WOMEN WHO INVENT: EXAMINING THE IMPACT

OF FORMAL AND INFORMAL EDUCATION

ON THEIR CREATIVITY

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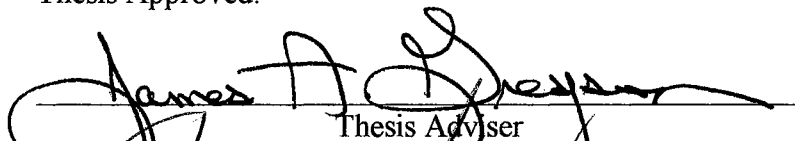Oklahoma State University
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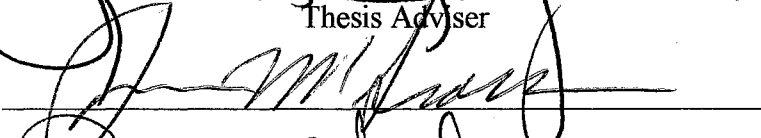University of Georgia
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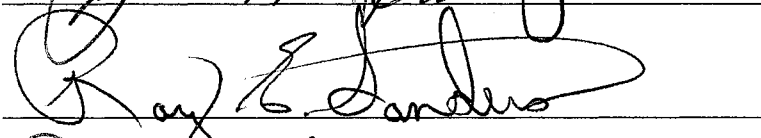DOCTOR OF EDUCATION
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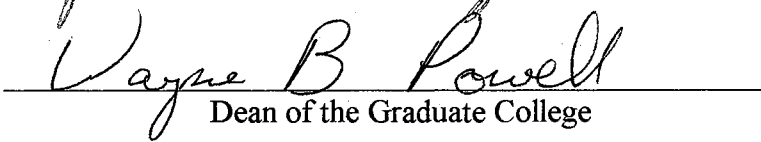
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"You are free to rise as far as your dreams will take you. Your task is to build the future of this country and of our world. You are our new global citizen."

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---Geraldine Ferraro

(Lerner-Robbins, 1996, p.74)

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CHAPTER ONE

INTRODUCTION

Voltaire (1764) stated "There have been learned women, and there have been women warriors, but there have never been women inventors" (as cited by Stanley, 1993, p. 305).

There is some evidence which suggests that America does not fully utilize its female ingenuity (Bernstein & Cock, 1994). In 1977 only 1/2 of one percent of all utility patents were attributable to women. In 1988, women's patents had increased to over 5.5 percent, and in 1995, woman-inventor patents constituted 8.2 percent of all U. S. originated patent grants (U. S. Patent & Trademark Office, 1995).

Even though women are making positive strides toward equality, traditional educational practices have kept women from excelling in many areas (Morrison, 1992; Ochse, 1991; Piirto, 1991). Because of the curriculum used in education, the knowledge base, the examples seen in books and materials which are created by and are primarily about the white middle-class male experience, white middle-class males are more likely to

be successful. This is true both in the education system and in the society that values the system (Tisdell, 1993).

According to futurists McCorduck and Ramsey (1996), the traditional white-male dominant culture is beginning to crumble, and a variety of scenarios could occur. The least disruptive settlement would be that education take a pro-active stance and educate girls and women in the manner in which they learn best, rather than in the traditional manner (McCorduck & Ramsey, 1996). Landrum (1994) has stated that a more appropriate approach to teaching and learning for women is one based on personal relationships, holistic, intuitive, and group oriented learning.

Background of the Problem

For centuries men have considered women incapable of achieving creative success. Although women may have historically achieved personal satisfaction from creative product oriented achievements such as baking, home furnishing, fashion, and the like, these types of creative works produced by women tend to be underrated or ignored in history (Showell & Amram, 1995).

Women have historically been encouraged to marry and raise families, and were typically not motivated to pursue creative achievement. Some studies have even shown that women have avoided success in favor of retaining their intimate connections with others (Horner, 1974).

Socrates and his pupil Plato continue to receive constant homage; however we

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rarely if ever hear of Socrates' teacher Aspasia, a woman (Rosser, 1986). Surely women's

contributions have existed; they simply have not been documented. Charles Darwin

admitted that his sister was smarter than he was (Stanley, 1993), so why was she not

mentioned in the history books? Thomas Edison's mother taught him through home

schooling, thus allowing his creative genius to blossom. He attributed much of his success

to his mother's natural tolerance for and understanding of the creative process

(Cunningham & Torrance, 1965).

History is full of snippets of women's achievement; however, women inventors

have historically not been recognized. For example, the Cotton Gin was invented, not by

Eli Whitney as reported in history, but by a woman Catherine Greene (Stanley, 1993).

Stanley reported that Whitney was hired by Green because he was known to be a practical

mechanic. This was during the winter of circa 1722. The work was done in Greene's house

under her supervision; however, at that time in history, women were not allowed to own

property and were little more than servants (Stanley, 1993). Greene was either not

allowed or was too intimidated to apply for the patent. It is quite probable that history is

full of these instances of women doing the inventing and men taking the credit.

Ochse (1991) has suggested the most important determining factor in a person's

creative achievement is the opportunity to work alone. "Aloneness" was a term used to

describe Einstein. It was said that Edison had to work in complete solitude, and

Tchaikovsky could not tolerate even minor interruptions when composing (Ochse, 1991).

According to Ochse (1991) women are constantly held up by people who demand their

attention and interrupt their work because "they have no wives to insulate them from

outside intrusions" (Ochse, 1991, p. 340).

Although Ochse (1991) concluded that a strong need for social intimacy and a strong desire to create are not mutually enhancing, this may be true only for men. Many studies concerning the psychology of women (Antler & Biklen, 1990; Gilligan, 1982; Helson, 1978; Landrum, 1994) might disagree with this conclusion. There is a possibility that women may not need the luxury of complete uninterrupted solitude to be creative. In fact, a body of research is emerging which reports that women typically work better in an atmosphere of companionship, collaboration and intimacy (Kaplan, 1995; McDaniel, Cummins, & Beauchamp, 1992; Rosser, 1990, 1995). This would be a case for informal education.

While there is evidence to suggest that educators in formal educational settings try to practice gender equity, many educators have not realized the white-male dominance of their styles of teaching (Hart, 1992). Educators in general and adult educators in particular need to systematically study and pay attention to the values of women in their classrooms. Hart (1990) advocated for educators to deliberately re-establish the connection between human work and the improvement of life, thereby affirming the life experiences that women find important, such as joy, passion and creativity. These aspects of learning contribute to education becoming an empowering process (Hart, 1990).

Teaching creative thinking strategies and techniques is much more effective when it occurs in cooperative environments (Torrance, 1981; 1995), and cooperative environments tend to typify women's learning preferences (Belenky, et al., 1986; Gilligan, 1982). They also tend to typify informal learning settings. Females value collaboration and

cooperation, in contrast to more competitive, individualistic styles of the male dominated society (Landrum, 1994). According to Philbin, Meier, Huffman & Boverie (1995), the learning style of most women is different from the traditional style still used in most formal educational settings. There is a large body of research on women's preferred learning styles which indicates that most women have cooperative and collaborative learning styles which value experience and connecting with others (Belenky, Clinchy, Goldberger & Tarule, 1986; Gilligan, 1982, 1993, 1994).

Statement of the Problem

There is considerable empirical evidence which suggests that formal, as well as informal education, may have not promoted creativity through the teaching/learning process. Further, there appears in the literature the realization that there is a lack of a deep understanding of how formal and informal education has impacted the creativity of women. This is problematic not only for reasons of gender equity but also because there is evidence that formal and informal education need to develop creativity among women in order for them to be successful in the emerging postindustrial workplace and society.

Purpose of the Study

This study has two primary purposes. The first purpose of this study is to ascertain, through a quantitative approach, the extent to which the *BD-TTCT* establishes that women inventors are in fact creative, as defined by Torrance. It can be argued that women inventors are creative by the very nature of their having attained a patent. However, attaining *BD-TTCT* scores from women inventors will assist in providing insight into how their creativity compares to other populations where norm scores have been established. Thus, the use of the *BD-TTCT* will be helpful in recognizing the creativity of women inventors, though it needs to be acknowledged that other characteristics such as perseverance may have contributed to them becoming patent holders.

The second purpose of this study is to develop a deeper understanding of how formal and informal education has impacted (ie. helped or hindered) the creativity of women inventors. Specifically, the qualitative aspect of this study will report the thoughts, feelings and behaviors of women inventors regarding the context of their formal and informal education.

Research Questions

Question #1: To what extent do women inventors demonstrate creativity as measured by

the *Brief Demonstrator - Torrance Tests of Creative Thinking?*

Question #2: How has formal and informal education been perceived by women inventors

to have impacted their creativity?

Researcher Subjectivity

In qualitative research, the expertise of the researcher is of great importance

(Stewart & Cash, 1985). Further, there is an acknowledgement by qualitative researchers

associated with the critical school of thought that researchers' beliefs, values, and lived

experiences play a significant role in the conceptualization, implementation, and analysis of

the researcher (Gregson, 1996; Lakes & Bettis, 1995). Thus, while independent reviewers

were used in this study to code data, the researcher's lens still impacted the study. This

section is provided to readers so that they can gain further insights into the formation of

the researcher's "lens".

As a young adult, my interest in inventing was sparked. Becoming thoroughly

involved in creating a new idea put me into the "flow" state described by Csikszentmihalyi

(1975), in *Beyond Boredom and Anxiety.* In the flow state, the heartrate decreases, time

seems to stand still; the experience is one of optimal psychological satisfaction. Getting

into the flow state is akin to getting into an altered state of consciousness where one experiences relaxation yet total focus (Csikszentmihalyi, 1990). Today's athletes call it "getting into the zone".

Since I began inventing I have received patents on several different products. I've sold a few for royalties and I am making a living doing what I love: doing research, developing ideas, solving problems creatively.

I can relate to the experiences that women in this study have described; especially the desire to collaborate and connect with others on creative projects. I prefer to work in collaborative settings. Sharing my ideas with other people and getting their feedback is important to me and a satisfying element of the creative process. In Torrance's (1965) definition of creativity, his last sentence reads "and finally communicating the results". Torrance (1988) stated that sharing the results with someone about what you have discovered or created is a strong human need.

My educational achievements include a bachelor's degree in elementary education, a master's degree in community counseling and an educational specialist's degree in adult education. During my career I have taught various levels of public school, worked with gifted and talented programs in the schools, including Invent America, and have also served as a school counselor. These experiences contributed to my knowledge of interviewing and relating with inventors.

Assumptions

It was assumed that the participants of this study experienced an event in both formal and informal education which impacted their creativity.

Limitations

The study included only women who had received an individual utility patent in the year 1995 (U.S. Patent and Trademark Office, 1996). As a result, this study will limit the generalizability of the results to women who have attained a utility patent.

Definitions of Terms

The following definitions of terms used in this study correspond with the use of these terms in other major studies:

Behavioral Event Interview (BEI) - McClelland (1978) developed the *Behavioral Event Interview* because it used detailed descriptions of critical incidents the participant had experienced. Through this interviewing technique not only are the respondents' behaviors identified but also their thoughts and attitudes.

Brief Demonstrator - Torrance Tests of Creative Thinking (BD-TTCT). The *BD-TTCT* , an even shorter version of the demonstrator, was first used by Torrance, Clements & Goff (1989) as a method of identifying creativity in population of adults, ages 55 and up. "The *BD-TTCT* works well with adults because of its brevity, and was designed by Torrance to identify the concepts of creativity that can be used in creating educational activities" (Goff, 1993 p. 244).

Connected teaching - A commonly used term for a style of teaching which has been shown to be very effective with women; connected teaching encourages interactions and relationships with one another and with the environment or society. Connected teachers focus on experiential events of the individual to make learning personally relevant versus the less time-consuming teaching techniques of white male-oriented teaching styles which tend to be based on verbal competition in groups, making use of presentations which are not personally relevant, and for the experience of practice to be the goal (Gilligan, 1982). Connected teaching is strongly oriented to the humanistic philosophy of education. Everyone's views are received and treated with respect. The role of the teacher is to draw out the best in people which leads to a positive self-image of the learner (Belenky, et al, 1986; Brush, 1991; Gilligan, 1982; Seymour & Hewitt, 1994).

Connected learning - Connected learning may also be called "relational learning" or "women's learning". In these learning situations, a personal relationship exists between the learner and a caring teacher

Creative indicators - The criterion-referenced creative indicators are described as creative strengths and consist of twelve figural indicators and eight verbal indicators of creative strengths. See Chapter 2 for a listing of the creative strengths. For lengthier descriptions see *The Search for Satori and Creativity* (Torrance, 1979a).

Creative process - The creative process is the process of using specific techniques which lead to creative thinking. By making a process out of it, creativity can be broken down into a series of steps which can then be taught (Wallas, 1926). The creative process is assessed in this study.

Creative thinking - Creative thinking is actually the process of coming up with ideas which are creative or unusual. Creative thinking occurs when the thinker diverges from ordinary thinking responses, and often through brainstorming, achieves new and different ideas to solve old problems (Parnes, 1962).

Creativity - Creativity is the process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypothesis about the deficiencies: testing and retesting these hypothesis and possibly modifying and retesting them; and finally communicating the results (Torrance, 1988, p. 47).

Demonstrator - Torrance Tests of Creative Thinking (D-TTCT) - In 1980, this version of the *TTCT* was introduced (Torrance, Wu & Ando, 1980). It was originally designed to be a screening tool where it was not feasible to administer the entire verbal and figural batteries of the *TTCT* (Torrance, et al., 1980).

Divergent Production - Divergent production, also known as creative production, is the process of producing divergent or creative products as a result of creative ideas.

Elaboration - Elaboration is one of four creative strengths measured by the *TTCT* and the *BD-TTCT*. Elaboration is the ability to embellish ideas with details (Torrance, 1979a). It involves planning what must be done, who will do each task, when, how, the cost, and other details needed to bring the idea to life (Torrance, 1979a).

External reliability - External reliability addresses the issue of whether independent researchers would discover the same phenomena or generate the same constructs in the same or similar settings.

External validity - External validity addresses the degree to which representations may be compared legitimately across groups.

Female inventor - For this study, female inventor shall mean a women who invents and has received a utility patent from the U.S. Patent office, in the calendar year 1995.

Flexibility - Flexibility is one of four creative strengths measured by the *TTCT* and the *BD-TTCT*. Flexibility is the ability to look at situations or problems from different perspectives (Torrance, Wu & Ando, 1980). Flexible thinking provides for shifts in thoughts, detours in thinking to include differing points of view, alternatives, approaches and perspectives of a situation (Eberle, 1971).

Fluency - Fluency is one of four creative strengths measured by the *TTCT* and the *BD-TTCT*. Torrance (1979) identifies fluency as the generation of multiple ideas, alternatives or solutions. Brainstorming, first introduced by Alex Osborn (1963), is often used to stimulate the generation of many ideas and options. Brainstorming is an excellent technique for strengthening fluency, the imagination and communication skills (Torrance, 1979).

Formal education - In a report to the U.S. Department of Commerce Advisory Board on innovative learning environments, Anne Branscomb (1990) defined formal education as any organized educational activity which is for credit or certification including: public and private schools, Vo-Tech, professional/higher education, corporate training, university-industry collaborative training and military training.

Informal education - The Branscomb (1990) report to the DOC defined informal education as non-formal education which does not fall into the formal education category including: personal contact and parenting, film and drama, books and magazines, learning

by doing, television, entering competitions such as innovation contests sponsored by community and community educational programs. Informal education may take place on a university campus, such as renting a room in the student union to hold the training or learning seminar or class, without being considered formal education (Darkenwald & Merriam, 1982).

Internal reliability - Internal reliability refers to the degree to which other researchers, given a set of previously generated constructs, would match them with data in the same way as did the original researcher.

Internal validity - Internal validity refers to the extent to which scientific observations and measurements are authentic representations of some reality.

Invention - An invention, according to the U. S. Patent Law is something that is "novel, non-obvious, and useful" (U.S. Patent & Trademark Office, 1993).

Non-formal education - (same as informal education; for this study: the impact such programs have on the creativity of women inventors)

Originality - Originality is one of four creative strengths measured by the *TTCT* and the *BD-TTCT*. Originality is the ability to 'make do' with what you have (Goff, 1992). Original ideas are often described as unique, wild, or unconventional. According to Torrance

(1995), original ideas are statistically infrequent because of the discomfort involved in being in a minority of one.

Torrance Tests of Creative Thinking (TTCT) - The *TTCT* was originally published in 1966 after nine years of work by Torrance and his colleagues. Scores were based on factors of fluency, flexibility, originality, and elaboration, originally observed by Guilford (1956). The *TTCT* evolved over time. It was revised in 1974, and in 1984 a streamlined scoring was made available (Torrance & Ball, 1984). Until 1988, the *TTCT* continued to be used solely to identify creative thinking skills in children and adults.

Utility patent - A utility patent is issued by the U.S. Patent and Trademark Office, for the invention of a new and useful process, machine, manufacture, or composition of matter, or a new and useful improvement thereof (Patent & Trademark Office, 1993). A utility patent differs from a design patent. A design patent is a patent only on the way something looks, or it's design. A design patent is very much less complex than a utility patent. The women inventors in this study all had the more complex utility patents.

Overview of the Dissertation

This chapter provides the reader with a background of the problem and purpose of the study. According to Piirto (1991), very few women (compared with their male counterparts) have received recognition for creative contributions to society. Male judges

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of creative contributions tend to favor work similar to their own; therefore women's contributions generally do not receive the same recognition (Helson, 1978). In our culture, rarely do women become scientific discoverers, inventors or composers (Torrance, 1995). In 1993, women made up only 1% of the overall science and engineering workforce (Holloway, 1993).

The purpose of the study was discussed as being twofold. The first purpose was to ascertain through a quantitative approach, the extent to which the *BD-TTCT* establishes that women inventors are in fact creative as compared to norms. The second purpose was to develop a deeper understanding of how formal and informal education has impacted the creativity of women who have received patents. Specifically the qualitative aspect of this study reported their thoughts, feelings and behaviors, in the context of their formal and informal education experiences.

Chapter two provides the reader with a review of the literature. The ways in which women learn best are discussed at length. Creativity is also discussed at length. It would seem that in today's global economy, America would choose to utilize it's creative individuals regardless of gender (Macdonald, 1992). This great natural resource of women's creativity can be tapped by changing traditional formal education. Women become empowered in environments which are connected and collaborative, in which they naturally excel (Reinharz, 1992).

Landrum (1994) outlined some specific differences between male and female approaches to learning. The female approach incorporates negotiation, compassion and understanding. The female focus is on personal relationships, holistic, intuitive, and group

oriented learning. The male approach to learning tends to incorporate aggression, competition and ego-gratification. The male focus is on impersonal relationships, and specific, rational, and self oriented learning.

In chapter three the first research question asked the extent to which women inventors demonstrate creativity as measured by the *Brief Demonstrator - Torrance Test of Creative Thinking*. Using *Behavioral Event Interviewing*, the second research question asked how formal and informal education was perceived by the women inventors to have impacted their creativity. The study proposed a two part methodology. A quantitative approach was used to address research question one, and a qualitative approach was used to address research question two.

Chapter four discusses the findings of the study. The women inventors tended to agree with the literature on all counts. They preferred connected, relational learning situations which were facilitated by caring teachers. The women in this study felt that learning situations which were less structured tended to increase both their self-esteem and their creativity while traditional male-oriented learning situations were seen as being detrimental to both their self-esteem and their creativity.

Chapter five provides the reader with implications and recommendations for education. To date, it seems there has been little interest in the creativity of women. Only a handful of studies have been conducted regarding women's inventing and patenting status, and no study has endeavored to discover the extent to which women inventors are creative or the role that formal and informal education has been perceived to have played in their creativity. This study proposes to do both.

"I have met brave women who are exploring the outer edge of possibility, with

no history to guide them, and a courage to make themselves vulnerable,

that I find moving beyond words to express it. "

---Gloria Steinem

(Lerner-Robbins, 1996, p. 151)

CHAPTER TWO

REVIEW OF RELATED LITERATURE AND RESEARCH

Chapter Overview

This chapter is divided into four sections. Section one focuses on the creative

thinking process. A brief history of the creative thinking process as well as an in-depth

examination of techniques for increasing creative thinking in children and adults are

described in section one of the literature review.

Section two of the literature review is an overview of the history of women

inventors. This section addresses the topic of the invisibility of women in history, the

social structure of a society which has virtually ignored the creative input of it's women,

and briefly discusses several outstanding women in history who have patents and

inventions.

