤ ⑥ ⑦
5. Being open minded is an important trait one must possess to be considered creative in my field.	① ② ③ ④ ⑤ ⑥ ⑦
6. When faced with a problem or challenge a creative person is able to distinguish clearly between relevant and irrelevant information.	① ② ③ ④ ⑤ ⑥ ⑦
7. The ability to resist the impulse to accept the first solution that comes to mind and to explore all possible ideas would be a trait of a creative person in my field.	① ② ③ ④ ⑤ ⑥ ⑦
8. Creative people in my subject area tap into their emotions in order to generate ideas or solutions to a problem or challenge.	① ② ③ ④ ⑤ ⑥ ⑦
9. A creative person has the ability to put together ideas into novel and pleasing combinations.	① ② ③ ④ ⑤ ⑥ ⑦
10. A creative person has the ability to fantasize and go beyond concrete reality.	① ② ③ ④ ⑤ ⑥ ⑦
11. A creative person seeks out ways to stimulate more than one of their senses to increase their flow of ideas.	① ② ③ ④ ⑤ ⑥ ⑦
12. A creative individual may look at everyday objects and see something novel and exciting.	① ② ③ ④ ⑤ ⑥ ⑦
13. A creative person in my field is interested in looking beyond exteriors; exploring the inner workings of an object, problem or idea.	① ② ③ ④ ⑤ ⑥ ⑦
14. The degree to which a person is able to look past the task at hand and visualize the systems it functions in is a characteristic of a creative person.	① ② ③ ④ ⑤ ⑥ ⑦
15. Creative people in my field have the ability to see peculiarity and have the ability to combine ideas or images in unusual ways that evoke surprise.	① ② ③ ④ ⑤ ⑥ ⑦
16. In my field the ability to be humorous or playful is an indicator of a creative person.	① ② ③ ④ ⑤ ⑥ ⑦
17. A key component of a creative person in my field is a concern for the future, and a desire to be a part of its shaping.	① ② ③ ④ ⑤ ⑥ ⑦
18. Creative people in my field usually show unusual interest in their particular pursuit.	① ② ③ ④ ⑤ ⑥ ⑦
19. Creative people in my field have great tolerance for vagueness.	① ② ③ ④ ⑤ ⑥ ⑦
20. Creative people in my field possess great knowledge of the principles and theories relating to their area of interest.	① ② ③ ④ ⑤ ⑥ ⑦
21. Creative people in my field are known for the persistence that they bring to their work.	① ② ③ ④ ⑤ ⑥ ⑦
22. Creative people in my field have the ability to improvise.	① ② ③ ④ ⑤ ⑥ ⑦

Personal Traits (continued)

No.	Statement	Not important … Extremely important
23.	Creativity in my field is really a gift that cannot be taught.	1 2 3 4 5 6 7
24.	Creative people are seldom satisfied with their work and would rather not bring quick closure to a task.	1 2 3 4 5 6 7
25.	Creative people display flexibility of mind; they are capable of changing their mental set easily.	1 2 3 4 5 6 7
26.	Creative people can manipulate many related ideas at the same time.	1 2 3 4 5 6 7
27.	Creative people possess high intrinsic motivation for their work.	1 2 3 4 5 6 7
28.	Creative people tend to have novel ideas relating to their subject.	1 2 3 4 5 6 7
29.	Creative people have high sensitivity to problems: they can see challenges in situations where others are oblivious to them.	1 2 3 4 5 6 7

Environment

This section of the questionnaire asks you to evaluate the extent to which each of 15 statements relate to the role environment plays in promoting creativity in your field. Please circle the number (*1 = not important, 7 = extremely important*) you feel best reflects the degree in which environment contributes to creativity in your subject area.