Section three of the literature review focuses on the topics of formal and informal

learning in women and gender equity in education in general. It takes an indepth look at

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the learning preferences of women and seeks to answer the question of which learning environment has the greatest impact (ie. helped or hindered) on the creativity of women inventors.

Section four is a review of literature on the history of the instruments used in this study. The *Brief Demonstrator - Torrance Tests of Creative Thinking, (BD-TTCT)*, a quantitative measure, was used to identify the creative strengths of the women inventors. The *Behavioral Event Interview (BEI)*, a qualitative measure, was then used with this same group, to obtain information from the women inventors regarding formal or informal educational experiences which impacted their creativity.

Section 1 - The Creative Process

History of the Creative Process

In 1906, the idea of children being able to think and reason was first suggested at length by Miller in *The Psychology of Thinking*. Next came the investigation of creativity both in adults and in children. Creativity was not examined as a process, but was only studied in the arts, for the first quarter of the twentieth century (Torrance, 1962). Then in 1926, Wallas reported the first study of the creative *process* of an individual. Wallas contended the creative process consisted of four steps which could be taught. The steps were: preparation, incubation, illumination, and revision.

Wallas's (1926) study of creativity as a process flowed as follows. First, there is a need or deficiency. This period requires pinning down the problem and exploring many possible solutions. The first step is therefore called preparation. Next these possible solutions are critically analyzed and incubated upon or thought about, for advantages and disadvantages. Third the flash of insight, or illumination, occurs about the most promising solution. Fourth, the promising solution or idea is revised and perfected.

Many have elaborated on and refined Wallas's conceptualizations (Torrance, 1988). In 1948, Alex Osborn defined the principles and procedures for the creative problem solving process as having three steps: (1) Fact-finding, (2) Idea-finding, and (3) Solution finding. Sid Parnes (1962), a student of Osborn, worked with Osborn to revise the creative thinking process to be (1) Fact-finding, (2) Problem-finding, (3) Idea-finding,

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(4) Solution-finding, and (5) Acceptance-finding.

That same year, E. Paul Torrance (1962) published his first book on creativity called *Guiding Creative Talent*. Some traits Torrance (1962) found in creative children were: (1) creative children may alienate friends, (e.g. creative people usually are not afraid of what others may think), (2) creative children may not be well-rounded, (3) creative children prefer to learn on their own, (4) creative children like to attempt difficult tasks, (5) creative children may undertake dangerous tasks, (6) creative children are searching for a purpose, and (7) some creative children can't stop working, because they can't stop thinking.

In 1965, Torrance published his definition of creativity for research purposes. He described creativity as a process of sensing difficulties, problems, gaps in information, missing elements, something askew; making guesses and formulating hypothesis about these deficiencies; evaluating and testing these guesses and hypothesis; possibly revising and retesting them; and finally communicating the results. Such a definition places creativity in the realm of everyday living and does not reserve it for ethereal and rarely achieved heights of creation (Torrance, 1988).

Knowledge can be learned and retained with such force that a person might be unable to break away from that knowledge and stretch out into the unknown to produce future knowledge that has not yet been produced (Taylor, 1988). Therefore it is important to use a creative and provocative approach when working with students. By using provocative methods, teachers treat students as thinkers in class and activate their active learning processes, ideas, and eventually products with creative features (Taylor, 1988).

However, using provocative methods in teaching may be difficult.

Torrance (1995) declared that creativity is a disturbing force in education because it upsets the old order in building the new. Creativity is often condemned in organizations where the powers-that-be have decided to maintain the system. This is particularly true in education. New educational philosophies need to include the enhancement of talents and provide a climate of opportunity for individuals to experience creativity in schools.

Generally creative individuals do not work for status or power; the freedom to create and be creative is their greatest reward (Torrance, 1995). Creative individuals may try new ideas without official permission or they may seem to be inactive, when actually hatching new ideas or incubating.

Redmond, Mumford, and Teach (1993) argued that facilitators can do much to increase creativity in learners, simply by acknowledging the creative potential of a person. Recognizing this potential, inspires learners to continue to develop their creativity. Research has shown that creative teaching efforts have indeed resulted in creative growth as measured by changes in performance tests on creative thinking abilities (Torrance, 1981).

Creative Thinking Abilities Measured by the *TTCT*

One method of defining the creative thinking process is to use the four creative thinking skills measured in the *TTCT*. These are: (1) fluency, (2) flexibility, (3) originality, and (4) elaboration. These four creative thinking abilities are described below.

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Fluency - Torrance (1979) identified fluency as the generation of multiple ideas, alternatives or solutions. There is considerable evidence that the more ideas we have, the more likely we are to find a useful solution or answer. Because people have different styles of learning and thinking, fluency is vitally important in teaching to meet the needs of all students.

There is considerable evidence to support the idea that deliberate training and practice does produce growth in fluency (Goff, 1991; 1992). One of the tools used in an experimental study of creative thinking in adults was a brainstorming game which adults played weekly as part of their treatment (Goff & McCracken, 1989). Results of this longitudinal study showed that fluency was significantly increased in this population, by using creative programming (Goff, 1991). Brainstorming, first introduced by Alex Osborn (1963), is often used to stimulate the generation of many ideas and options. Brainstorming is an excellent technique for strengthening fluency, the imagination and communication skills (Torrance, 1979a; Goff, 1991; Goff, 1992).

Flexibility - Flexibility is the ability to look at situations or problems from different perspectives (Torrance, Wu, & Ando, 1980). Flexible thinking provides for shifts in thoughts, detours in thinking to include differing points of view, alternatives, approaches and perspectives of a situation (Eberle, 1971). Eberle (1971) developed the SCAMPER technique to assist people in improving their flexibility. SCAMPER is an acronym for the following: Substitute, Combine, Adapt, Modify, Put to other uses, Eliminate, Rearrange. This checklist is used to encourage flexibility in order to think of ideas or concepts which might not have otherwise been produced or considered.

Originality - Originality is the ability to make do with what you have (Goff, 1992).

Original ideas are often described as unique, wild, or unconventional. According to

Torrance, (1995), original ideas are statistically infrequent because of the discomfort

involved in being in a minority of one. Original thinkers must often face skepticism and

ridicule. One way of facilitating originality is to be respectful of unusual ideas or

alternatives (Torrance, 1995).

Elaboration - Elaboration is the ability to embellish ideas with details. It involves

planning what must be done, who will do each task, when, how, the cost, and other details

needed to bring the idea to life (Torrance, 1979a). A good way to facilitate elaboration is

through storytelling, encouraging the learner to describe each character using details and

descriptive words (Torrance, 1995).

There is considerable research evidence to support the belief that the creative

process can be taught (Osborn, 1963; Rhodes, 1987; Torrance, 1979a, 1988; Torrance &

Safter, 1990). Methods that provide practice in the creative thinking process include

activities which stimulate fluency, flexibility, originality and elaboration in individual, small

group, and team settings (Torrance, 1979a).

Strategies for Teaching Creative Thinking

The Incubation Model of Teaching

The Incubation Model of Teaching (Torrance, 1965; Torrance & Safter, 1990) is a

three-stage model of teaching creative thinking skills. Torrance (1965) suggested this

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three stage teaching process to enhance creative learning. The three stages are: (1) warm-up, (2) digging-in, and (3) follow-through. The Incubation Model has been used successfully as a method of teaching with all age groups. The three-stage model is simply a framework for presenting information and stimulating thinking which incorporates creative thinking abilities into a lesson or topic (Torrance, 1997).

Stage 1 - Warm-Up.

During the first stage of " warm-up", curiosity is heightened and a desire to know is stimulated. Warm-up may take the form of a field-trip, a story or poem, a brainstorming session or any technique to whet the appetite of the participant to learn more about the subject.

Stage 2 - Digging-In.

The second stage of "digging-in", occurs when the learner goes beyond the surface of a subject, to search for more information, to summarize, simplify, and discard useless or erroneous information. "Digging-in" often involves solving the problem with solutions that open up new and complex questions.

Stage 3 - Going Beyond.

The third stage in the process is "going beyond" which allows the learner to do something with the information. It is imperative that genuine creative thinking take the learner beyond the activity or classroom. This third stage allows the learner to continue thinking about the topic by applying it to his or her own experiences, personal situations or dilemmas.

Awareness has always been the key to success. If educators were aware that

practicing the simple techniques of "warm-up" and "going-beyond" made such a big difference, they would begin following the suggestions immediately (educators have always facilitated stage two,"digging-in"). To some educators, it seems an exciting prospect.

Creative Problem Solving (CPS)

Creative problem solving has become extremely popular in today's education (Torrance, 1995). Torrance (1987) reported that the best results of increasing creative thinking have come from various modifications of the Creative Problems Solving Process (Parnes, Noller & Biondi, 1977). The most successful approaches to CPS, which involve both cognitive and emotional functions, provide adequate structure and motivation, and give opportunities for involvement, practice, and interaction (Torrance, 1987).

The Creative Problem Solving Process (Parnes, 1962) has five steps. These are: (1) fact finding, (2) problem-finding, (3) idea-finding, (4) solution-finding, and (5) acceptance-finding. This process works very similarly to the Incubation Model of Teaching (Torrance, 1965; Torrance & Safter, 1990). The steps of fact-finding, problem-finding, idea-finding, and solution-finding are all in Stage two of the Incubation Model, "digging-in".

Step five of the CPS process, acceptance-finding, is very similar to the third stage of the Incubation Model of Teaching, "going beyond". Both CPS and the Incubation Model originated from Osborn's (1948) definition of the creative problem solving process as having three steps: (1) fact-finding, (2) idea-finding, and (3)solution-finding.

Future Problem Solving (FPS)

One team problem-solving activity which is very popular is the Future Problem Solving Program (Torrance & Torrance, 1978). FPS is a curriculum project for gifted and talented students from grades 4-12, and it culminates with an interscholastic competition. FPS allows an opportunity to practice, and encourages the development of problem-solving skills. It encourages teamwork, collaboration, and future-thinking skills.

Currently this national competition is only available to children; however the techniques can be used with adults as well. There is a good possibility that FPS competitions may expand to adults in the future if there is sufficient interest (personal conversation with Torrance, 1996).

Invent America

Invent America, was recently developed by the U.S. Patent Model Foundation. Similar to FPS, this project is also currently available only to children. In Invent America students create inventive solutions to problems in the home, school and community with parent and teacher support. Invent America has gotten teachers excited about using creative problem solving techniques necessary for the competition. Students are quite enthusiastic about competing for a patent on their idea. After inventions are judged at the local schools, the winners in each age category go on to state and national competitions culminating with the winners being presented patents in Washington, D.C.

Renzulli and Callahan Creative Thinking Techniques

Research has consistently shown that students can improve the quantity and quality of their creative thinking techniques. However, researchers have provided evidence that teachers often lack the skills for teaching the basic techniques and strategies for developing creativity (Renzulli & Callahan, 1981). They listed four basic principles underlying creativity training: the fluency principle, the open-endedness principle, the environmental relevancy principle, and the enjoyment principle. The fluency principle states that the more ideas a person generates, the more likely he or she will come up with new and original ideas. Open-endedness implies there should be room for students to think of many solutions to a problem, not just one correct answer. Environmental relevancy implies that the learner should be able to draw from his or her own experiences. The enjoyment principle emphasizes the enthusiasm of the teacher and the teacher's willingness to become an active participant in the activity on an equal basis with the student, in a free and open atmosphere (Renzulli & Callahan, 1981).

Awareness Plans

A strategy suggested by Leff, Thousand and Nevin (1994) is the use of awareness plans for facilitating creative thinking. An awareness plan is described as a deliberate mental procedure for dealing with situations. The plan could be to examine the situation from a bizarre perspective in order to overcome barriers to creative thinking. When teachers learn how to use awareness plans, they can teach students to apply different awareness plans to their lives.

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Future Scenario Writing

Torrance and Rockenstein (1988) also suggested several approaches that facilitate the creative thinking process. One approach was future scenario writing, which is an approach used by futurists to forecast events. This type of activity employs creative thinking while still emphasizing basic skill development.

Sociodrama

Sociodrama (Torrance, 1975; Torrance, 1979b; Torrance, Murdock & Fletcher, 1996) is a group creative thinking activity whose purpose is to examine a social problem by dramatic methods. Sociodrama uses active role playing as a problem solving process.

Other Creative Thinking Strategies

Torrance (1987) stated that it is possible to teach creative thinking in a variety of ways. Torrance (1963) has suggested encouraging creative thinking by: (1) treating unusual questions and ideas with respect, and if there are no answers, letting the learner guess freely about possible answers or solutions, (2) providing opportunities of self-initiated learning and giving credit for it, and (3) providing periods of non-evaluated practice or learning.

The most successful approaches seem to be those that involve both cognitive and emotional functions, provide adequate structure and motivation, and give opportunities for involvement, practice and interaction. Facilitating favorable conditions certainly makes a difference, but the greatest most predictable differences are consistently shown to occur

when deliberate teaching is involved (Torrance, 1995).

The creative thinking processes seem to work equally well in increasing creative thinking skills of both men and women (Torrance, 1965; 1972). All that is truly required is an open mind.

Summary of Section 1

There is a substantial amount of literature which provides evidence that the creative process can be enhanced in individuals by using techniques designed to increase creative thinking skills. The history of the creative process, and techniques which are currently used to enhance the creative process, were examined in this section. Even though these techniques were originally designed for use with children, recent studies (Goff, 1991; 1992) have shown them to work with adults as well.

In longitudinal studies from 1958 to 1980, Torrance found that characteristics of the creative thinking abilities differ from those abilities involved in intelligence. According to Torrance (1995) using intelligence tests to identify creative students misses about 70% of those students.

The few studies which have focused on creativity in adults show significant increases in creative thinking skills when those individuals were taught using creative methods (Goff, 1991; Torrance, Clements & Goff, 1989; Torrance, 1965). The Incubation Model of Teaching (Torrance, 1965; Torrance & Safter, 1990) was discussed at length, as it seems to be highly useful as a method for enhancing creative learning. Strategies were

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suggested for adult educators as well as a review of creative thinking programs available.
Piirto (1991) believes that women have not been encouraged by traditional education to be
creative thinkers.

Section 2 - History of Women Inventors

Great women, sometimes overcoming enormous social obstacles, have made
contributions that have changed the world and continue to change our lives. In examining
women in American history, we find women who have made vast contributions to society
(Stanley, 1993) even though at the time, the male social structure did not recognize
women's inventions as such.

American settlers had to be extremely inventive and creative to survive. The
success of the colonies depended on the creativity of its settlers, both men and women. In
the early 1700s women did work not generally thought of as feminine. They farmed,
operated mills and learned trades. But as colonies grew, women's roles became more
restricted (Stanley, 1993). Men formed governments based on the "old countries" in
Europe while women were expected to center their activities on their husband and
children. Once a woman had children, she was no longer viewed as a person in her own
right. Therefore the history of women inventors is also the history of women's changing
roles in society (Stanley, 1993).

As the social order of America became more established, it became more difficult
for women who showed an interest in machines or other technology to be taken seriously

(Stanley, 1993). Women were educated differently than men. During the eighteenth and nineteenth centuries, and for much of the twentieth century, women were trained in the manners and morals of polite society and in the care of home and children while men studied science, technology and politics (Panabaker, 1991).

During the 1800s, most women's lives were filled with long hours of milking cows, churning butter, washing, cooking and cleaning. They also gave birth to children and raised them, and often worked in the fields. If a woman took time to invent something new, it was usually a way to ease her burdens (Panabaker, 1991).

In 1870, a woman named Margaret Knight invented a flat-bottomed paper bag folding machine. But Charles F. Annan, a man who had seen her models, beat her to the patent office. She filed a lawsuit against him claiming he had copied her idea. His defense against her was that she could not have invented the machine because a woman could not understand machinery. Fortunately, many people told the court they had seen or been involved with her in various phases of her work and she won her case and received one of the first patents granted to a woman (Macdonald, 1992).

During World Wars I and II, women pitched in to replace the men who were called away from factories, laboratories, hospitals and other businesses. Through inventions, they also helped the war effort in many ways. A 1923 report from the U.S. Department of Labor lists these inventions by women: automatic pistol; bomb-launching apparatus; mine; railway torpedo; single trigger mechanism submarine. Women also invented many other defense-related devices during the Second World War (Vare & Ptacek, 1993).

In the 1960s, the women's movement began changing ideas concerning women's

roles in society. After a long struggle, women have finally gained acceptance in most

institutions of higher learning, and it is against the law for employers to discriminate

against women (Ardis, 1995).

As late as the 1950s, about one-half of one percent of all patents were in women's

names, but since the 1960s, the number of women applying for patents has increased every

year. By 1995 the number of patents issued in women's names had risen to over 8% of all

those issued (U.S. Patent & Trademark Office, 1996). Women are experiencing more

equality in the creative arts and sciences (Gallop, 1994) with equal opportunities for

becoming engineers or entrepreneurs (Dash, 1990). The challenge is for today's young

creative women to take advantage of opportunities and prepare themselves for whatever

career they wish to pursue (Moussa, 1991).

Summary of Section 2

Most investigations of creativity have focused on the creativity of men. At best,

generalizations based on male samples have been assumed to be applicable to females; at

worst, creative functioning in women simply has been ignored altogether or eliminated

from consideration. Historically it has been presumed that the creativity of women occurs

with such insufficient frequency as to not be worth studying (Rieger, 1983).

Women have been seen as a reflection of men far too long. Now it is time to study

women in their own light (Mednick, 1981). Women make up over half the population.

Why are women not creating at a rate that is comparable with men? Perhaps one reason is

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that education is not meeting the needs of women in today's world. The U.S. needs to utilize the creative strengths of all of it's citizens. In the past women have not been encouraged to produce, only to reproduce. Women are demanding educational opportunities that meet their needs, which are different than men's, and new pedagogies that account for differences in women's learning are appearing (Davis, et al., 1996).

Section 3 - Gender Equity in Formal and Informal Education

Gender Equity in Education

According to researchers Biklen and Pollard, gender is "the social construction of sex" (1993, p. 1). Equity means "justice, impartiality, the giving or desiring to give each person his or her due," according to Webster's Unabridged Dictionary. Concern about gender equity arises from the different expectations that people hold for females and males, based solely on sex differences (Bitters & Foxwell, 1990). The Affirmative Action definition of gender equity is the elimination of sex-role stereotyping and sex bias from educational process (Rebell & Murdaugh, 1992).

In the late 1980's the American Association of University Women conducted a poll of 3,000 school children. The association's subsequent report *Shortchanging Girls, Shortchanging America* (1990), declared that girls face a pervasive bias against them from preschool through high school. The AAUW study *How Schools Shortchange Girls* (1995) further revealed that girls and boys are not treated equally in public schools and that they

do not receive the same quality, or even quantity, of education. The key concerns for girls that surfaced in these two studies by the AAUW include: (1) low self-esteem, (2) low academic achievement, and (3) low aspirations and career goals.

Low Self-Esteem

In the 1990 report from the AAUW (*Shortchanging Girls, Shortchanging America*), it was reported that:

"Teachers initiate more communication with males than with females, thus strengthening boys sense of importance. Teachers ask more complex, open-ended questions to boys which provide for more active learning. Teachers are more likely to give detailed instructions to boys and more likely to take over and complete the task for girls, depriving them of active learning. Teachers praise boys more for the intellectual content of their work, and girls were praised more for neatness and good behavior. Teachers tell boys their failure is due to a lack of effort and girls are not given this message, suggesting that effort would not improve their results (pp. 19-20)."

Males typically have greater self-esteem than females because of these and other traits of teachers (Schuster, 1991). Jaffee (1991) reported that one reason girls suffer from low self-esteem is due to society's expectations of the "ideal woman" being "white, tall, most often blond, and above all thin" (p. 71). Because of the curriculum, the knowledge base, the examples seen in books and materials which are created by and are primarily about the white middle-class male experience, white middle-class males are more

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likely to be successful, both in the education system and in the society that values the system (Tisdell, 1993).

Suggestions for Gender Equitable Classrooms

Vandell and Fishbein (1990) have suggested some keys to effective change. First, teachers must be empowered by the administration to be more sensitive to the importance of gender equity in the classroom environment. The curriculum materials should be evaluated for gender bias. Textbooks should portray both men and women in a positive manner. Female as well as male role models need to be represented in all resource materials. Teachers need to check copyright dates and be aware that older material probably contains gender stereotyping which should be eliminated.

Research has shown that cooperative learning environments seem to be appropriate for men as well as women (Ochse, 1991). When men are exposed in the classroom setting, to the teaching styles preferred by women, they (the men) have shown no decrease in learning (Rosser, 1990; Ochse, 1990; Piirto, 1991) and have actually benefited from these practices (Ochse, 1990).

Technology instruction is particularly important to females. According to Burstyn, "Our society rewards those who develop skills related to technology" (1993, p. 114). Female students often do not get hands-on experience in manipulating products and projects in the classroom, and therefore may be much slower and more clumsy than boys when using tools. The teacher will need to be patient and not pit the males against the

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females in any case to encourage competition. Females will refuse to participate if this occurs (Burstyn, 1993).

Education can be greatly enhanced when teachers encourage female students to participate in class from the beginning. Sandler and Hoffman (1992) suggested that teachers tell students on the first day of class that they expect them to participate equally. Teachers should call on females directly, even if they do not have their hands raised and call on both genders in proportion to their ratio in the classroom. Also teachers must wait a sufficient amount of time for a response after asking a question. Teachers should also provide opportunities for females to use equipment typically reserved for males and vice versa (Scott & McCollum, 1993).

Teachers should praise students who work cooperatively and share leadership roles. Males can learn to be sensitive to females in doing hands-on activities using tools females are not familiar with for example, and females can help males in this situation by providing opportunities for practicing cooperation and collaboration which are necessary skills in the real world (Vandell & Fishbein, 1990).

Gender and Academic Achievement

Myra Sadker (1991) summarized the situation of low academic achievement in women by stating that gender differences and differentiated treatment of boys and girls in formal education has caused girls to fall behind in every academic area, particularly math and science. However in a study by Linn (1991) females tended to make better grades in

graduate school classes than males. It may be that by graduate school, highly intelligent

women have learned to adapt their natural relational learning styles to those used in

traditional formal education

Keohane (1990) reported that a large number of current feminist researchers

believe that males and females do develop differently in their moral judgements, their

ambitions, and their ways of relating to other human beings. Whether this cause be nature

or nurture, the fact remains that males and females do approach things in different ways.

Gilligan (1982) showed that adolescent females approach problem solving from the

perspective of interdependence and relationship rather than from the competitive and

hierarchical viewpoint favored by most adolescent males. Rosser (1995) stated that

females prefer approaching problems and experiments that involve understanding the

relationships of the particular problem and the context of the bigger problem of which the

solution may be a part.

When females do push themselves to compete and excel in education, which may

not be considered feminine, they still receive fewer rewards in the workplace (Adelman,

1991). This lack of external rewards sends a message to women that their achievement

does not matter and ultimately discourages females from striving to excel (Pollard, 1993).

Kerr (1994) has reviewed women's tendency to consistently underestimate their

own abilities. As a group, she found that women take fewer academic risks and avoid

courses in math and technology because they do not feel they are intelligent enough. Kerr

reviewed this fear of success syndrome and found that women consistently under-achieved

when competing against men.

Matina Horner (1972) first discovered this pattern in formal education when she observed the typical woman was afraid to win against a man in competition, for to win against a man was actually to lose. Lose what? Femininity perhaps, or his goodwill.

When competing, research shows that females do their best when competing against other females, but consistently hold back their efforts to win against males in order to preserve intimacy (Kerr, 1994). This tendency is confusing to the women who actually catch themselves doing it. They cannot explain why they do it; it is simply part of women's nature not to compete against males (Kerr, 1994). Obviously, a traditional formal competitive learning environment is not going to benefit women nearly as much as it will benefit men (Tannen, 1990).

Many of the eminent women of our past received individualized instruction in a same-sex educational environment. Same-sex education gave the girls and women the attention they deserved and provided many role models of intellectual achievement. Many affluent creative women such as Eleanor Roosevelt, Gertrude Stein, Margaret Mead, Georgia O'Keefe and Katherine Hepburn, to name a few, had all-girls formal schooling. A less affluent creative women of our time, Maya Angelou, got her opportunities to excel and stretch her talents in same-sex informal education experiences including being raised by a loving grandmother and being taught in a supportive female church environment (Kerr, 1994).

A leader in the field of adult education's progressive movement, Hal Beder (1989) suggested that formal adult education serves a vital social function and has become indispensable. The need for adult training (formal education) is due in part to the constant increases in technical knowledge which quickly becomes irrelevant and must be constantly updated and revised. Beder (1989) is basing his theory on beliefs that everyone should have access to learning the things required for basic functioning in the current male-dominated society. Beder, typically, does not mention the education of women or their needs specifically.

In 1977, Srinivansan described an educational system that was not female-friendly. She suggested that education was demeaning to persons without previous formal education, and that education was a teacher-dominated system that robs the learner of self-respect by demanding compliance with teacher rules and not allowing the adult learner to have any say in the direction their learning will take.

Around the same time as the beginning of the women's movement in this country, Paulo Freire (1970) saw the problem of traditional education methods in Brazil. Freire came to the conclusion that learners need to be liberated from the oppression of the traditional teacher regardless of the learning setting. By allowing learners to participate in their own learning they can make decisions about what they need to learn in order to change for the better (Freire, 1970). A growing body of research documents the need to change the way women are taught (Gilligan, 1982, 1993, 1994; Harding, 1986; Helson,

1973, 1978; Keller, 1988; Piirto, 1991; Rosser, 1986, 1990, 1995; Tisdell, 1993). Based on these investigations, new approaches have evolved for teaching formal education classes in a more female oriented manner (Rosser, 1995).

Formal education which focuses on traditional male-oriented pedagogy encourages competition in independent work, in verbal discussions, in projects and in assignments. This competitive method, so often used in formal adult education, does not meet the learning needs of women. It forces women to learn the materials for the class in a way that is not natural for them (Tannen, 1990).

There are other social constructs regarding formal education and why it favors male learners. The physical realities of maleness and femaleness shape all aspects of a person's socio-cultural lives and values, including their education (Chafetz, 1988). For instance, a woman is much more likely than a man to need child care while attending formal education activities. The deterrents to formal education seem greater for women due to this single aspect of femaleness, motherhood (Chafetz, 1988). This singular important social construct tells women the responsibility of motherhood is hers (Ochse, 1990) and formal education does not typically provide any solutions to this dilemma.

Derryck (1979) suggested that informal education fulfills educational needs far beyond the reach of formal programs. In rural projects for instance, informal education programs provide relevant cognitive and manipulative skills without high costs or delayed benefits associated with formal programs. Individuals in lower socio-economic groups, the majority of which are women, are more likely to benefit from theses informal programs.

Landrum (1994) outlined some specific differences between male and female approaches to learning. The female approach incorporates negotiation, compassion and understanding. The female focus is on personal relationships, and holistic, intuitive, and group oriented learning. The traditional male approach to learning tends to incorporate aggression, competition and ego-gratification and focuses on impersonal relationships, and specific, rational and individualized learning (Landrum, 1994).

Women seem to do best in learning environments where forms of knowledge that come from life experiences are valued and where an effort is made by the teacher to relate theoretical concepts to real-life experience (Gardner, Dean & McKaig, 1989). Keohane (1990) advocated that educators be aware that certain ways of putting together knowledge makes more sense to women, and in some ways makes more sense to men.

Glass (1996) suggested the communication gap can be closed and the likelihood of seeming offensive or being offended can be reduced by learning how the opposite gender thinks. According to Glass, women are very descriptive and men get right to the point. Men find details distracting and become impatient and interrupt wanting to get to the point. When women talk to men, they can bridge this gap by starting with the ending of the story and then filling in the details. "If you tell a man up front why he needs to know something, he will be more receptive" (Glass, 1996, p.4). Glass (1996) further contended that men are used to taking the floor and interrupting each other if they want to get into a discussion, while women prefer to encourage mutual participation in a conversation by

pausing often and asking each other questions. Men can communicate better with women

by remembering to stop and ask questions of women that invite them to respond and give

input. "A get-to-the-point clipped style may seem efficient to a man, but sounds rude to a

woman" (Glass, 1996, p.4).

Women do not want control, nor do they want to be controlled, or made to

compete in learning situations, as it is against their basic nature (Belenky, et al., 1986;

Gilligan, 1982).

Women care about others in the learning setting and want *every* learner to be

nurtured and to do well. It is very interesting to note that recent studies are showing that

men also do well in collaborative educational environments (Ochse, 1990; Piirto, 1991;

Rosser, 1990; 1995). Thus, we see that collaborative environments work equally well for

women and men, and traditional competitive environments work well for men, but not for

most women. Females who do thrive in a competitive environment of traditional formal

education are typically highly intelligent and have adapted their natural learning styles

(Davis, Ginorio, Hollenshead, Lazarus, Rayman, & Assoc., 1996; Helson, 1979; Rosser,

1995).

A growing body of literature on women's development has begun to illuminate

issues regarding women's learning styles. Much of the literature has reported that

historical and current educational norms and approaches may not serve men and women

equally (Taylor & Marienau, 1995). Studies have shown that women exhibit similar

learning style preferences (Carter, 1990).

In research, learning styles have typically been described as bipolar distributions of

characteristics. Two styles are the analytic/relational style of learning (Anderson & Adams, 1992), and the field sensitivity/independence style of learning (Witkin & Moore, 1977). These are admittedly more simplified than the reality they are describing, yet they both have descriptive value when applied to gender differences in learning among college students (Adams, 1992).

Studies have shown that women often exhibit similar learning style preferences (Carter, 1990). Relational learning and field sensitivity learning styles correspond most closely to the female orientation to learning which in this study is called *connected learning*.

Analytic Verses Relational Learning Styles

The differences between the analytic and relational learning styles were described by Anderson and Adams (1992). They found relational learners tend to place an emphasis on relevance and personal meaning in what is taught, and have a strong need for qualitative feedback. In contrast, analytic learners more easily learn materials that are inanimate and impersonal and are not greatly affected by the opinions of others. The analytic style matches most traditional school environments. The relational style, which women prefer, conflicts with most traditional school environments (Anderson & Adams, 1992).

Field-Independent Verses Field-Dependent Orientations

Similarly, Witkin and Moore (1977) compared field-dependent and field-

independent orientations with respect to gender. They found that field-dependent learners tend to focus on needs, feelings and interests while field-independent learners focus on the task. Field-dependent learners encourage group achievement. In contrast, field-independent learners encourage individual achievement. Field-dependent learners become emotionally involved while field-independent learners remain emotionally detached.

Connected Learning Styles

Belenky, Clinchy, Goldberger and Tarule (1986) maintained that women learn best in environments which value life experience and relate theoretical concepts to real-life experience. In connected education, everyone's views are received and treated with respect. This type of caring teacher, who practices connected teaching, tends to draw out the best in people, which leads to a positive self-image of the learner. Or, put another way, a humanistic atmosphere promotes self-actualization (Maslow, 1971).

Connected teaching uses groups in which members nurture each other's thoughts to maturity. Belenky, et al. (1986) described this as the "mid-wife" style of learning. All discussions are conducted using methods of drawing out information; rather than in an adversarial style most often used by men, which can actually be hurtful to women. Like Freire's partner-teacher, the mid-wife teaching style assists in the emergence of consciousness (Belenky, et al., 1986).

Adult learning is defined as a continuous, cumulative, essentially lifelong process of growth that takes place in a variety of contexts (e.g., families, the workplace, clubs and associations, schools and colleges) (Antler & Biklen, 1990). Adult women typically learn

best in informal, non-structured learning situations such as intimate one-on-one or small group discussions, cooperative learning situations, and other non-traditional learning approaches. In connected environments women feel empowered to think independently, to think critically, and to come to their own conclusions (Belenky, et al., 1986). It is in these connected teaching-learning situations that women come to recognize and hear their own voices (Gilligan, 1993).

Gender and Education's Impact on Creativity

Maslow (1971) stated that we cannot study creativity in an ultimate sense until we realize that the creativeness of women has been overlooked entirely. Maslow (1962; 1964; 1971) learned from his peak experience studies to identify women and feminine creativeness as being worthy of study.

According to Piirto (1991), very few women have been recognized for their creative contributions. Helson, an early advocate for the creativity of women, stated in 1979 that male judges of creative contributions tend to favor work similar to their own; therefore women's contributions generally do not receive the same recognition. As recently as 1995, Torrance, possibly the world's most eminent expert on creativity, stated again that in our culture, rarely do women become scientific discoverers, inventors or composers.

Ochse (1990) stated that it is not that women do not have the talent to do creative work, it is that they do not have the time. The reality, according to Ochse (1990), is that

women are the caregivers of the human race. Society sees being feminine as giving up the sense of self necessary to establish a sense of self as creative (Helson, Stewart & Ostrove, 1995). Many women in a study by Pohlman (1996) rebelled against the images imposed by society of being feminine as being a parent and spouse.

Historically women's role in society entailed remaining in the household, caring for the children, and obeying the will of their husbands, and until children begin to learn differently, they will continue to grow to maturity thinking women should be the slaves of men (hooks, 1984). Being a woman is much more than being a caregiver; being a woman involves participation in all aspects of life (hooks, 1981).

hooks (1984) noted that liberation is still spoken of in man's terminology. Even Freire, the father of the educational liberation movement, spoke of people's liberation in his 1970 book *Pedagogy of the Oppressed* as something from which a new man emerges, no longer oppressed. In 1985, Freire admitted he was in sympathy with the women's movement; however because he was not a woman, it was not his battle. "Women's liberation is their own struggle; they need to establish their own language to express their own identity" (Freire, 1985, p. 186). However, in an interview with Freire in 1987, he claimed: "I am also a woman" (p. 166), not because he wanted leadership in the women's movement but "because women must know that their struggle also belongs to men who don't accept the machismo position in the world" (p. 166). "In order for society to be free and creative, it cannot be sexist" (Shor & Freire, 1987, p. 167).

Time alone may be crucial to being able to create. Ochse (1991) maintained that most creative men have time alone to create. Husbands tell their wives they have work to

do and that they are not to be disturbed. Traditionally, wives shelter their husbands from the distractions of a busy world by handling the mundane daily tasks which so often interrupt one's creative thought (Ochse, 1991). Women, especially those who are mothers, rarely are afforded this luxury. However, current thought on this subject is that women may not need to be alone, as men do, to do creative work. Ochse (1990) recommended that women work best in collaborative environments and that inventing, creating, and creative ventures of all kinds are open to women who learn to use the skills of interdependence.

Simonton (1976; 1984) studied the relationship between level of formal education and creative achievers. Although he did not study women specifically, Simonton found that "creativity is discouraged with increases in formal education" (1976, p. 224). One suggestion by Simonton (1984) was that creative potential can be stifled by excessive training and knowledge, that formal education may inhibit creativity by causing the learner to become over-committed to the dogma inherent in the discipline of the study.

Most important to women is that schooling be interesting and relevant (MacKinnon, 1978). In research by MacKinnon (1978) it was shown that creative achievers in formal education tend to produce very good work, when the work was in courses that caught their interest; however when the work was deemed uninteresting, creative achievers did little to no work and thus were not successful. Much of the literature involving educational approaches and norms suggested that innovative new pedagogy used with women are likely to serve both men and women better than do traditional instructional approaches (Taylor & Marienau, 1995).

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Summary of Section 3

Within the wide body of literature which reflects feminist pedagogy, all share a common concern: an emphasis on connecting and relationship rather than the male pedagogical counterpart of competition and separation. If women succeed in formal education despite the fact that most of the "experts" in the field and most of the examples used in case studies in texts are male, most of the instructors are male, and often most of the other students are male, she is still likely to be paid less than the male for the same job (Tisdell, 1993).

Section 4 - History of the Instrumentation

History of the *Torrance Tests of Creative Thinking*

The original *Torrance Tests of Creative Thinking (TTCT)* (Torrance, 1990) were first published in 1966. They were created as part of a long-term research program that emphasized classroom experiences that stimulate creativity. Scores of the *TTCT* are based on the factors of fluency, flexibility, originality and elaboration. Over time the *TTCT* evolved. In 1974 a revision was published (Torrance, 1974) and in 1984 a streamlined scoring was made available (Torrance & Ball, 1984).

This battery of tests of creative thinking abilities has been used with people from

kindergarten through graduate and professional education (Torrance, 1995). The *TTCT* are the most widely used tests of creative talent in the United States, have been translated into over 30 languages, and have been standardized in France, Italy and China.

Concurrent and Construct Validity of the *TTCT*

Torrance (1974) presented intercorrelations among the scales of the *TTCT* as evidence of the construct validity of the measure. Torrance reported correlational studies which suggest that a relationship exists between composite scores and an evaluation of originality of imaginative stories. When comparing 12 measures of divergent thinking with the *TTCT*, Torrance (1981) found moderately strong correlations which provide evidence of construct validity for the figural form of the *TTCT*.

Content Validity of the *TTCT*

Torrance (1990) believed that his experience in using this instrument personally and his observations that it correctly identifies creativity, along with his years of research in the field of creativity, allowed him to personally conclude that the *TTCT* figural forms do have content validity even though no concrete content validity studies have been done.

Reliability of the *TTCT*

Treffinger (1987) noted that it is not appropriate to assess reliability via internal consistency with instruments which yield open-ended responses. The *TTCT* is such a measure. It is comprised of open-ended items which represent a range of distinctly

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different abilities and performances. Test scores reflect multidimensional traits rather than

unidimensional traits. In the *Ninth Mental Measurement Yearbook* (Mitchell, 1985), Chase

reported reliability figures to lie in the .60's and into the .70's for the *TTCT*. In a second

review, Treffinger (1985) reported that equivalent forms of reliability have ranged from

.50 to .93 and "given the complexity of creative thinking, it seems that the *TTCT* displays

reasonable reliability for group and researcher applications" (p. 1633).

Scoring Reliability of the *TTCT*

Reliability of the scoring procedure is important due to the subjective nature of the

task. Therefore, interrater reliability has been empirically examined. In a study with a

random sample of 50, Torrance (1990) reported interrater reliability coefficients for the

norm-referenced measures to be from .95 to .99. The results of Torrance's study revealed

that there should be a relatively small discrepancy between scores, regardless of the

scorer.

Studies of the *Torrance Tests of Creative Thinking (TTCT)* with Adults

In a personal correspondence with Torrance (1997) he stated:

> "The *TTCT* has been used on adults from the outset. When I began developing this
>
> test, my ambition was to develop an instrument that could be used on all ages,
>
> from kindergarten to graduate school, and with senior adults. Many said that this
>
> was not possible, but I believed that it was possible, since the instrument was
>
> open-ended. This open-endedness has also made it appropriate for women as well

as men, and for all socioeconomic groups, because an individual could respond in terms of his or her own experience."

Torrance's longitudinal study of creative women.

In 1980, Torrance (1981) collected data from 116 young women (ages 26-33) who had been elementary school students between 1958 and 1964 and had each year been administered a battery of the TTCT. Those obtaining overall creativity scores above the mean of the sample were designated as High Creatives and those whose scores fell below the mean were designated as Low Creatives.

He found that creative women more frequently pursued career paths and family concurrently, resulting in a chi square which was significant at the .001 level. Overall marital patterns were not found to be significant. High Creatives were reportedly much more likely to be childless than Low Creatives. The differences are significant at the .001 level. High Creatives were more likely to attain education at all levels than Low Creatives. The differences were significant at the .001 level.

Reiger's 21-year longitudinal predictive validity study.

The predictive validity of the TTCT as a measure of creative potential was clearly demonstrated in this 21-year follow-up study by Rieger (1983). In the original study conducted by Torrance, children were tested annually from 1958-1964 on the TTCT. Subjects who scored above the median index score of 202, were classified as High Creatives and subjects who scored below the median were classified as Low Creatives.

Twenty-one years later, Rieger (1983) followed up with 83 women who participated in the original testing: High Creatives (N=42) and Low Creatives (N=41). "The women identified as High Creatives in elementary school have been fulfilling that potential as adults to a significantly higher degree than the Low Creatives" (p. 98).

Rieger (1983) found major differences between the two groups in sheer number of creative achievements. Although there were no differences in IQ found between groups, the High Creatives consistently out-performed the Low Creatives in career success and creative achievements. Results showed that girls identified by the *TTCT* to be High Creatives while in elementary school did tend to become creatively productive adults.

Thompson's study of older adults using the *TTCT*.

Thompson (1995) studied creative thinking abilities of older adults using the *TTCT*. She found no differences in females and males on any of the measures of fluency, flexibility, originality and elaboration. Findings from this study concluded that older adult males and females were similar in their creative thinking processes. Thompson (1995) suggested that more research with this population needs to be conducted with regard to different cohorts of older adults and different life-stages of older adults and corresponding creative thinking processes.

History of the *Demonstrator-Torrance Test of Creative Thinking*

The *Demonstrator-Torrance Test of Creative Thinking (D-TTCT)* is a much

shortened version of the original *Torrance Tests of Creative Thinking (TTCT)* (1966). The

D-TTCT version was designed by Torrance, Wu & Ando in 1980, to be used as a

screening tool where it was not feasible to administer the entire figural and verbal batteries

of the *TTCT.*

Validity of the *D-TTCT*

In a study using the *D-TTCT* to examine the relationship between humor

production and creativity in adults, Townsend, Torrance and Wu (1982) found a product-

moment coefficient of .51 between the humor production measure and the creativity index

of the *D-TTCT* (p<.01).