No.	Statement	Not important … Extremely important
1.	Creativity is enhanced when people work in groups.	1 2 3 4 5 6 7
2.	Creativity is enhanced in environments that allow risk taking.	1 2 3 4 5 6 7
3.	Creative people in my field tend to be more productive when they work by themselves.	1 2 3 4 5 6 7
4.	In my field work environments that are open and offer flexibility are aids to creative work.	1 2 3 4 5 6 7
5.	Classrooms that offer structure can be beneficial to the development of creativity.	
6.	An atmosphere of competition tends to have a positive effect on creative work.	1 2 3 4 5 6 7
7.	Creativity is aided in environments that offer rewards for such work.	1 2 3 4 5 6 7
8.	Creativity is aided in environments that offer feedback about a person's work.	1 2 3 4 5 6 7
9.	Being able to work within constraints is a measure of creativity.	1 2 3 4 5 6 7
10.	Creativity is fostered when people are encouraged to pursue activities that are of interest to them.	1 2 3 4 5 6 7
11.	Creativity is more likely to be achieved when one's activities are aimed towards a goal.	1 2 3 4 5 6 7
12.	Creative environments are usually messy or chaotic.	1 2 3 4 5 6 7
13.	In the classroom creativity is aided if the teacher provides guidelines for how the work should proceed.	1 2 3 4 5 6 7
14.	In the classroom students are more likely to be creative when the teacher allows them freedom to work in their own way.	1 2 3 4 5 6 7
15.	Students are more likely to produce creative work if they receive sound instruction in the knowledge and principles relating to their work.	1 2 3 4 5 6 7

Appendix B

Correspondence with Participants

Initial Correspondence with Art and Technology Education Participants:

Beginning of Online Survey

Dear Teachers,

This research survey is part of a dissertation project intended to gain insight into how you feel creativity is approached in your field. I am very interested in how Art, Technology, and Music teachers view the creative process, creative products, creative environment, and personality traits of creative people relative to their subject.

The survey will take only ten minutes of your time and will greatly impact this dissertation project.

All of the responses will be kept confidential and each potential participant has been assigned a unique code only for the purposes of data analysis and eliminating your name from future contacts to complete the survey. The data from the survey will be kept by research staff at the University of Minnesota for only research related to the objectives of this project.

Please click on the link below to access the survey:
https://oms.umn.edu/survey/Surveys/TakeSurvey.aspx?s=C8CD43E285EB4142AAB5A3B05560248B

Your input is very valuable to me and I truly appreciate your time.

Sincerely,
David Stricker
612-624-6204
stri0026@umn.edu

Correspondence with Art and Technology Education Participants:

First and Second Online Reminder October 2007

This is a brief reminder to please take a few minutes and complete the following survey. Many of your fellow teachers from the Minnesota Technology Education Association and the Art Educators of Minnesota have been kind enough to contribute to the study thus far. Since I am a teacher as well, I realize that time is at a premium. Therefore, I am offering a chance to win 1 of 15 $10 Amazon.com gift certificates. These are as good as cash since you can buy anything from outdoor equipment to music and, of course, books. Your information is extremely critical to my study and I am willing to send you a personalized summary of the results when it is complete.

Thank you very much,

David Stricker

Correspondence with Music Education Participants:

First and Second Paper Reminder October 2007

This is a brief reminder to please take a few minutes and complete the following survey. Many of your fellow teachers from the Minnesota Music Educators Association have been kind enough to contribute to the study thus far. Since I am a teacher as well, I realize that time is at a premium. Therefore, I am offering a chance to win 1 of 15 $10 Amazon.com gift certificates. These are as good as cash since you can buy anything from outdoor equipment to music and, of course, books. Your information is extremely critical to my study and I am willing to send you a personalized summary of the results when it is complete.

Thank you very much,

David Stricker

Appendix C

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The IRB: Human Subjects Committee determined that the referenced study
is
exempt from review under federal guidelines 45 CFR Part 46.101(b)
category #2
SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF
PUBLIC
BEHAVIOR.

Study Number: 0708E15502

Principal Investigator: David Stricker

Title(s):
Creativity Assessment of Student Work:
Identifying Unique and Transparent Creativity Traits
in Art, Music, and Technology Education

_______________________________________________________

This e-mail confirmation is your official University of Minnesota RSPP
notification of exemption from full committee review. You will not
receive a
hard copy or letter.
This secure electronic notification between password protected
authentications
has been deemed by the University of Minnesota to constitute a legal
signature.

The study number above is assigned to your research.  That number and
the title
of your study must be used in all communication with the IRB office.

Research that involves observation can be approved under this category
without
obtaining consent.

SURVEY OR INTERVIEW RESEARCH APPROVED AS EXEMPT UNDER THIS CATEGORY IS
LIMITED
TO ADULT SUBJECTS.

This exemption is valid for three years from the date of this
correspondence.
You will receive a notification requesting an update after three years,
at
which time you will have the opportunity to renew your study.

Upon receipt of this email, you may begin your research.  If you have
questions, please call the IRB office at (612) 626-5654.

You may go to the View Completed section of eResearch Central at
http://eresearch.umn.edu/ to view further details on your study.

The IRB wishes you success with this research
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