In three separate studies by Torrance (Torrance, Wu & Ando, 1980), graduate

students were administered the *D-TTCT* and a variety of other creativity measures to

examine their relationships. From these studies Torrance, Wu and Ando (1980) provided

evidence to suggest that the construct and concurrent validity of the *D-TTCT* appeared to

be "satisfactory" (p. 6).

The most serious limitation of the *D-TTCT*, according to Torrance, et al. (1980) is

the brief time limit allowed for each of the test tasks, thus giving little time to the

incubation process. Because of the timed element, it was projected by the authors

(Torrance, et al., 1980) that a higher degree of correlation would exist between the *D-*

TTCT and intelligence tests, than would be derived from the regular *TTCT*. Even so, in a study of 104 Taiwanese seventh graders, Lin (1981) found that the *D-TTCT* picked up several students that would have been missed by five IQ screening procedures. This indicates that there may be far stronger support to the validity of the *D-TTCT* than had been anticipated originally (Torrance, et al., 1980).

Overview of the *Brief Demonstrator - Torrance Tests of Creative Thinking*

The *Brief Demonstrator version* of the *Torrance Tests of Creative Thinking (BD-TTCT)* is the instrument being used in this study. The *BD-TTCT* is an adaptation of the original *Torrance Tests of Creative Thinking*, used extensively in the 1960s with children. In 1989, The *BD-TTCT* was first used by Torrance, Clements and Goff with a group of healthy older adults, both female and male. The brevity of the shortened instrument, which used only three components of the original, makes the instrument practical in identifying creativity for educational purposes (Torrance, 1992).

History of the *Behavioral Event Interview*

Qualitative research attempts to uncover and understand what lies beyond a phenomenon, like the educational experiences of women inventors, about which little is yet known. Qualitative methods also can give intricate details about phenomena that are difficult to convey with quantitative methods (Strauss & Corbin, 1990). Given the

emphasis on detail and depth of information, qualitative studies normally involve a small number of respondents. (Hakim, 1987; Marshall & Rossman, 1995; Strauss & Corbin, 1990). Interviews based on a sample of the members of an organization often constitute a good source of information (Hakim, 1987).

The *Behavioral Event Interview (BEI)* was developed by Harvard Professor David McClelland (1978) and colleagues at McBer and Company. It is based on the *Critical Incident Technique* that was created by Flanagan (1954).

Flanagan (1954) described a critical incident as follows: "(1) an incident must be a description of a behavior that is sufficiently complete in itself to permit inferences and predictions to be made about the person performing the act; (2) it must occur in a situation where the purpose or intent of the act seems fairly clear to the observer; and (3) its consequences are sufficiently definite to leave little doubt concerning its effects" (p. 328). Consequently, the *Behavioral Event Interview* was found to be an appropriate research method for collecting and organizing certain descriptive data used in this study.

Overview of the *Behavioral Event Interview*

McClelland (1978) labeled his form of critical-incident interviewing the *Behavioral Event Interview (BEI)*, because it produced a detailed description of several critical incidents the participant has experienced while participating in a particular behavior. Through this technique not only are the respondents' behaviors identified but also their thoughts and attitudes.

With the *BEI,* the goal is to elicit very detailed behavioral descriptions about an experience (McClelland, 1978). The *BEI* permits a researcher to thoroughly explore episodes of a few respondents until all the relevant behaviors have been elicited (McClelland, 1978). The purpose of the interview is to get raw behavioral data which will be coded by the researcher. The *BEI* has been utilized with groups of all sizes and has been shown to be effective for small groups as well as large (Huff, Lake & Schaalman, 1982).

Summary of Section 4

The history of the *Torrance Tests of Creative Thinking (TTCT)* (Torrance, 1966) was described. In it's original version, the *TTCT* was used extensively with children; therefore, a thorough review of literature on the original *TTCT* was not attempted. The *TTCT,* as well as it's shortened version the *D-TTCT,* have been used much more often with adults, and longitudinal studies have shown it to have strong predictive validity.

A brief history of the *Behavioral Event Interview* was also described and a review of the literature of this qualitative instrument was presented. The *BEI* has been used successfully with large and small groups for obtaining qualitative data regarding critical incidents in a person's experience. This study asked participants to recall two critical incidents, one in formal education and one in informal education, which had an impact on their creativity. A description of exactly how the *BEI* is used in this study is found in Chapter 3.

Chapter Summary

Abraham Maslow (1971) first addressed the issue of creativity and gender. He stated "the creativeness of women has been overlooked entirely" (p. 62). Maslow learned from his peak experiences studies (1962, 1964, 1971) to look to women and to feminine creativeness as being a field worthy of study. Ravena Helson (1978) has studied the creativity of women and believes adult women to be self-directed learners who have experience and motivation to be creative achievers. Other more recent research has shown that women are more likely to become achievers through the use of connected learning techniques in education, which value cooperation and collaboration, rather than the competitive techniques traditionally used in educational settings (Belenky, et al., 1986; Gilligan, 1993, 1994; Seymour & Hewitt, 1994; Tisdell, 1993).

The world has many problems which need solving. Some problems will be solved with new patented products and processes. If this country is to work at full potential, the creativity of women must be nurtured by providing women opportunities to learn in way in which they naturally excel. These methods, which nurture the creativity of women, have been identified in this chapter. The large quantity of literature reviewed has shown to be consistent regarding the environments in which women learn best. The economic success of the United States is rooted in the creative genius of all of it's citizens. We can not afford to ignore women and the contributions which they can make if given an equal chance (Showell & Amram, 1995).

"Nobody can make you feel inferior without your consent."

---Eleanor Roosevelt

(Lerner-Robbins, 1996, p. 98)

CHAPTER THREE

RESEARCH METHODOLOGY

The purpose of this chapter is to describe the study design, sampling procedure, and instrumentation that was employed. The method of data collection and data analyses are also described.

The Population and Sample

In this study cluster research sampling was used. The advantages of the cluster sample is because it is the cluster, not the individual that is initially selected; subsequent samples may be drawn from the cluster if needed (Miller, 1991). A disadvantage of cluster sampling is the larger error rate due to the inability to assign persons to a sample, but this is not a problem in the current study as the cluster was defined by the U.S. Patent & Trademark Office as all women who received utility patents in the year 1995 (N=896 women patentholders). After selecting the cluster to be sampled (N=896), a systematic sampling technique, of using every third name, was employed to select individuals for this

study (N=300). The advantage of systematic sampling is the simplicity of drawing a sample that is relatively random within the cluster (Miller, 1991). Additionally, selecting 300 of the 896 names gives a confidence interval of .95.

The disadvantage is increased variability which may be introduced if the sampling interval is related to an ordering of the population. In the current study this is not a problem because the sample population was randomly chosen.

Research Questions

Question #1: To what extent do women inventors demonstrate creativity as measured by the *Brief Demonstrator - Torrance Tests of Creative Thinking*?

Question #2: How has formal and informal education been perceived by women inventors to have impacted their creativity?

Purposes of the Study

This study has two primary purposes. The first purpose of this study is to ascertain, through a quantitative approach, the extent to which the *BD-TTCT* establishes that women inventors are in fact creative. It can be argued that women inventors are creative by the very nature of their having attained a patent. However, attaining *BD-TTCT* scores from women inventors, will assist in providing insight into how their creativity compares to other populations where norm scores have been established. Thus, the use of the *BD-TTCT* will be helpful in recognizing the creativity of women inventors, though it needs to be acknowledged that other characteristics such as perseverance may have contributed to them becoming patent holders.

The second purpose of this study is to develop a deeper understanding of how formal and informal education has impacted (ie. helped or hindered) the creativity of women inventors. Specifically, the qualitative aspect of this study will report the thoughts, feelings and behaviors of participants regarding their formal and informal education experiences.

Design of the Study

This descriptive study will be multi-faceted in that a combination of methodologies will be utilized. This study will employ both a quantitative and qualitative approach. The quantitative data, supplied from research question one, (regarding creativity scores of the women patentholders) will be analyzed; then the qualitative data, supplied from research question two, will be analyzed.

Sampling

This study used a cluster sample that was randomly generated and which included only women who have demonstrated their creativity by receiving a patent in 1995. This list of women who received a patent in 1995, was available through the U.S. Patent and Trademark Office. One of the advantages of cluster sampling is that the researcher may use the same cluster for subsequent samples since it is the cluster, not the sample, that is selected initially. Substitutions of individuals in the cluster is permissible (Miller, 1991). Cluster sampling, is the selective study of particular persons, groups or processes that are expected to offer especially illuminating examples (Potter, 1996).

Qualitative research can be focused selectively on particular persons in groups or clusters related to the research topic. In cluster sampling the researcher must have a specific reason for why the group was selected for study or analysis (Hakim, 1987). In this

instance, it was suspected that a group of women inventors would probably consist of women who would be considered highly creative.

Data Collection Procedures

First the U.S. Patent Office was contacted. The executive director of the Patent Office was given an explanation of the researcher's interest in studying women inventors. A formal request was made for a diskette which listed all the names and addresses of women who had individual utility patents granted in the year 1995 (See Appendix A). This resulted in a cluster or focused sample. Additionally, it was possible to get these 896 names in random order. This list of names and addresses of 896 women patentholders randomly printed onto labels was ordered. Systematic sampling was then done to produce the 300 subjects initially selected to participate in the study.

Next all necessary paperwork was submitted to the Internal Review Board at Oklahoma State University. Included was a copy of the cover letter, consent form, demographic information sheet, the *BD-TTCT* instrument, and the follow-up questions of the *Behavioral Event Interview* (See Appendix B). The Internal Review Board granted permission to the researcher, with committee approval, to conduct the study as submitted.

Initial packets were sent to 300 systematically selected women patentholders. Twenty-one women returned the packet with the completed creativity test and demographics information and 151 were returned undeliverable. The 129 remaining women inventors were sent a reminder postcard after a specified length of time had

elapsed, and seventeen more packets were received from the reminder mailing (N=37).

The thirty-seven participants were told in a cover letter that they would receive a copy of

their creativity scores. When the creativity scores were mailed back to the respondents, a

request for further information was made. Of the thirty-seven women inventors who

responded to the initial survey of creative thinking, thirteen continued with the qualitative

portion of the study.

Instrumentation

The Quantitative Measure: The *Brief Demonstrator - Torrance Test of Creative Thinking.*

The *Brief Demonstrator version* of the *Torrance Tests of Creative Thinking (BD-TTCT)* was the quantitative instrument used in this study. In 1989, The *BD-TTCT* was

first used by Torrance, Clements and Goff with a group of healthy older adults, both

female. Additionally Goff (1997) conducted a series of experimental studies using the *BD-TTCT*. Norms for the *BD-TTCT* have been established using these studies. The brevity of

the shortened instrument, which used only three components of the original, makes the

instrument practical in identifying creativity for educational purposes (Torrance, 1992).

Reliability of the *BD-TTCT*

In the previously mentioned study of older adults (Goff & Torrance, 1991), the

BD-TTCT tests were scored by two separate trained evaluators. The composite creativity

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score was expressed in terms of a total score comprised of five subscores: fluency, flexibility, originality, elaboration and the creative strengths indicators (e.g. extension of boundaries, humor, resistance of premature closure). Interrater reliability coefficients were generated from 48 randomly selected protocols. Overall, interrater agreement ranged from .95 to .99 for the *BD-TTCT* (Goff, 1992; 1993).

Validity of the *BD-TTCT*

Goff (1992) reported statistically significant differences in her study using the *BD-TTCT*. All of the creativity scores of the experimental group had increased whereas all of the creativity scores of the control group declined. Analysis of covariance was used to determine if the differences between the group means were statistically significant at the .05 level. The total creativity score, and the subscores of fluency, and flexibility had increased significantly (p<.05). The group mean scores of originality, elaboration, and the creative indicators increased but were not significant at the .05 level.

Generally based on the analysis, there is sufficient evidence to indicate that the overall creativity, fluency and flexibility scores of the adults in this study increased significantly due to educational intervention (Goff, 1992). Learning to brainstorm may have contributed significantly to the increase in fluency scores of the experimental group, as brainstorming was a common warm-up technique used by trainers. An explanation for flexibility increase might be the flexible nature of the program (treatment).

Although the scores of originality, elaboration and the creative indicators increased, they did not reach the .05 level of significance. One explanation might be that

these are higher level cognitive abilities (Michael & Wright, 1989) which require more time to be developed. The *BD-TTCT*, will identify the creative thinking strength of fluency, flexibility, originality and elaboration.

Directions for Administering the *BD-TTCT*

Verbal test directions.

The verbal test (Activity 3), required respondents to read the directions and write (sentence) answers to a written problem. The directions read:

"...just suppose you could walk on air or fly without being in an airplane or similar vehicle. What problems might this create? List as many as you can." (Torrance, Wu & Ando, 1980, p. 64).

Figural test directions.

The figural test (Activity 5) was divided into two sections, both appearing on the same page. Section 1 consisted of two incomplete figures. Section 2 consisted of nine triangles.

For Activity 5 - Section 1, the respondents were required to read the directions and respond. The directions read:

"...make some pictures from the incomplete figures below. Try to think of pictures that others will not think of. Make your pictures communicate as interesting and as complete a story as possible. Make up titles for your pictures." (Torrance, Wu & Ando, 1980, p.66).

For activity 5 - Section 2, the respondents were also to read the directions and respond. The directions read:

> "...see how many objects or pictures you can make from the nine triangles below just as you did the incomplete figures above. DON'T FORGET TO ADD LABELS OR TITLES!" (Torrance, Wu & Ando, 1980, p. 66).

Scoring the *BD-TTCT*

The *BD-TTCT* is scored for four norm-referenced variables and 20 criterion-referenced indicators of creativity (Torrance, et al., 1980). These variables and indicators are presented in detail in *The Search for Satori and Creativity* (Torrance, 1979). The four norm-referenced variables, fluency, flexibility, originality and elaboration have been described in chapter one, definition of terms and elaborated on in chapter two. The 20 criterion-referenced creativity indicators incorporated in the figural and verbal creative indicators test do not contribute to the overall creativity score in points. Only extra credit is given for the creative indicators, in the form of plus (+) marks.

The criterion referenced creativity indicators are described as follows:

Figural creativity indicators (Torrance, et al., 1980, p. 18-28).

1. Abstractness of Titles - If titles are abstract or capture the essence or deeper meaning of the drawing or tell a story, a plus will be given.

2. Openness; Resistance To Premature Closure - This indicator is scored on the basis of the responses to section 1 of Activity 5. If the figures were completed by closing immediately, then premature closure has occurred and no plus marks would be given.

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3. Context; Environment for Object; Articulate Story - This indicator occurs most frequently with the incomplete figures (section 1) but also occurs with the triangles. To be scored, there must be an environment to help the picture tell a story.

4. Combination/Synthesis of Two or More Figures - If two or more of the incomplete figures or triangles are joined or combined to make a picture tell a story.

5. Breakthrough of Closure/Extension of Boundaries - Extending the boundaries of the figures in order to get away from the most obvious responses.

6. Unusual Visualization, Different Perspective - Any visual perspective other than the static, upright, straight-on view. In scoring this indicator, objects seen from above or underneath or at unusual positions are given points.

7. Internal Visual Perspective - This is scored when the internal workings of an object are shown.

8. Humor; Perceptual or Conceptual Incongruity - Titles, captions and drawings are scored as humorous if they have the quality of portraying something comical, funny, or amusing.

9. Richness and Colorfulness of Imagery - Responses are scored for richness when they show variety, vividness, and intensity. Responses are scored for colorfulness when they appeal to the sense of touch, smell, feel, sight, etc. No credit is given unless at least two responses can be regarded as rich and colorful.

10. Feelings and Emotions Expressed - These may be communicated through titles and the drawings themselves. Verbal cues are: sad, happy, joy, freedom, love, anger, etc. Nonverbal cues include: tears, frowns, dancing, etc.

11. Fantasy - This indicator often appears in the form of Mother Goose characters, fairy tales, fables and myth characters and other fantasy literature. However original fantasy is also counted such as spirits, dancing raindrops, supernatural characters.

12. Movement and Sound - Indicators of movement and sound may be obtained from titles, speech of figures in drawings, and bodily postures of figures in drawings. Common indicators include running, dancing, kicking, flying, etc. Common indicators of sound include hiss, scream, yell, laugh, cry, etc.

Verbal creativity indicators (Torrance, et al., 1980, p. 29-31).

1. Synthesis (combination of two or more ideas) - (This indicator is based entirely on Activity 1, which was not included in this form of the *D-TTCT*).

2. Internal Empathic Perspective - (This indicator is based on Activity 1, 2, and 4, which were not included in this form of the *D-TTCT*).

3. Verbal Humor; Conceptual Incongruity - This indicator occurs in Activity 3, and is scored if a response is funny, makes you laugh, etc.

4. Richness and Colorfulness of Imagery - This indicator occurs in Activity 3. Richness is defined as variety, vividness, and strength of imagery. Colorfulness is defined as excitingness, mystery, and puzzlement of the imagery.

5. Fantasy - This indicator occurs in Activity 3. The following kinds of responses are scored as fantasy: figures from myths, fables, fairy tales, and science fiction; words such a pretend, imagine and just suppose; and magic or supernatural behavior, objects, etc. are scored.

6. Emotions/Feeling - In Activity 3, the flying or walking on air may make one joyous, jealous, angry, etc.

7. Provocative Questions - A provocative question is defined as one that makes a person think of an object or situation from a different point of view. The respondent is asked to project himself/herself into a different world, a new world, a new perspective.

8. Future Orientation - This indicator occurs when the future consequences are presented. For example, if people can fly with out being in an airplane or similar vehicle, there will be changes in the energy problems, the automobile industry, the aviation industry, and in law making and enforcement.

Scoring fluency.

In Activity 3 of the *D-TTCT*, the Fluency score is the number of different problems listed. The problems must be ones that might possibly be created by the improbable situation "if people could walk on air or fly without being in an airplane or similar vehicle" (Torrance, et al., 1980, p. 7).

In Activity 5 of the *D-TTCT*:

"The Fluency score is the number of objects or pictures made from the incomplete figures and triangles. If two or more triangles are combined to make one object, the score is one. To be counted, the incomplete figure or triangle must be used as a part of the picture. If additional incomplete figures or triangles are drawn and used, each of these is counted" (Torrance, et al., 1980, p. 7).

Scoring flexibility.

The flexibility score is based only on responses to Activity 5. Flexibility is

concerned with the number of different ways the shapes and triangles are processed or used. A scoring manual was designed by Torrance which lists the

"...twenty-five categories of changes or improvements, which 99% of the respondents in the initial groups chose. These common responses were labeled 'not creative'. Any changes or improvements which are not on that list are given a point and a flexibility score is obtained" (Torrance, et al. 1980, p. 10).

Scoring originality.

In scoring originality, "...a list of common responses have been compiled from a sample of 500 records. Responses that are on the list equal zero points. Responses which are not on the list of ordinary responses are considered creative and are given one point each" (Torrance, et al., 1980, p. 10).

Scoring elaboration.

Elaboration is scored only for Activity 5. In scoring Elaboration, "...credit is given for each pertinent detail (idea) added to the original stimulus figure itself, to its boundaries, or to the surrounding space. However, the basic response must be relevant before a point can be given. One point is given for each idea that contributes to the story. One point is given for decoration when it adds an idea to the basic response, or if the decoration tells a story in itself, an additional point may be given. One point may be given for each major variation of design which is meaningful and one point for a title that does more than just minimum describing (naming). If a line breaks one part of the picture into two, and the line has meaning, an additional point is given." (Torrance, et. al., 1980, p. 17).

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Expertise of the Scorer

The completed instruments were sent to a certified scorer to score. In addition to having a doctorate in Adult Education, this individual became a certified scorer whose interrater agreement with Torrance on the BD-TTCT ranged from .95-.99. All of the protocols for the BD-TTCT were evaluated by this certified scorer.

The Qualitative Measure: *The Behavioral Event Interview*

Overview of Qualitative Research

Qualitative research attempts to uncover and understand what lies beyond a phenomenon, like educational experiences of women who invent, about which little is yet known. Qualitative methods also can give intricate details about phenomena that are difficult to convey with quantitative methods (Strauss & Corbin, 1990). Given the emphasis on detail and depth of information, qualitative studies normally involve a small number of respondents (Hakim, 1987; Marshall & Rossman, 1995; Strauss & Corbin, 1990). Interviews based on a sample of the members of an organization often constitute a good source of information (Hakim, 1987).

Validity of Qualitative Research

The great strength of qualitative research is the validity of the data obtained. Individuals are interviewed in sufficient detail for the results of the in-depth interview to be taken as true and complete (Hakim, 1987). Its main weakness is that small numbers of

respondents cannot be taken as representative even if great care is taken to choose a fair cross-section of a sample (Hakim, 1987).

Interviewing

In his text, *Interviews - An Introduction to Qualitative Research Interviewing*, Kvale (1996) stated:

"In an interview, the researcher listens to what people themselves tell about their lived world and hears them express their views and opinions in their own words. The qualitative research interview attempts to understand the world from the subjects' points of view, to unfold the meaning of peoples' experiences, and to uncover their lived worlds prior to scientific explanations" (p. 1).

Taylor and Bogdan (1984) stated that interviews are effective communication which reduces ambiguity and insufficiency in the data that frequently hinder other methods of data collection. Because of the advantages of interviewing, this technique was incorporated into the present study.

The literature generally recognizes two forms of interviews, standardized (structured) interviews, and non-standardized (non-structured and semi-structured) interviews (Kerlinger, 1986; Stewart & Cash, 1985; Taylor & Bogdan, 1984). The structured interview is the favored techniques when standardization is a priority (Kvale, 1996). Standardization occurs when the interviewer asks all the subjects the same questions, verbatim, in the same sequence for every interview. The interviewer never deviates from the script so all subjects will have the exact same experience.

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A semi-structured interview, in contrast to the structured interview, is flexible and open. The researcher makes the decisions about the questions to be asked, the wording of the questions and the sequence of the questions even though the research still dictates the general area of interest (Kerlinger, 1986).

Structured interviews result in more uniform, precise and reliable data. If a significant body of knowledge is available about the research topic, the structured interview is the preferred technique (Kerlinger, 1986; Kvale, 1996). Since there is not a significant body of knowledge about the educational experiences of women who invent, a semi-structured approach was deemed most appropriate.

Although the interviewer guides the discussion to the topic of interest, the in-depth interview may be semi-structured in that it provides freedom for the respondents to bring in all sorts of matters which, for them, have a bearing on the main subject (Hakim, 1987). Semi-structured interviews, rather than structured pre-coded questionnaires, are thought to be appropriate for research on patterns of thinking and learning (Hakim, 1987). Semi-structured in-depth interviewing is a good way to obtain *descriptive* research data (Marshall & Rossman, 1995). It is described as "a conversation with a purpose" (1995, p.80).

Telephone interviewing

Telephone interviews have been found to be a very good way of conducting semi-structured in-depth interviews, and very few discrepancies have been found between personal face-to-face interviews and telephone interviews (Strauss & Corbin, 1990). In a

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study by Miller (1991) it was reported that a lower response rate (5% lower) occurred for telephone interviews; however, this 5% was not large enough to be considered statistically significant. Semi-structured in-depth interviews are typically tape-recorded so that direct quotations may be used in the final report, in place of tables and statistics offered in a survey report (Hakim, 1987).

The real concern when doing in-depth interviewing, especially telephone interviewing, is about establishing rapport between respondent and interviewer. Telephone techniques must give priority to establishing motivation and trust equal to the face-to-face survey (Miller, 1991).

The most important aspect of the interviewer's approach concerns an attitude of acceptance--that the participant's information is valuable and useful. Interviewers should have superb listening skills and be skillful at personal interaction, question framing, and gentle probing for elaboration (Marshall & Rossman, 1995). The subjects in this study were telephoned and asked two questions using the *Behavioral Event Interview* method developed by McClelland in 1978.

Specifics of the *Behavioral Event Interview*

The *Behavioral Event Interview (BEI)* was developed by Harvard Professor David McClelland (1978) and colleagues at McBer and Company. It is based on the Critical Incident Technique that was created by Flanagan (1954). McClelland labeled his form of critical-incident interviewing *Behavioral Event Interviewing* because it produced a

detailed description of several critical incidents the participant had experienced while on the job. Through this technique not only are the respondents' behaviors identified but also their thoughts and attitudes. Additionally, probing was utilized to acquire greater clarity. Though the *BEI is* usually recorded on tape, the interviewer should still take notes to assist in the process.

With the *BEI*, the goal is to elicit very detailed behavioral descriptions about an experience (McClelland, 1978). The *BEI* permits a researcher to thoroughly explore episodes of a few respondents until all the relevant behaviors have been elicited (McClelland, 1978). The purpose of the interview is to get raw behavioral data which will be coded by the researcher. Open coding will be done with responses. In open coding "the classification of concepts is discovered as subjects respond and when compared one against another appear to pertain to a similar phenomenon. Concepts are then grouped together to form a category" (Strauss & Corbin, 1995, p. 61). Initial coding pertains to "Formal Education," "Informal Education," "Helped Creativity" and "Hindered Creativity" and will then be further coded using the open coding method to gather deeper understanding when possible.

Gaining Expertise in Becoming a Behavioral Event Interviewer

I received training from a trained behavioral event interviewer. After developing the interview script, I conducted practice interviews. I then listened to the recordings of these interviews to identify instances of missed opportunity where I could have followed

up with an effective probe. A critique on each interview showed it's individual strengths and weaknesses.

However, the learning process never ended. Inevitably I would listen to an interview that I conducted for purposes of this study and identify instances where I could have asked a follow-up or probing question. The skills required to conduct an effective behavioral event interview continued to increase during the data collection process.

Steps in Conducting the *Behavior Event Interview*

Telephone interviews were arranged in advance with the participants. When the interview call was placed certain things were done. An explanation was given regarding the meaning of terms "impact" "formal education" and "informal education." These terms were defined as follows:

Impact, means "helped or hindered" as in how formal and informal education has impacted creativity;

Formal education - any organized educational activity which is for credit or certification including: public and private schools, Vo-Tech, professional/higher education, corporate training, university-industry collaborative training and military training;

Informal education - any education which does not fall into the formal education category including: personal contact and parenting, film and drama, books and magazines, learning by doing, television, entering competitions such as innovation contests sponsored by community and community educational programs.

It was anticipated that the participant would want to know why she was being asked to tell these two stories. My explanation consisted of the following:

> "As you know I'm studying the creativity of women and I need to try to know how education has impacted your creativity. You are an obvious expert in that you are a creative woman who has received a patent. I would like for you to tell me two true stories that you recall involving education and your creativity. First I would like for you to tell me a story of when *formal* education impacted your creativity and how. Second I would like for you to tell me a story about a time when *informal* education impacted your creativity and how."

At this point I asked permission of the respondent to tape-record the interview. I explained it this way:

> "With your permission, I would like to record parts of this interview to help me with my notes. Everything you say will be kept confidential and will not be shared with anyone else; however, if there is anything you want to say off the record or if you don't want me to record, just let me know and I'll turn off the tape".

Then I said:

> "First I want you to tell me a story of a time when formal education, that is when formal schooling such as high school or college courses you were in for credit, had an impact on your creativity. By impact, I mean how did it help or hinder your creativity?"

Once the respondent began talking I pushed hard for behavioral detail. For instance I might have said:

"Let me get this straight. Let's begin at the beginning. Where were you? What age were you? What class was it? What had you been doing when this came up? What was in your mind when this happened? How did this make you feel about your creativity?"

The goal was to get the participant to recreate the entire scenario. Here the interviewer becomes the investigative reporter, pushing to get clear exactly what happened, probing for more details, asking what the thoughts, feelings, perceptions were of the respondent when this event occurred. Probing results in more information without changing the original question. Examples of probing questions included: "How is that?" or "Can you explain that?" (Warwick & Lininger, 1976, p. 211). As a result, relationships and hypothesis can arise that were not originally a focus of the study.

When conducting a *BEI*, the goal is to get the respondent to begin at the beginning and take you through the story as it unfolded. The respondent may start by remembering the outcome of the event. If this occured, I said:

"That's exactly what I had in mind, now let's start at the beginning so I can understand what happened".

Some people need a lot of encouragement and stimulation to really get into the process of telling the story (McClelland, 1978). The major advantage of the *BEI* is that the interviewer gains access to information that is only relevant to the study. The *BEI* has been utilized with groups of all sizes and has been shown to be effective for small groups as well as large (Huff, Lake & Schaalman, 1982).

Data Analysis

Analysis of Research Question #1

The primary role of obtaining the composite creativity scores of this population was to determine the extent to which women who invent are creative. A breakdown of the scores into the four creative strengths of fluency, flexibility, originality and elaboration was done to see if women who invent tended to be creative primarily in one or more areas.

Preliminary norms for the *BD-TTCT* have been set by Goff in 1995. Scores from 249 adults were collected and analyzed. The scores tended not to vary across age and sex differences. The composite mean score was set at 50.10 (N=249).

Any scores which fall above the norms mean of 50.10 would be ranked "above average". We will compare the composite scores of the group of women inventors to the composite norm scores to determine if women who invent score significantly above the norm, and are therefore considered to be creative as identified by the *BD-TTCT*, as well as being considered creative by virtue of their having a patent.

Analysis of Research Question #2

The *Behavioral Event Interview (BEI)* was utilized to obtain personal stories from the women in this study, related to their formal and informal educational experiences and how those experiences impacted their creativity. Key themes and patterns were not predetermined but emerged from the data. Concepts were generated from and with the data, using coding as a means of achieving this (Coffey & Atkinson, 1996). Concepts

which emerged were then classified into categories.

Chapter Summary

In this chapter the quantitative measure and the qualitative measure were discussed at length. The quantitative measure, the *(BD-TTCT)* was used to determine the extent to which women inventors are creative. Women inventors were then asked to participate in the qualitative portion of the study, an indepth interview, the *(BEI)* concerning the way they felt both formal and informal education had impacted their creativity.

The sample was obtained from the U.S. Patent & Trademark Office and consisted of all women who received utility patents in the year 1995. Data collection procedures consisted of a direct mailing of letters to the women inventors to ask them to participate in a study of creative women. They were asked to complete and return the enclosed items, a short demographics questionnaire and a creativity test (the *BD-TTCT*), in the stamped addressed envelope. They were told they would receive a copy and a short description of their scores.

Data analysis procedures for the *BD-TTCT* was to send it to a trained scorer. The *BEI* was conducted by the researcher, information was recorded and later categorized into themes and categories by the researcher and her advisors.

"Many of you know and have felt what it is to be silenced, to be given less pay for equal work, to be ridiculed and trivialized. We must have courage and determination to claim our lives; to act, to move and do; to honor the spirit within. This is the heart of the matter."

<div align="right">

---Olympia Dukakis

(Lerner-Robbins, 1996, p. 170)

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CHAPTER FOUR

FINDINGS

Chapter three explained the sampling procedure, research design, instrumentation, data collection, and strategy for data analysis. The purpose of this chapter is to report findings relative to the research questions posed by this study.

The primary purposes of this study were twofold. The first purpose was to ascertain through a quantitative approach, the extent to which the *BD-TTCT* establishes that women inventors are in fact creative. Obtaining creative thinking scores from women inventors will assist in providing insight into how their creativity compares to other populations where norms have been established.

The second purpose of this study is to develop a deeper understanding of how formal and informal education has impacted (ie. helped or hindered) the creativity of women inventors. Specifically, the qualitative aspect of this study will report the thoughts,

feelings and behaviors of the women inventors in the context of formal and informal education.

More specifically, the research questions associated with this study were:

1. To what extent do women inventors demonstrate creativity as measured by the *Brief Demonstrator - Torrance Tests of Creative Thinking?*

2. How has formal and informal education been perceived by women inventors to have impacted their creativity?

Descriptive Analysis of the Sample

In order to investigate a population of creative women, it was determined to use a sample of women who had received utility patents for an invention in the year 1995. A mailing list of these 986 women was ordered from the U.S. Patent and Trademark Office. Of the 986 women inventors, 300 were randomly chosen. These 300 women were mailed a packet containing a request to participate in the study along with a copy of the *BD-TTCT* and a demographics questionnaire.

Within six weeks over half the packets were returned undeliverable because the inventor had moved and left no forwarding address. Twenty one women inventors completed and returned the instrument. A reminder letter was then mailed, and seventeen more women responded. Thirty seven women inventors ultimately returned the completed creativity test. (N=37). Characteristics of this sample are listed in Table 1. Of the thirty-

seven women inventors, thirteen continued with the *Behavioral Event Interview* portion of the study.

Note: If the participant did not volunteer to participate in the in-depth interview portion of the study, and return the request for her phone number, the researcher had no other way to contact her, as women are typically listed in phone directories under their husband's name. The U.S. Patent and Trademark Office was contacted regarding purchasing phone numbers for these individuals but they were not available.

Results Relative to Question 1

The first research question was asked: To what extent do women inventors demonstrate creativity as measured by the *Brief Demonstrator - Torrance Tests of Creative Thinking*? Of the 37 women inventors, all but one were Caucasian. All but two were in the age range of 31- 60. Fourteen of the 37 women had high school diplomas or the equivalent. The remaining 23 women had at least some college. Five of these 23 women had master's degrees and three had doctorate degrees. Table 1 addresses the characteristics of the sample population. Table 2 represents a report of the overall creativity scores of the 37 women inventors.

Table 1
Characteristics of Sample

Women Inventor Code #	Age	Ethnicity	Education Level
#001	21-30	Caucasian	GED
#005	41-50	Caucasian	High School Diploma
#028	51-60	Caucasian	Grades 7-12
#050	31-40	Caucasian	Masters in Nursing
#061	51-60	Caucasian	Bachelors in Nursing
#084	41-50	Caucasian	High School Diploma
#087	41-50	Caucasian	2 years college (Fashion)
#098	41-50	Caucasian	Doctorate in Physics
#106	51-60	Caucasian	Masters in Photography
#113	51-60	Caucasian	Cosmetology School
#124	51-60	Caucasian	GED
#125	51-60	Caucasian	Doctorate in Nursing
#130	41-50	Caucasian	Bachelors in Art
#134	31-40	Caucasian	High School Diploma
#141	31-40	Caucasian	Doctorate in Org. Chem.
#150	31-40	Caucasian	High School Diploma
#167	31-40	Caucasian	Bachelors in Anesthesia
#173	41-50	African/American	2 years college
#182	51-60	Caucasian	Masters in Education
#198	31-40	Caucasian	B.S. in Sports/Fitness
#203	41-50	Caucasian	B.S. in Chemical Eng.
#209	41-50	Caucasian	Bachelors in Economics
#210	41-50	Caucasian	Bachelors in Psychology
#239	51-60	Caucasian	Registered Nurse
#252	41-50	Caucasian	High School Diploma
#253	41-50	Caucasian	High School Diploma
#255	31-40	Caucasian	Masters in Leisure Sci.
#273	51-60	Caucasian	Registered Nurse
#274	41-50	Caucasian	High School Diploma
#285	51-60	Caucasian	2 years nursing school
#286	51-60	Caucasian	Masters in Metallurgy
#293	41-50	Caucasian	High School Diploma
#294	80+	Caucasian	High School Diploma
#312	41-50	Caucasian	GED - Tech courses
#315	31-40	Caucasian	High School Diploma
#335	51-60	Caucasian	High School Diploma
#338	51-60	Caucasian	Bachelors in Med.Tech.

Table 2

Composite Creativity Scores of Women Inventors (N=37)

Subject Number   - Scores Ranked Lowest to Highest
#134 - 21
#167 - 32
#294 - 40
#312 - 45
#335 - 47
#005 - 49
#050 - 50
#210 - 51
#252 - 53
#198 - 54
#087 - 59
#253 - 60
#209 - 61
#124 - 62
#315 - 63
#125 - 67
#150 - 68
#098 - 78
#173 - 80
#182 - 81
#285 - 81
#338 - 83
#286 - 83
#255 - 84
#203 - 90
#001 - 95
#141 - 110
#274 - 113
#113 - 113
#106 - 115
#061 - 122
#028 - 123
#239 - 146
#084 - 163
#130 - 165
#293 - 172
#273 - 529

Note:

The norms mean composite creativity score for the *BD-TTCT* has been established at 50.10. The composite scores have the sub-categories of fluency, flexibility, originality, elaboration and creativity indicators. However, for the purposes of this study, only the composite scores of the women inventors were used.

Table 3

Women Inventors Composite Scores: (N=37)

Range: 21 - 529
Median: 80
Mean: 94.19

5 Categories of Norms Composite Scores: (N=249) (Mean=50.10)
Very Low = 0 - 20.04
Low = 20.05 - 40.09
Average = 40.10 - 60.14
High = 60.15 - 80.19
Very High = 80.20 -100.24

Women Inventors's Composite Scores: (N=37) (Mean=94.19)

	Frequency Count:	Percentiles:
Very Low = 0 - 20.04	1	(3%)
Low = 20.05 - 40.09	2	(4.5%)
Average = 40.10 - 60.14	10	(27%)
High = 60.15 - 80.19	8	(21.5%)
Very High =80.20 - 100.24	16	(44%)

Discussion of Results Relative to Question One

None of the women inventor's scored in the very low range. Of the three women who scored in the low range, the one who continued on with the interview portion of the test did not complete an entire page of the test. She may have missed it. The other two female inventors who scored in the low range wrote in the margins that they were dyslexic and did not do well on tests. Neither of these two women volunteered to continue in the study.

Of the nine who scored in the average range, only two volunteered to continue with the in-depth interview portion of the study. Participant #005 was very verbal in the interview and was quite concerned about her average score, thinking she should have done better because she knows she is very creative. She also reported having severe dyslexia. This "problem with the written word" as she describes it, could account for her scoring in the average range on the *BD-TTCT*, which in this case, required participants to read directions and complete the test on their own. Participant #087, who also scored in the average range also volunteered to continue with the study. She considers herself to be a successful artist and is one of two of the thirteen women who are actually experiencing financial success with her invention. One reason she gave for her average score was that she is a very busy woman and might have rushed through the creativity test, while other women inventors who scored higher, might have put more effort into it.

Eighteen of the thirty-seven women inventors scored in the very high range or higher. For instance, eleven women scored well above 100 and one woman scored a 529.

Eight of the women inventors, who scored in the very high range and beyond, volunteered to continue with the interview portion of the study. Three of these women scored in the norms "very high" range (#285, #338 and #203) while the other five (#113, #106, #061, #293, #273) scored "well above the norms very high" range.

Eighty five percent (85%) of the women inventors in this study demonstrated above average to very high creativity as measured by the *BD-TTCT*. Results of the creativity tests suggest that women inventors, as defined by their holding a utility patent, are in fact creative. This is significant in order to establish the fact that women who hold utility patents are in fact creative. In addition, this information contributed to the continuing validation of the *BD-TTCT* as a useful instrument for identifying creative strengths. The *BD-TTCT* identified 85% of the women inventors in this study as being above the norm.

Question two explores the type of learning experiences which impacted the creativity of these women inventors. Thirteen women (Table 4) tell in their own words, through *Behavioral Event Interviewing*, how formal and informal education impacted their creativity. They also make suggestions for what education could do to encourage creativity in girls and women.

Table four represents the thirteen women inventors who were interviewed by the researcher. The women were originally given numbers to be identified by. The researcher gave each woman a fictitious name to be identified by. These fictitious names are listed in Table four along with the characteristics of the women inventors who participated in the interview portion of this study.

Table 4

Characteristics of Sample Who Participated in the Interview Portion of this Study

Characteristics of Interview Sample

Women Inventor Code # / Name	Age	Ethnicity	Education Level
#005 Alexa	41-50	Caucasian	High School Diploma
#061 Beth	51-60	Caucasian	Bachelors in Nursing
#087 Catherine	41-50	Caucasian	2 years college
#106 Diane	51-60	Caucasian	Masters in Photography
#113 Elizabeth	51-60	Assyrian	Cosmetology School
#134 Felicia	31-40	Caucasian	High School Diploma
#150 Geraldine	31-40	Caucasian	High School Diploma
#173 Hannah	41-50	African/American	2 years college
#203 Irene	41-50	Caucasian	Bachelors inEngineering
#273 Jan	51-60	Caucasian	Registered Nurse
#285 Katy	51-60	Caucasian	2 years nursing school
#293 Lucille	41-50	Caucasian	High School Diploma
#338 Mary Jo	51-60	Caucasian	Bachelors in Med. Tech.

Table 5

Creativity Scores of Interview Sample (N=13)

Women Inventor Code # / Name		Composite Score	Flu.	Flex.	Orig.	Elab.	C.I.	Norms Composite Score: 50.10
#005	Alexa	49	18	4	9	12	6	
#061	Beth	122	40	3	39	31	9	
#087	Catherine	59	15	3	13	21	7	
#106	Diane	115	21	7	9	61	17	
#113	Elizabeth	113	22	5	14	64	8	
#134	Felicia	21	7	1	3	7	3	
#150	Geraldine	68	14	6	5	36	7	
#173	Hannah	80	20	8	11	29	12	
#203	Irene	90	18	6	15	35	16	
#273	Jan	529	120	1	98	270	30	
#285	Katy	81	20	5	6	43	7	
#293	Lucille	172	11	3	13	126	19	
#338	Mary Jo	83	21	5	6	45	6	

Women Inventors's Who Participated in the Qualitative Portion of the Study (N=13)

Creativity Composite Scores

	Frequency Count:	Percentiles:
Very Low = 0 - 20.04	0	(00%)
Low = 20.05 - 40.09	1	(08%)
Average = 40.10 - 60.14	2	(15%)
High = 60.15 - 80.19	2	(15%)
Very High = 80.20 - 100.24+	8	(62%)

The second research question asked: How has formal and informal education been perceived by women inventors to have impacted their creativity?

In reporting these data, information was broken down into two categories: formal or informal educational experiences, and whether these experiences helped or hindered creativity. Thirteen women were interviewed using the *BEI* method to address this question. The participants in this phase of the study responded to the request for involvement and returned their phone numbers to the researcher. The researcher contacted each woman inventor who agreed to participate to schedule this interview over the telephone. Each woman inventor was told the interview would take approximately thirty minutes of her time and was told ahead of time, in writing, what was expected of her in the telephone interview. She was asked to tell two stories.

One story would be of an experience she had in formal education which she felt had an impact on her creativity. The other story would be of an experience she had in informal education which she felt had an impact on her creativity. The story was one which stood out in her mind as having some kind of impact on her creativity. The women inventors were also given definitions, in writing, of formal and informal education and what constituted each, as well as an explanation of "impact on creativity" as being one which was perceived as either helping or hindering her creativity.

The thirteen women inventors were then interviewed by the researcher (see Table 4 for descriptions of the women). Interviews were tape recorded, transcribed and coded by categories. Six categories emerged from the data and were listed in no particular order. These six categories fell into both formal and informal experiences, which both helped and hindered creativity. The six common categories were:

#1 - Learning experiences that contributed to these women's creativity tended to occur in less structured environments regardless of whether the educational setting was formal or informal;

#2 - Learning experiences, both formal and informal, that contributed to these women's creativity tended to be hands-on experiences that were meaningful to their everyday lives;

#3 - Learning experiences that contributed to these women's creativity tended to be both cooperative and self-directed;

#4 - Learning experiences that contributed to these women's creativity tended to be facilitated by a nurturing teacher who role modeled creativity;

#5 - Women inventors had some definite ideas about how education could promote creativity and therefore increase self-esteem and improve the self-concept of women; and

#6 - Women inventors consistently indicated that gender discrimination hindered their creativity.

Descriptive Analysis of the Collected Data by Category

Category #1

<u>Learning experiences that contributed to these women's creativity tended to occur in less structured environments regardless of whether the educational setting was formal or informal.</u>

All stories (both formal story and informal story of each women) were first placed into structured or less structured categories. All of the examples given by the creative women inventors regarding their experiences in education, whether formal or informal, which helped creativity took place in relatively unstructured learning environments. Every woman said her creativity was impacted in a positive way or helped when there was less structure in the learning environment. The following examples from the participant's stories relate to how less structured environments helped their creativity.

<u>Examples of formal education in unstructured learning settings that helped creativity:</u>

Alexa (#005) related the story of the library teacher who taught her to read in high school by giving her a speed reading apparatus which moved a bar down a page. This was done while in the library in a less structured environment.

Beth (#061) related the story of a much loved elementary teacher whose uncommon

methods impacted her creativity. She recalled:

> "My 6th grade teacher taught class creatively, through art projects...she didn't give grades....it was different and everyone loved her."

Catherine (#087), who now has a successful art career in New York City, stated that:

> "In high school art class I was recognized as having talent and was singled out and asked to draw posters of caricatures of the cheerleaders and football players. I got a lot of encouragement to be creative in my artwork from the teachers."

Diane (#106) told a story of how the less structured environment of the yearly science fair became a way for her to excel. She explained:

> "I won that science fair every year. It became a way of blending my artistic side with research and experimentation that was required in school. I just couldn't sit in the classroom...I would go crazy, just sitting there working with all the chairs in straight rows."

Felicia (#134) shared that she is tone deaf and as a child couldn't sound out words to learn to read. In the 5th grade it was also discovered that she was dyslexic. She told the story of how her creativity was encouraged by a teacher who let her learn in an unstructured environment, at her own pace. She recalled:

> "My second grade teacher told me I was stupid and lazy. Hell, I was just trying to fit in, I didn't know how to be lazy at learning. It took all the fun out of trying to learn. But in the fifth grade, I had a good teacher that discovered my dyslexia and turned me on to art. She let me explore with a variety of mediums at my own pace."

Geraldine (#150) also reported to be severely dyslexic. She stated:

"I absolutely cannot learn in a typical classroom setting where the teacher is

teaching the group. I HAVE to have one-on-one, hands-on experience. I like

correspondence courses that use videos so I can learn at my own pace."

Katy (#285) shared this experience of unstructured education:

"An example I can think of that helped my creativity was summer school. There

was a more relaxed atmosphere, we didn't have to dress up, we were the only ones

in the building and we could make noise and leave the room."

She continued the story by discussing the teacher's style which made the experience so

helpful to her creativity. (Her story on the teacher's style of teaching will be reported in

full in Category #4, which relates to the teacher's nurturing and role-modeling creativity.)

Mary Jo (#338) described an less structured formal experience that was helpful to

her creativity. She took a continuing art education photography class that met one night a

week for eight weeks. The learning consisted of taking photos all week and then showing

them in class which instilled an understanding and appreciation of the viewpoint of the

photographer. She explained:

"Looking at the world through the lens of a camera, one's whole perspective

changes."

This formal learning experience was held in a classroom setting, yet it was less structured.

Students were allowed to use their own creativity in choosing topics to photograph and

were encouraged to share their own viewpoint. And they were taught to appreciate the

viewpoints of others.

Mary Jo continued:

> "Learning to see the world from the viewpoint of another is an important skill
>
> which people don't often have a chance to learn."

According to these women, the key to enhancing their creativity was the less

structured nature of the learning environment. It appears that these women believe that

activities involving self-directed learning are important in stimulating their creativity.

<u>Examples of informal education in less structured learning settings that helped</u>

<u>creativity:</u>

Regarding informal educational experiences, Alexa stated:

> "I worked in a nursing home, it was on-the-job learning. I had no formal
>
> training, just watching others. I was good at solving the little problems that nobody
>
> else wanted to bother with. I had an ability to see the little things. Everyone
>
> thought I was so creative, but all I did was notice the little details that make life
>
> easier."

Catherine explained her informal learning experience:

> "I attended high school in Spain and since I was studying art even then, I spent all
>
> my free time roaming the countryside drawing castles and being a Bohemian. I
>
> know this world experience helped my future art career in New York City."

Diane also described worldly experiences as the informal learning experiences which she

felt impacted her creativity the most. She asserted:

> "World experience has been very enriching. That and my being an art teacher for

27 years at the college level. These two things have continually impacted my

creativity in a positive way."

Felicia explained how less structured environments were important to her. She said:

"Learning was encouraged by strong women in my family, and the love of

animals. I believe I have learned my creativity from being around animals. Even at

age 38, I would rather spend time with my dog than socialize with my peers."

The only African American woman in the study, Hannah, described an informal

educational experience which had the most impact on her creativity. She shared:

"I think my creativity was impacted most by my belonging to Camp Fire Girls. I

guess I was encouraged by all those beads and patches. I wanted to collect them

all. It was an opportunity for me to excel and have fun."

Lucille, whose patent is for a garden tool, was very busy running her business when we

talked to schedule her interview. I purchased one of these ergonomically contoured hand

held garden tool to fit a women's hand. When asked to relate an experience in informal

education that impacted her creativity, she stated:

"I can't think of any one incident really. I'm better alone. I learn everything I need

to know by reading books and articles."

She claimed she couldn't remember any experience from school which impacted her

creativity in any way. She even stated that she asked her brothers, who were in school

around the same time, if they remembered anything from school, and they all had a curious

lack of remembering any details. She suggested this was because it was so dull.

<u>Examples of formal education in structured learning settings that hindered creativity:</u>

Several participants told stories regarding formal educational experiences, all structured examples, which they considered to have hindered their creativity. Alexa said she was terrorized by the nuns at her school when she was small. She was made to ice skate in a pageant, and she just could not skate well. She said she begged and cried not to have to, but they made her. So when she fell in front of all those people and then would not go back out and perform, knowing she would fall again, the nuns shamed her. She recalled:

"The nuns at the Catholic elementary school were very structured. In this very structured environment, which used fear tactics, I know my self-esteem was severely damaged."

Hannah remembered how a structured, non-creative art teacher in junior high hindered her desire to excel or be creative. She stated:

"I had this one junior high art class where I did this project which I thought was really good. Now I wasn't a good student particularly, I made B's and C's, but this art project was at the beginning of the year, and I had promised my parents I'd try harder. So I worked so darn hard on that project...and I was so proud of my work. Then the teacher gave me a C. She didn't even look at the creativity of the project, she just looked at the end results which were not exactly like she wanted. I just thought, what's the use? And I quit trying again."

Jan, who had the extremely high score of 529 on the creativity test, declared:

"School was a non-event for me, because as a woman and even as a young girl, I

was never encouraged to learn. My brothers were. Even my teachers did not

bother with the girls back then. This was 50 years ago. I was not allowed to study

at home, as my mother and father thought I should be doing something

constructive with my time, such as housework. Creativity was never encouraged

unless there was a practical use for it such as decorating a cake to eat or making an

centerpiece for Christmas. Any other creative endeavor was seen as wasteful idle

time which could best be spent doing chores. Everyone in my family belittled my

creative efforts growing up and then I married a man just like my father who

continued to stifle my creativity. My husband won't let me take art lessons and

insists on giving me art lessons himself. This has been very discouraging, but I

literally cannot stop my mind from creating possibilities."

Examples of informal education in structured learning settings that hindered creativity

Beth related a devastating experience involving a supervisor when asked about an

informal learning experience which impacted her creativity. She shared:

"I experienced a horrible situation which nearly ruined my creativity and my health.

We got this new supervisor where I worked as a nurse. She was a very controlling

woman who believed there was no way but her way. She went by the book. I

nearly lost all my creativity and my sanity to boot."

The learning setting was on-the-job but the supervisor herself was extremely structured so

that the entire setting became unbearably restrictive.

Mary Jo also related a story about a time when a too-structured environment nearly ruined her creativity. She shared:

"This story immediately came to mind about an informal experience which caused me to feel rejected about my creativity. My mother and I were doing an art project together. My mother was very controlling [structured] having her own idea of how my creativity should look. My work was unsatisfactory to her because it wasn't what she had envisioned herself."

Summary of Category #1

It is quite obvious by the responses from this group of creative women that structured environments tended to hinder creativity and impact it in a negative way. On the other hand, it was equally obvious that unstructured learning environments tended to help creativity and impact it in a positive way.

A clear preference for informal or formal education did not emerge in this population. A clear preference for unstructured environments did emerge. Additionally this population identified structured environments as having negative impacts on their creativity.

Just as Lucille claimed she could not remember any experience from school that impacted her creativity, the other inventors did not describe a single incident where structured environments helped their creativity. Additionally, none of the inventors described a single incident in a less structured learning setting, informal and formal, that

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hindered their creativity. These female inventors felt that their creativity was encouraged in informal and formal learning settings as long as the tasks were unstructured.

Category #2

Most learning experiences, both formal and informal, that contributed to these women's creativity tended to be hands-on experiences that were meaningful to their everyday lives.

Only one story was told by each participant regarding a formal experience and one story was told regarding an informal experience which impacted her creativity. These two stories were later examined closely. From the participant's own words used to describe the experience which either helped or hindered her creativity, strong themes emerged. One of these themes was that all participants preferred to learn by doing things that were meaningful to them.

For example, Alexa said that she prefers to learn using hands-on methods. She explained:

"When that library teacher saw I was having trouble reading, she taught me to speed-read and I went from like 100 words a minute to like 3600 words a minute. After this I loved reading and read everything in sight. I feel this [learning to speed read] probably changed my life and impacted my creativity in a positive way."

Regarding her desire to learn using hands-on experiences, Elizabeth stated:

"I do not like to read manuals and follow step by step instructions. I learn best by doing."

She continued:

> "I wish there would have been more hands-on activities which gave me
>
> opportunities to show my creativity. There weren't and my self-esteem still
>
> suffers."

Elizabeth's informal educational experience story about her aunt who taught her to sew

reflects her preference for hands-on learning. She shared:

> "My aunt literally taught me one-on-one, step-by-step to sew and she encouraged
>
> my interest in sewing, taught me to make patterns, and the skill has served me well
>
> throughout my life".

Catherine, who is a successful artist in New York City and a self-described entrepreneur,

asserted:

> "You have to experience getting your art on the wall...that is 'just do it' so people
>
> will see it, and you will get recognition for it...and you will be rewarded and
>
> encouraged to continue doing it."

Catherine then related a story of an informal educational experience which gave her the

opportunity to get hands-on, real world experience. She reported:

> "The informal example I thought of could be called on-the-job training so to speak,
>
> traveling and relating to people through art; traveling through Spain as a young
>
> person and moving to Greenwich Village, NYC at age 19 to be an artist. I feel by
>
> actually doing it allows you to get the concept from your mind into reality for
>
> others to see. Again, just do it".

Felicia related that her creativity and desire for learning were hindered by teachers who did

not understand her severe dyslexia. Geraldine, who also labels herself as being severely dyslexic, told how in traditional education a student must watch the teacher to learn and that didn't work for her. She shared:

"In the regular classroom you have to learn by watching the teacher teach a whole class in every subject. I am severely dyslexic and need one-on-one or hands-on techniques".

Geraldine also chose to tell a story of a self-directed informal learning experience which impacted her creativity in a positive way, she reported:

"I took a home course in advertising and marketing on videotape so I could watch and take notes at my own pace. Then I would go out and try out what I had learned. For instance, take the example of learning about real estate. I'd rather go out and buy some real estate and then sell it in order to learn about it, rather than take a real estate class. That's how I'd rather do it. In fact, that's how I did it."

Hannah stated that she never even knew she was good at math until she was married to a military professional and she got a job on base as secretary. She recalled:

"In school I was always terrible in math class. Then I got a job, and even though it was secretarial, it was a military project which was very much involved in math. I was just amazed that I could do it so easily and that I was so good at it. I could figure out the math problems we were encountering on our project, even with no math background. I guess I'm just naturally good at math, yet in school nobody ever noticed that in me. I think that had to do with my being a girl. Girls weren't supposed to be good in math, so I never knew I had a natural ability. In fact I

always did terrible in math in school. I guess none of my teachers ever took the time to encourage me."

Irene, who is a chemical engineer, has a strong background in problem solving. She suggested:

"Problem solving essentially is what engineering is. In organic chemistry, it is known as 'synthesis'. Synthesis is when you do the kind of thinking which brings the sculpture out of a piece of raw clay. In organic chemistry synthesis is a big deal."

Irene also described an experience in formal education and how she preferred to learn by doing. She recalled:

" In elementary school, all my science classes were hands on, not just books. That is how I got such a good foundation in science."

She also stated:

"I prefer hands-on and learning-by-doing, but also I learn from a careful concentration on the material itself, such as in Organic Chemistry. Also knowing how to do syntheses, a technique which makes all kind of creative options available, makes me feel capable of independent learning."

Jan, the one inventor with the extremely high creativity score of 529, told a story of how she was hindered in her formal education because she had no encouragement to get lessons or to go to college. She had no opportunity to experience hands-on, learner centered education. She stated:

"My parents wouldn't pay for art lessons because they felt art was nonproductive

work. Because I am a female I didn't receive equal opportunity in education, no

girl did back then. Even now I sometimes feel guilty when I do creative work, until

the psychological need to create becomes more uncomfortable."

She continued:

"I was criticized by having all the things that were wrong pointed out to me by my

husband. It was wrong if it didn't look like the picture. If I put my own creative

touch on it, I was told it looked stupid. I feel this probably increased my creativity

in the long run."

Katy described a formal education experience that used hands-on experiential methods

that were personally relevant. She recalled:

"It was a summer school class and we got to do fun activities in class. One

example was drawing an object out of a paper bag and writing a five minute

speech about it. It was fun to see what my mind could come up with on the spur of

the moment like that."

Then she said :

"But I do remember the teachers who went only by the book...rote

learning...how boring. I always had to struggle to make passing grades under those

circumstances."

Mary Jo described a very hands-on, experiential episode in formal learning. She related:

"Each week in class there would be a mini slide show with each person showing

and telling how their photos, for them, captured or depicted the assigned subject.

The group discussion was not a critique in any way of the photography, but as an

understanding and appreciating the viewpoint of the photographer."

Information about the inventions

The women in this study all patented an invention. The inventions which the women patented were original concepts designed to solve problems that were meaningful to their everyday lives. Because inventors were chosen as the population of this study, the participants usually brought the subject of their invention up, and the interviewer often had to guide the participant back to the original stories about their educational experiences. Some participants did not bring up the subject of their invention, if they did not, the interviewer did not.

Some of these stories can be shared in order to demonstrate how meaningfulness is a necessary component of a creative idea. These women inventors arrived at their original ideas, on which they received patents, in a variety of ways. One common thread is that all of their inventions were developed to address a need.

Alexa, who invented the Laptop Braille Slate, stated:

"I have a brother and a sister and a niece that are all legally blind. I wanted to learn braille too, so I started learning and my arms got so sore that I could hardly move them from making the dots and moving the slate and trying to remember where I was. I thought my gosh there's got to be an easier way."

Catherine invented the "Breezer Fan Cards", a twenty-five cent item, of which she sells millions. These fans fold out of a playing-card sized cardboard square. She sent me some samples. She manufactures and sells them to advertisers for sporting events. So far she has

several big name beer accounts among others. She explained:

> "People are always looking for new ways to get their product into the public eye. The fans are sturdy and reusable, and offer a new way to advertise products."

Diane invented a coffee, tea or beverage maker and explained that she invented this product to solve an immediate problem. She said:

> "My invention came from a need which I encountered on a camping trip in Tibet. I wanted a coffee maker which was portable and would not break. There wasn't one, so I created it and the rest as they say, is history."

Geraldine invented an electrical outlet casting box (OCB) which in her words was a need item. She explained:

> "At eleven months my son was climbing and he put something in an electrical socket and got zapped. I tried every plug cover on the market, but he could get them off. Anyway I just stared at that outlet for about ten minutes, and I came up with a new design for one which even he can't get off. I figured I'd rather invent something to fix the problem than get gray hairs from worrying about it."

Hannah invented a static control material in response to a need. She explained:

> "I was in the business of making lab coats and often I'd hear customers complain about things which annoyed them in the lab. One thing was that even minute amounts of static electricity could ruin an experiment, and one of them said 'I wish someone would invent cloth that wouldn't conduct static electricity'. So I went home that night, exhausted, and dreamed the entire formula. The patent is EXACTLY (her emphasis) like my dream showed me and the product is selling

world-wide."

Irene invented the "Meal Minders Mat". She described how she learned inventing:

"Now here is how I learned inventing. First I learned how to independently learn.
Ok, in most thinking and school work the 'cart is after the horse', one goes from A
to B to C. In synthesis, one is often given C. Now which of the myriad of possible
and then likely then indeed optimum ways can you find A and B? It feels like the
cart before the horse. But once you get the hang of it, you have acquired a
valuable skill."

She continued the explanation:

"Many people have the vision to come up with ideas. It is much easier to dismiss
those ideas if you don't have the expertise of 'synthesis'. As soon as in idea hits me,
I envision a sketch of possible A's and B's. This provides strong form and
substance to the idea. I know that understanding synthesis and non-linear thinking have
lead me to become an inventor."

Katy invented a bug catcher vacuum. Rather than telling about her specific patent, she
explained that she has several patents and the way she invented each one was the same.
She described the technique she used:

"In high school I was taught a very creative technique for speech writing. First you
take a piece of paper and down the left side of the page write down everything you
can think of about a concept in one or two word phrases. Down the other side of
the page you write every prepositional phrase you can think of such as 'first of all'
or 'secondly' or 'on the other hand' or 'in conclusion' and others. Then put

sequential numbers by the first list in a way that organizes or makes sense of them.

I use this technique to invent my products. I teach other inventors to do it too.

When I use this technique it usually gives me the 'connections' that I am looking

for, that will make something work...that will make a worthwhile invention."

Lucille invented the garden tool specially contoured to fit a woman's hand. She stated:

"My husband has a blacksmith shop. I showed him what I needed and asked him to

make a garden tool to fit my hand. I was having a lot of arm pain...I have carpel

tunnel syndrome...and needed a tool which was designed in a way which would

relieve the pressure on my forearms. The device works so well that we are selling

them as fast as we can make them."

Summary of Category #2

Responses from this group of individuals clearly showed a preference for "hands-

on", "learner-centered", "experiential" learning which had "personal relevance". Whether

the educational experience was in a formal or an informal setting, creative women

inventors agreed that they would rather have someone show them how to do something

and then let them do it.

Additionally, several of the inventors described the development of their

inventions. This was included in Category #2 because all the inventions were meaningful

and had relevance to the woman inventor's life. They all fulfilled a perceived need.

Several participants expressed the feeling of not having had the opportunity to

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"show" their creativity in educational settings and used these examples as stories which they believed hindered their creativity. Whether in formal or informal educational settings, all participants said their creativity was impacted in a positive way in classes that were student oriented and gave opportunities for them to learn by doing. Likewise, in both formal and informal educational settings, all participants who said their creativity was impacted in a negative way gave examples of experiences which did not allow for opportunities for self-expression and which were not oriented toward allowing them to learn by doing.

Category #3

Learning experiences that contributed to these women's creativity tended to be both cooperative and self-directed.

There seemed to be no strong preference of women inventors for working alone in a self-directed situation or in cooperation with others. Invariably, most said they prefer working in groups, but added that when doing a creative project, especially at the earliest stages, it is often necessary to work alone. Considering that these women are all inventors and this research dealt with how they felt that education had impacted their creativity, many of the responses were in reference to their inventing. Several stated that when an inventor gets that first idea, it is necessary to work alone because nobody else "sees it" yet.

For example Beth said that she preferred cooperative learning and excitedly told of

an experience in the sixth grade in which the teacher made the entire class feel special. She

reported:

"I prefer group work...class participation where you are made to feel intelligent

rather than embarrassed...by special teachers."

Beth also gave an example of a negative experience which allowed no cooperative learning

or self-direction. The instructor gave her no opportunities to think for herself. She shared:

"The experience I recall was a very bad experience where our job trainer used her

power to belittle you in any way. She had a military style. Your thinking was not

tolerated. You were to wait for instructions. You learned quickly not to ask

questions. And no creativity or original thinking was allowed or tolerated."

Catherine, who is today a successful entrepreneur and artist said she preferred working

alone sometimes and working in collaboration at other times. She said:

"In art, certain things must be done alone, drawing and sketching, for

instance, but it's always more fun to work in groups. For instance when a bunch of

us kids in high school would go to downtown Madrid to the museums and art

galleries....then we would sit on the grass and sketch and give the pictures to local

people who were passing by...that was a way to communicate with the local

people. That was more fun than going alone would be, but actually any artist must

work alone when doing the actual art."

Diane described how she works best alone. She stated:

> "Because of my dyslexia, I was given private art lessons all year round. My parents encouraged it because it was something I could do well. I got to work at my own pace, with one-on-one instruction. I do much better this way than in a group."

Elizabeth shared:

> "Learning one-on-one works best for me. I usually learn by doing. I do not like to read manuals and follow step-by-step verbal instructions. I need someone to show me how to do it, like for instance, learning to crochet and macrame. I was shown how to do a sampler piece and then, on my own, I went on to a huge complex project. So I learn best from others, yet I prefer working alone or with one other person."

Geraldine, who labels herself as self-directed, expressed her preference for learning using home videos. This is an example of flexibility. She looked at her problem or situation from many different angles until she found a learning system which let her work at her own pace. She stated:

> "I saw an infomercial and sent away for the tapes. This way I can go through them at my own speed. I am dyslexic. I am very, very slow. I can't learn something in a classroom where the teacher is teaching the group."

Hannah, who invented the static resistant lab coat material, said she preferred both cooperative learning settings and self-directed learning. She asserted:

> "I enjoy the encouragement you get (and give) when working with people. But take my invention for instance, I dreamed that solution after listening to two

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customers complain about things that annoyed them in the lab. One thing was that

even a minute amount of static electricity could ruin an experiment in an

electronics lab. I was exhausted that night and fell asleep and dreamed the entire

formula for the product, which is now selling world-wide. I immediately jumped   up

from the dream and went to my lab and made one."

Irene, who is a chemical engineer, said she preferred to work alone. She reported:

"Once I took a class and asked the professor if I could just take one test, and if I

passed it, pass the course. I worked with a tutor for a couple of weeks but found I

could learn the material on my own without the tutor. The most important thing

the tutor taught me was the concept of synthesis."

She also stated:

"It is no accident that artists have a lot of solitude. You have to give [self-

directed] people solitude...some time to think...there must be time given for

production of ideas and problem solving."

Jan said that she worked alone because nobody paid any attention to what she did anyway.

Katy shared a glowing story of a cooperative learning experience. She recalled:

"My best example of when education impacted my creativity was in a

summer school class. Everyone in that class encouraged each other. We had a sort

of bond, it was really great. Everyone in the class loved it. I wish all classes could

have been like that. But it was the only experience like that I've ever had in formal

education."

Regarding working alone, Katy stated:

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"I enjoy working with people more than working alone, but sometimes an

inventor has to work alone, because she or he is the only one who "sees" it. Then

after the initial alone period, I always prefer input from others."

Lucille described herself as someone who prefers to be self-directed. She said:

"I was and still am better at working alone in creating. I have learned to rely on

myself to solve problems from within and discover new ways to think about

problems. I spend a lot of time alone where it's quiet and where I can think without

distraction."

Mary Jo, whose experience related to a photography class she took, described how

working alone was necessary some of the time. She said:

"In photography class, we all ultimately have to do our own work."

When asked about other areas of her learning besides photography, she stated:

"Although I would have to say there is a time for both, usually I prefer to work

with others. But times such as when I'm taking photographs, I like the solitude of working

alone."

Summary of Category #3

It seems that most of these women inventors required some solitude in their work,

some self-directedness, some time for incubation and reflection, especially during the

initial stages of the creative process. Even so, most of them stated that they preferred to

work with others. Research from recent studies (Kerr, 1994) presents evidence that

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women prefer collaborative interaction. The data from this study also supports this research and adds another dimension to the perspective that women prefer to work collaboratively. It adds the dimension of women having original ideas which stem from self-directed learning and creativity.

Generally, the participants contended that when a person is engaged in the initial stages of the creative process much work has to be done alone. After the idea is created, many of these inventors expressed the desire to share the work of bringing the idea to fruition. Many indicated that an important aspect of their inventing was the desire the share the results with significant others. This seems to support Torrance's (1965) contention that communicating the results is part of the creative process.

Category #4

Learning experiences that contributed to these women's creativity tended to be facilitated by a nurturing teacher who role modeled creativity.

Category #4 suggested that nurturing teachers who role model creativity can make significant differences in the life of a girl or a woman. The responses by the women inventors gave examples of adult educators, on-the-job trainers, public school teachers from second grade through high school, and college teachers who were role models that positively impacted the participants' creativity. Their other teachers either were not remembered at all or were remembered as causing a negative impact on creativity. It is important to note that no specific questions were asked about teachers. Information

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grouped into this category was gathered from the stories told.

Alexa, the woman who struggled with reading said it was a creative teacher who taught her to speed read. She shared this about a caring teacher who taught her to read:

"I think that if a teacher will take the time to spend with a student and show her she cares, that student is going to learn. We all need encouragement."

Beth described an experience in elementary school with a creative teacher. She reported:

"A teacher in 6th grade encouraged us and made us feel so intelligent. Everything she did was different. It was her, not formal education, that impacted my creativity. She let us do creative projects and didn't count off for neatness or for bad art (I am not artistic at all). She let us use our imaginations and encouraged us to envision possible futures. I loved it."

She then related a story of informal education which greatly impacted her creativity in a negative way. The story was of a supervisor at the hospital where she worked as an anestheologist nurse. She recalled:

"This so-called instructor totally hindered my mind in every way, my creativity was nearly lost and my life was nearly ruined due to this selfish, power-hungry, evil woman."

Elizabeth described an aunt who helped her creativity by introducing her to the Chicago world of textiles at an early age:

"My aunt, who was employed as a blouse designer in Chicago, took a great deal of individual interest in me. She took time with me and taught me, step by step, how to sew. She encouraged me and also taught me to visualize the finished product before I even started."

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These women were consistent in sharing that, whether in formal or informal educational settings, a teacher or instructor (or significant other such as an aunt) who is nurturing can have a major positive impact on one's creativity.

Jan related an experience about a teacher whom she feels role-modeled creativity. She stated:

> "One teacher made his class memorable for me in a pleasant way. He was non-judgemental, kind, open, accepting, encouraging, gentle and fun. He was non-threatening. He provided an opportunity in his class for expression, he allowed us to choose our own form of expression, ie. humor, lecture, acting, whatever."

Jan talked about nurturing and how she has longed for encouragement and nurturing. She suggested that nurturing plays a big role in women receiving patents and becoming more creative. She declared:

> "Women will have more patents when they have more encouragement, understanding and acceptance."

Jan also described how in another art class in school, the teacher nearly ruined her creativity. She recalled:

> "I only remember this art teacher because she was so dull. She gave no opportunities in her class for individual expression. She was obviously uninterested in me, and this made me feel threatened, that is, invisible and unimportant. It's amazing how much power teachers have."

Teachers who were seen as strict, non-creative, non-caring individuals were associated with experiences in education that were seen as hindering creativity. Katy described a

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good experience with a teacher who was caring and role-modeled creativity. She stated:

> "This teacher had the ability to inspire and electrify his students. His style was fluid
> and free as I recall. Whenever Mr. Jackson would see one of us struggling, he
> would start saying stuff like 'come on' and 'you can do it'."

Lucille told a story of a teacher in college that hurt her desire to learn more. She said she
would never take another college class because she felt it was a waste of time and money.
She could find out what she needed to know from books and magazines. She suggested
that expectations are important:

> "In school if I was challenged by a teacher to do my best, I would. In college I had
> one teacher that never challenged his students at all. He never pushed us to do our
> best. If anything, this hindered my creativity. It certainly didn't make me want to
> excel or strive to learn anything."

Mary Jo described the special teacher in her photography class. She recalled:

> "The important quality of this photography teacher was her ability to draw out the
> best in her students. She encouraged us to strive to make our pictures really
> special."

Mary Jo then told a story of informal education which she perceived to have hindered her
creativity because of the teacher, which in this story, was her mother:

> "The story that immediately comes to mind is when I was making a cloth doll with
> my mother. She had to go out for a time. While she was gone I put a face on the
> doll myself with a crayon. When mother returned she was NOT pleased. She had
> envisioned that the face would have been embroidered. People with preconceived

ideas of exactly what they want, tell you you're free to be creative and never communicate their wishes or expectations. This can severely hinder your creativity."

Mary Jo went on to say:

"On my Torrance test score, my lowest area was originality. In the description of originality Torrance said that original thinkers must often face skepticism and ridicule. I think this is true and the experience I had early on with my mother may have affected my originality by making me fearful of being original."

She then added:

"Teachers should always be respectful of unusual ideas or alternatives."

Beth, who had an extremely negative experience with a teacher, stated:

"Teachers can destroy learning in persons. Perhaps teachers could be made to take personality tests especially on flexibility and nurturing, before being allowed in any type situation where they are dealing with good minds; before being allowed into certain fields or positions. Let them work alone or with a machine!"

Summary of Category #4

There seemed to be consensus among the women inventors that teachers who cared, who encouraged and who took a special interest in their students [were nurturing], were more likely to be good teachers and be seen as creative role-models. While there is no way to determine if these teachers were actually creative or not, the participants

reported that teachers who served as positive role models were accepting and not threatened by the creativity in their students. They actually encouraged creativity, even if they felt they were not creative themselves. This is to say they encouraged the student's fluency (finding many options to problems), their flexibility (allowing students to explore problems from different aspects and angles), their originality (respecting new ideas) and their elaboration (they let students carry out their ideas and elaborate on them until the student reaches satisfaction).

Several participants stated that if it had not been for a specific teacher, they probably never would have become an inventor. Interestingly, very few of these female inventors could recall more than one teacher who they felt role-modeled creativity. Yet even if only one instance was recalled, it was told to the interviewer as a story of an educational experience which helped her creativity. Conversely, the few participants who told stories of experiences which hindered their creativity blamed the episode on the teacher or the instructor. Clearly the facilitator who was nurturing and role-modeled creativity was perceived as the most important aspect of education to these women inventors.

Category 5

Women inventors had some definite ideas about how education could promote creativity and therefore increase the self-esteem and improve the self-concept of women.

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After telling the two stories of education requested by the investigator, the women inventors were asked what they thought that education could do to increase creativity in girls and women. Nothing was asked specifically about self-esteem, yet the topic of self-esteem kept recurring in response to the question regarding how educators could "help" creativity. Here are some of their responses.

Catherine suggested:

> "I think schools need to have more creative time. An ironic situation is that my daughter who is very talented and artistic, got identified as gifted, but in order to be in the gifted class she has to give up either music or art. By the time you get all the college prep courses in, the things that get thrown out are music, art and theater. I think this is regrettable because I think that is one thing where women probably excel better than the boys, because it doesn't take stamina or brute force or this engineering and math capability that boys are supposed to be better at. Music and art give girls an opportunity to show their creative side and that bolsters their self-esteem and it puts the recognition back on a more equal basis."

Diane suggested that the language we use is important and represents our self-concept. She stated:

> "I was thinking that teachers could catch female students using self-defeating language such as starting a sentence with 'I don't know' or 'This didn't turn out the way I wanted it to' or 'Oh my house is a mess'. The teacher could catch them and teach them to re-phrase the statement and instead say something like 'at this point there are a lot of options' or 'I'm confused at this point'."

Elizabeth suggested:

> "The most important thing is self-esteem. Women don't have self-esteem or confidence like men do. We feel intimidated. At least I did in education. I wish women had more hands-on activities which give us opportunities to show our creativity."

She then elaborated about her daughter who is a corporate woman:

> "I would suggest self-esteem classes for women...even in corporations. Corporate women are being suppressed. Companies like IBM suppress creativity by not catering to women. I know a lot of corporate women who need confidence. I think every women needs a formal education class in confidence. I know I still do."

Elizabeth said her self-concept was damaged for life because of an experience in elementary school. She explained:

> "Throughout my life I've always had a fear of putting myself out in front of people. I went into hairdressing as a career. I could have done more but I had no self-confidence."

She also remarked:

> "It feels good knowing that I scored high on the creativity test. I was afraid to get my scores back really. I guess I was afraid that I would fall into the average range."

Geraldine related a positive example of how her self-esteem was encouraged in education:

> "In fifth grade, this teacher told my parents that I had a wild imagination. The way she said it made me feel good. I think I have let my imagination run wild after that

time. That teacher encouraged me by making me feel that having a wild imagination was something to be proud of."

Geraldine continued:

> "My brain is still on high power, my friend says 'my god your mind is going CONSTANTLY' because my brain is coming up with new ideas constantly. I keep a notebook by my bed because my brain is always on high power. I can be asleep and think of something and wake up and jot it down."

Hannah expressed:

> "Girls should be given extra encouragement. And they should be told there is nothing that they cannot do. That's the message I got from my folks so strongly, that I didn't get from the education."

Irene's shared an experience she had in organized sports where she got a lot of good self-esteem from her ability to pitch hard. It really made her angry when the coach asked her to pitch softly to girls. She felt the coach was asking her to give less than her best and was trying to take from her the only thing she claimed to do well. She stated:

> "My dad played with us in the back yard...you know since he didn't have boys he played rough and tumble with us girls. At school I wasn't allowed to play with the boys at recess so I pitched the ball hard to the girls. That pitching was really important to my self esteem because it was something I could control. I could make the decisions about what kind of pitch to throw and could strive to master it. I think this experience was extremely detrimental to my creativity because of the mindset which rewards girls for continuing with the status quo. Girls don't

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compete in other words. I wasn't worried about the other girls 'feelings'. If I could get a

no-hitter I would. I wasn't there to hurt them, but I wasn't going to throw   soft either."

Irene then expressed how competition was very important to women and without it

women could not excel. However, the competition she spoke of was different. She related:

> "Stepping on another person was never a motivation for me to win. Creativity
>
> could be encouraged in girls by acknowledging the natural ways in which girls are
>
> competitive. I don't think women compete with the thought of putting the other
>
> person down."

She went on to say:

> "Only a few women are willing to invent or do other creative things when it
>
> continues to require such a price [putting the other person down, ie. making them
>
> losers, rather than just competing for the sake of winning and perfecting one's
>
> skill]."

Irene then spoke about how women are the caretakers of the world and aren't taught that

they need time alone to develop their own self-concept. She suggested:

> "I think all people have to be given some solitude...some time to think. There must
>
> be time given for production of ideas and problem solving. I don't think schools are
>
> teaching this. And I think girls in particular need this."

Jan, who had the extremely high creativity score but no educational encouragement,

suggested:

> "When women get more respect they will feel better about pursuing their ideas into
>
> completion. Even when a man is considered a kook or an eccentric, he gets more

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respect. Praise for a job well done. Respect. Recognition. Feeling special. These things are important to our self concept. I believe that through education and encouragement, you get self esteem which assists you in achieving your goals, which is a way to increase your self-worth."

Katy expressed the belief that the teacher is most responsible for the student's self-esteem. She described an experience she had:

"I had one great teacher who caused all of his students to excel. We all felt special. He drew out the best in everyone. He made me feel good about myself. He made me realize that I could do anything."

Katy continued to describe working with other inventors:

"Brainstorming is good, but the real trick is to discover where you need to go or the direction you need to pursue with the idea. I tell new inventors this when I am advising and encouraging someone. People just get my name here and there from somebody out of the blue and call me up to ask questions. I believe it helps my self confidence every time I get to help another struggling inventor."

Lucille described a classroom where girls are made to compete with boys. She declared:

"I think girls should not be catered to exactly, but should have more attention paid to them than they do now. In school if a boy raised his hand at the same time as the girl, he is picked to answer the question. Girls tend to be shy, teachers have to coax them out, but it would be worthwhile. Girls aren't so shy alone, but put boys in there and the girls clam up. Girls don't want to compete with the boys. They don't want to look silly. So if a teacher would encourage a girl even though her

hand's not up...you know teachers have an idea of who knows what, if girls were

given the opportunity to answer questions I believe that would help."

Mary Jo, the inventor who drew the face on the doll in crayon at age six much to the

dismay of her mother, stated that early criticism of her creative ability may have damaged

her self-esteem. She alluded that this trend continues to haunt her and makes her feel self-

doubt. She stated:

> "The same pattern of being told to create as you wish and then have the results
>
> rejected or redone as unsatisfactory can re-occur in many areas of everyday
>
> life...writing a memo, creating a menu for a group meal, designing a poster for a
>
> meeting, just anything. I'm not referring to normal corrections or suggestions, I
>
> mean total do-overs that make you doubt yourself. Personally I'm very sensitive to
>
> this."

Summary of Category #5

Most of the examples given by the participants regarding what education could do

to increase creativity in girls or women related to increasing self-esteem. The question

asked by the interviewer did not use the word self-esteem, nor did the interviewer ask

specifically about self-esteem, yet it became a strong recurring theme. In order to provide

an equal education to girls, these inventors recommended building their self-esteem,

providing more time for creative activities and encouraging their excellence.

Category #6

Women inventors consistently indicated that gender discrimination hindered their
creativity.

The topic of discrimination was not brought up by the investigator in the interview.

When mentioned, it emerged as part of the story being told by the participant. In every

example or story which had a discrimination aspect, it was perceived by the woman

inventor to be a gender issue. It is interesting and heartening to note that the one African

American woman, Hannah, did not mention race as being an issue of any kind. However,

she suggested that her math abilities were ignored in school because she was a girl and

girls weren't supposed to be good in math.

Regarding her career as a photographer and the issue of gender discrimination,

Diane stated:

"Women have to prove themselves longer. Women are just not as quick to get the

recognition. Sometimes I think you have to re-prove yourself over and over. You

have to prove you are going to be there over the long haul."

Diane continued:

" I don't think women are discriminated against persay, but I teach at a university

and I think we are more like slightly overlooked or not taken as seriously. Put it

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this way, I've had to work longer and more consistently than I believe a man would have had to work, to get the respect I deserve."

Elizabeth shared the discrimination she felt as a woman in business. She stated:

"Women can do anything, but they are not in the positions of power. Women just aren't expected to excel like men are."

Geraldine described her experience in trying to get a start-up loan for her business. She declared:

"A lot of guys think that a woman can't do anything. When I went for a business loan out of seven of us, four were granted....to the men. Two women and I were turned down. The banker slipped and said 'only the guys made it' meaning that he didn't give loans to women."

Geraldine continued:

"I find it a lot harder to run a business as a woman. Everywhere I go they look at women as nothing. We aren't taken seriously, or haven't you noticed? If a man had invented this it would already have been on the market. I think women also have a harder time finding manufacturing and marketing."

Irene shared her experience of discrimination in school sports. She explained:

"The gym teacher had the mindset which rewarded girls for continuing with the status quo."

Irene continued:

"Another thing...people are very much wrong if they think girls aren't competitive. Just listen to teenage girls conversations about who is doing what with boys,

clothes, vacations, you name it. Girls as a group are generally seen not to have any natural inclinations to competition. This is not true! Girls should be taught, not differently than the boys, but acknowledging the competitive ways that appears to be girls natural inclination...and should have that connection between competition and creativity encouraged. I just feel that being encouraged to compete is just as important to girls."

Jan described what her life has been like. She felt she was always discriminated against because she was "only" a girl. Jan explained that no matter how hard she strived, she was never taken seriously. She shared:

"I was teased by my brothers, told I was chubby and dumb. I was always the butt of family jokes and I was considered kooky and flaky even though I was an honor roll student. Even when a man is considered a kook or an eccentric, he gets more respect in my opinion, than a woman in similar circumstance."

Lucille, who now teaches college art classes, remembered her school experience as being one in which women were discriminated against. She expressed this by saying:

"If a boy raised his hand at the same time as a girl, invariably he was called on to answer the question. I guess there was some sort of understanding that women were to get married and have children, they didn't need creativity."

Lucille continued:

"Before I went to art school I was told to just go by initials and I would probably be ok because I paint like a man. It was like, you will be taken seriously if they think you are a man."

Seven of the thirteen women brought up the topic of gender discrimination in the stories they told regarding their experiences in education. Teachers need to praise females for working cooperatively and sharing leadership roles which are their natural strengths (Vandell & Fishbein, 1990).

One gender inequitable situation mentioned by several women inventors was their lack of training in mechanical abilities. Even though they may have shown an interest or aptitude in mechanics, there was no opportunity in school for women to learn.

Chapter Summary

A description of the sample, analysis of the data, and findings of the study were presented in this chapter. A descriptive analysis of the sample, provided the following information: The sample that responded to the creativity test consisted of 37 women inventors who obtained utility patents in the year 1995. Their ages ranged from 21 to 80 and above. The vast majority of the sample were Caucasian. Sixty percent of the participants ranged from having some college to having PhD's. Only one inventor did not receive a diploma or GED.

The creativity instrument used in this study (*BD-TTCT*) identified 85% of the women inventors as being above the norm. Additionally, the norm mean score for the *BD-TTCT* was 50.10, yet the mean score of the women inventors was 95.27.

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In the qualitative phase of the research, more specifically in research question #2, these 37 women inventors were asked to participate in a continuation of the study. All thirty-seven inventors were mailed a request with the two questions and definitions. They were asked to return the form with their phone numbers so the interview could be arranged and conducted over the telephone. Thirteen women responded to this request to be interviewed, using the in-depth interviewing technique, the *Behavioral Event Interview (BEI).*

The *BEI* was conducted to determine the extent to which formal and informal education were perceived to have impacted the creativity of these women. The women were asked to relate two true stories of their educational experiences, one story from an experience in formal education and one story from an experience in informal education, which they felt impacted their creativity. (Impacted was defined as helped or hindered.)

The thirteen women inventors who ultimately participated in the study responded to the interviewer with their stories of formal and informal educational experiences which they felt impacted their creativity. The findings in general were consistent with the literature. The women preferred to work in less structured environments, both in formal and informal learning settings. They desired more opportunities to learn hands-on techniques for solving meaningful problems. They needed time alone to create but also expressed a desire for emotional support from others of significance. Even though they consider themselves to be self-directed, they tend to prefer working collaboratively on projects.

Teachers were seen as the most influential people to impact creativity in education.

Several women could remember only one teacher who impacted their creativity for the better, yet the impact of that one significant teacher who encouraged, nurtured, supported, and cared about them, was recalled again and again as having made a significant impact on their creativity as well as making a difference in their lives. Conversely those who remembered teachers who were harsh or did not seem to love teaching or care about their students, only caused the women in this study to hate school more.

Women inventors felt that education had not prepared them "emotionally". Repeatedly the women mentioned that self-esteem and self-confidence were critically important to girls. They suggested repeatedly that schools should strive to instill self-esteem and provide specific opportunities for creative expression in young women.

Finally, the topic of gender discrimination was not initiated by the interviewer. Yet over half of the women in this study brought up this topic and gave examples of how they felt they had been discriminated against because of their female gender.

"We must combine our voices and encourage one another to become the

powerful and successful women that we have the potential to be."

Helene Lerner-Robbins (1996, p. 116)

CHAPTER FIVE

SUMMARY, CONCLUSIONS, & RECOMMENDATIONS

The first section of this chapter contains a summary of the study. The second

section focuses on a presentation of implications for education. The third section focuses

on recommendations for adult education. The fourth section focuses on recommendations

for further research.

Summary of the Study

Statement of the problem

There is considerable empirical evidence which suggests that formal, as well as

informal education, may neither have fully met the needs of women nor promoted

creativity through the teaching/learning process. Further, there appears in the literature the

realization that there is a lack of a deep understanding of how formal and informal

education has impacted the creativity of women. This is problematic not only for reasons

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of gender equity but also because there is a need to develop creativity among women in order for them to be successful in the emerging postindustrial workplace and society.

The Sample

The sample was a group of women inventors who had patented an invention in the year 1995. Information was obtained on the sample from the U.S. Patent & Trademark Office.

For the quantitative portion of the study - Research Question #1, the sample consisted of 37 women who returned completed creativity tests and demographics information forms. There were 36 Caucasian women and 1 African-American woman. The mean age of the sample was 46.6. Fifty-seven percent had completed some college studies.

For the qualitative portion of the study - Research Question #2, the sample consisted of 13 of the original 37 women. Thirteen women inventors volunteered to continue with an in-depth interview. Twelve of the thirteen women were Caucasian, one was African-American. The mean age of the sample (N=13) was 48. Sixty-two percent had complete some college studies.

Instrumentation

In this study, the creative thinking of 37 women inventors was measured using the *Brief Demonstrator-Torrance Tests of Creative Thinking (BD-TTCT)*. Of these 37 women inventors, 13 agreed to be interviewed using an in-depth interview technique known as *Behavioral Event Interviewing (BEI)*.

Data Collection

Data was collected by first obtaining a mailing list from the U.S. Patent Office (Appendix 1) and mailing packets to randomly selected women, who received utility patents in the year 1995. Three hundred women inventors received a packet with a copy of the creativity test, a letter requesting their participation in a project on women inventors, a consent form and a demographics/ education information sheet. Thirty-seven women inventors returned the packet with a completed creativity test (*BD-TTCT*).

The 37 respondents were again contacted by letter as there was no way to obtain their telephone numbers. They were thanked and asked to continue to participate in the study and be interviewed over the telephone. All 37 were asked to complete a short form and return it in the enclosed stamped envelope. This form gave me their phone numbers and a time to call to set up the interview. The letter explained what questions would be asked and gave definitions of terms such as "impact their creativity" and "formal and informal education." They were also sent their creativity test scores with a brief explanation and comparison with norms scores at this time (See Appendix C).

Thirteen women ultimately volunteered to continue with the study and be interviewed. The interviews with these 13 women were conducted in order to determine both formal and informal educational experiences and how these experiences impacted their creativity.

Findings

Question #1: To what extent do women inventors demonstrate creativity as measured by

the *Brief Demonstrator - Torrance Tests of Creative Thinking*?

Creativity of Women Inventors (N=37)

Eighty-five percent (85%) of the women inventors in this study demonstrated

above average to very high creativity as measured by the *BD-TTCT*. Results of the

creativity tests suggest that women inventors, as defined by their holding a utility patent,

are in fact creative. Therefore the *BD-TTCT* seemed to be an effective self-administered

instrument for verifying creativity in women who invent.

Creativity of Women Inventors (N=13)

Results of the creativity scores of the thirteen women inventors who continued on

with the interview portion of this study showed that eleven out of thirteen women

inventors (85%) scored from above norms average to the very high norms range. Five of

these scores (38%) were well above the very high norms range.

Question #2: How has formal and informal education been perceived by women inventors

to have impacted their creativity?

The second purpose of this study was to develop a deeper understanding of how

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formal and informal education has impacted (ie. helped or hindered) the creativity of women inventors. Specifically, the qualitative aspect of this study reported the thoughts, feelings and behaviors of the thirteen women inventors, in the context of formal and informal education.

Results of the *Behavioral Event Interviews (BEI's)* were coded into six descriptive categories which emerged from the stories. These categories are:

Category #1 - Learning experiences that contributed to these women's creativity tended to occur in less structured environments regardless of whether the educational setting was formal or informal.

Category #2 - Most learning experiences that contributed to these women's creativity tended to be hands-on experiences that were meaningful to their everyday lives.

Category #3 - Learning experiences that contributed to these women's creativity tended to be both cooperative and self-directed.

Category #4 - Learning experiences that contributed to these women's creativity tended to be facilitated by a nurturing teacher who role modeled creativity.

Category #5 -Women inventors had some definite ideas about how education could promote creativity and therefore increase self-esteem and improve the self-concept of women.

Category #6 - Women inventors consistently indicated that gender discrimination hindered their creativity.

Implications For Education

One implication is that there exists a gender bias in basic educational philosophy.

Gender bias is occurring in education (Gilligan, 1993; AAUW, 1995). This means

that education is not doing enough to ensure epistimological equity. As long as women are

excluded from the subject matter in education; for example in scientific theories, historical

narratives, and literary interpretations, there is no epistimological equality (Martin, 1994).

Even though throughout history women have reared and taught the young and have

themselves been educated, they are still excluded as both the subjects and objects of

educational thought from the standard texts and anthologies (Martin, 1994).

Plato's account of the education of women is in Book V of The Republic, yet many

texts and anthologies omit all references to Book V. Plato's proposal was for all who are

suited to rule should, regardless of sex, be given the same education. These texts are either

not mentioned or are distorted significantly (Pagano, 1994).

Piaget had an obvious bias which lead him to equate male development with child

development. He observed boys and girls at play. Girls, Piaget observed, had more

pragmatic attitudes toward rules and thus were more tolerant toward rules and more

willing to make exceptions and more easily reconciled to innovations. As a result, Piaget

concluded that the legal sense which he considered essential to moral development to be

far less developed in girls than in boys (Gilligan, 1994).

Another "father" of educational philosophy, Eric Erickson, admitted that his eight

stages were for males when he said that the sequence is a bit different for women. A

woman, according to Erickson, holds her identity in abeyance as she prepares to attract the man by whose name she will be known, by whose status she will be defined, the man who will rescue her from emptiness and loneliness by filling her inner space. Despite Erickson's observations of sex differences, his chart of life-cycle stages remains unchanged (Gilligan, 1994). Where are the "mothers" of educational philosophy?

Another implication is that girls are not encouraged in education.

Women have come a long way, but not nearly far enough. Over half the women in this study related an experience in which she felt she was discriminated against because of her gender. Recent research clearly shows women have not received equal opportunity in education (American Association of University Women Report, 1990; 1995) and young girls are now willing to stand up and file lawsuits against schools, in order to help change for the better.

Research consistently shows that girls are not expected to excel and are not encouraged in school as much as boys are. The American Association of University Women (1990, 1995) reported that girls face a pervasive bias against them from preschool through high school in textbooks, teachers, and tests. They further revealed that girls and boys are not treated equally in public schools and that girls and boys do not receive the same quality, or even quantity, of education. One of the key concerns that surfaced in these two studies by the AAUW was that girls seem to have low self-esteem, possibly due to education's treatment of them. The women in this study supported this assumption.

A third implication is that education contributes to low self-esteem in women.

Many of the women in this study admitted to having low self-esteem. Those who brought the issue up said that education could do a lot to increase the self-esteem of young girls by treating them equally in the classroom. Several women had very strong self-concepts who had strong women role-models in their families and were listened to and validated as a child.

Not labeling or pigeon-holing women into pre-determined slots, simply by virtue of their gender, will do a lot for helping women to have a positive self-concept. Several women in this study mentioned they were not happy with what they were made to do as kids. They wanted to do what the boys were doing, but were told they could not. This led to frustration and rebellion in at least two different instances. "Playing football is for boys only." "Throwing a softball too hard is not good." "Only boys are good in math." Statements like these (whether made directly or inferred) hurt girls' self-esteem and self-confidence.

When asked what education could do to promote creativity in women, responses focused on two general areas. First, decision makers in education should hire creative teachers who would nurture the creativity of their students. Second, education should better prepare women by offering them more opportunities to increase their self-esteem and self-confidence.

A fourth implication is that nurturing is very important to women's learning.

Women inventors in this study corroborated these findings by describing learning

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situations which were nurturing in nature as being those experiences which helped their creativity. Women in this study were unified in their belief that nurturing is a vital ingredient in women's learning.

Whether because of biological or sociological reasons, women seem to possess a unique power to nurture. This nurturing power can be used not only with loved ones and teaching our children, but also to build and lead teams in stressful everchanging work environments.

An example of progress.

An example of growing gender equity is in physical education. With the advent of Title IX, since 1972 it has been against the law to discriminate against women in school. Sports are currently taking advantage of the law and more opportunities are being provided women in this arena. Quiet recently, probably due to the success of women in the 1996 Olympics, women's sports has begun experiencing tremendous growth. Suddenly strong looking, female role models are appearing on primetime television, in commercials, as sports heros, coaches, sportscasters, sports analysts and general managers. This may ultimately help women reach equality more quickly than anything else.

Rebecca Lobo (July 5, 1997), the Olympic basketball star, now playing for the New York Liberty was recently interviewed on television. She said:

"Teachers told me I wasn't supposed to play football and that I shouldn't try to act like a boy...my parents said I should do what I love.... and they bought me a football uniform. Now I play professional women's basketball for a living."

<u>One recommendation is that educators begin using Torrance's method of teaching.</u>

The women inventors in this study had a strong preference for teachers who role-model creativity. For teachers who wish to learning about becoming role-models for creativity, a good start would be to learn to use Torrance's three-step method. The book *The Incubation Model of Teaching* (Torrance & Safter, 1990) gives ideas and examples of lesson plans for teaching all ages, including college/adult classes, using the three step method: Before (Warm-up), During (Dig-in), and After(Going Beyond). Teachers who use this book can greatly enhance their effectiveness. Additionally the three-step Incubation Model works well in less structured environments which women in this study preferred.

Another book which offers interdisciplinary lesson plans for adults using Torrance's model is *Everyday Creativity* (Goff, 1997). Although Torrance and Goff (Goff is a protege' and follower of Torrance) have focused on creative learning rather than women's learning specifically, this method seems to be effective with teaching women. It provides opportunities to connect, to relate and share personal experiences which are relevant, in a hands-on way.

In The Republic of South Africa, Dr. Kobus Neethling, who is also a follower and student of Torrance, was appointed the National Director of Education right before Apartheid was abolished. He worked with Nelson Mandela directly to create smooth transitions. Dr. Neethling set up the new educational system of South Africa and has even

trained the military police and diplomats in the three stage incubation model developed by Torrance and referenced in this study. This model is a curriculum methodology which provides a structure for teaching subject matter creatively and can be used in less structured environments.

Another recommendation is for educators to develop an understanding of women's learning preferences and how these differ from men's learning preferences.

Landrum (1994) outlined the female approach to learning. She suggested that women prefer learning which incorporated negotiation, compassion and understanding. She also stated that the female focus is on personal relationships or relational learning. Women seem to do best in learning environments where forms of knowledge that come from life experiences are valued and where an effort is made by the teacher to relate theoretical concepts to real-life experience (Gardner, Dean & McKaig, 1989). Again, the Incubation Model is an excellent technique for relational learning because Step 3 of the model is building a connection between the subject matter presented and everyday life.

In general, women prefer the relational, hands-on methods of teaching. It appears that women learn better this way and that it does not hurt men to learn this way, in fact most actually prefer it. Numerous studies have been conducted indicating that many people, men and women, prefer creative ways of learning.

Research indicates that women's learning can be greatly enhanced by using creative, hands-on methods in the classroom. A colleague of mine teaches a class on this campus using Torrance's method. Reports from her students have been very positive.

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A third recommendation is for educators to consciously address gender equity issues in the classroom.

Gender equity must be consciously addressed, rather than dismissed as "there is no inequity in my classroom." All teachers do it. Even women teachers. We have had no other role-modeling. Teachers must strive to give equal time to women in class, to allow women to have experiential opportunities in which learning becomes relevant and relational, and allow for groupwork (Gilligan, 1991).

A fourth recommendation is for educators to create learning environments which are less structured and thus more conducive to women's learning styles.

Research shows that the environments favored by women are also conducive to learning in men. Men show no ill effects from learning in relational and connected settings, but benefit from the experience (Ochse 1990; 1991).

Adults have long been believed to be self-directed learners (Brookfield, 1982; Cross, 1988; Knowles, 1980). On the other hand, women have been reported consistently in the literature as being cooperative learners (Belenky, Clinchy, Goldberger and Tarule 1986; Gilligan, 1994). Reports from the women in this study support both findings; they preferred to be self-directed and also preferred to work in cooperative environments. This can be accomplished in a less structured educational environment. A less structured environment allows for flexibility in which a person may work alone or may collaborate with others, as the need arises.

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A fifth recommendation for adult educators is to give women learners opportunities for collaboration in the classroom.

Several women stated that by its very nature, inventing was something which had to be done alone until the initial concept or idea was born. Then cooperation is valued and often sought when pursing the details such as building the prototype, patenting the invention, marketing, and the like. Women may be naturally adept at using the skills of *inter-dependence* (Henderson, Presbury & Torrance, 1983), meaning in this case: women with complimentary but different strengths join forces and collaborate. According to Torrance (1983), rather than trying to be perfectly well-rounded, you should do what you love and what you can do well, and learn the skills of inter-dependence.

A sixth recommendation for educators is to make learning personally relevant to women; to make sure women understand how the learning relates to their experiences.

Women in this study were in complete agreement with current trends in progressive adult education which state that adults, regardless of gender, tend to prefer experiential learning which focuses on making learning relevant. Experiential learning does not totally exclude paper and pencil assignments, but it minimizes the use substantially.

Having the opportunity to experience hands-on learning was also consistently linked to self-esteem by women in this study. Women who had opportunities to experience hands-on learner-centered teaching reported higher self-confidence than those who just wished they had the experiential learning opportunities.

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Discussion

Nurturing teachers and very important.

Stories, which referred to a teacher as very nurturing, indicated that the teacher

had also been creative in their teaching. A teacher's care and nurturing was perceived by

women in this study, as being a critical issue in stories of positive impact. Teachers must

build relationships of care and trust (Noddings, 1995). Even if the woman had only one

nurturing teacher, this one experience was perceived to have made a significant positive

impact on her creativity.

Women prefer less structured learning environments.

Learning environments are rarely totally structured or totally unstructured. Most

learning environments fall somewhere along a continuum of structure. Teachers who make

these decisions have some constraints, yet it is possible to make even a formal educational

environment one which is less structured and conducive to exploration and discovery. It is

the environment that is unstructured enough to allow for creativity in the classroom, that

the women in this study appreciated.

Women suggested self-esteem classes specifically for them.

Many suggestions were made regarding "self-esteem classes" which were felt to be

something which would increase creativity. Some said self-esteem classes should be part

of the required curriculum for girls, while others added that there should be more

opportunities for girls to do hands-on manipulative learning with tools and equipment of various sorts. Being able to use equipment typically limited to males (saws, drills, lathes, etc.) would increase not only the self-worth of women who like to build or make things, but would give them an opportunity to express their creativity. It was also suggested that educational experiences should encourage girls to pursue more math and science.

Women have a desire to learn strong communication skills.

We need to let others know our talents, abilities and accomplishments, by learning to powerfully communicate our ideas (Lerner-Robbins, 1996). Traditionally it has been the man who speaks, in church for instance. Women may have never had any opportunity to claim this power.

Recommendations for Further Research

1. Even though the women in this study said that nurturing teachers are creative, there is a void in the literature linking the two. This is a potential area for study.

2. Based on these findings, further research could be conducted on the impact of different environments on learning.

3. More studies are needed on these concepts of self-esteem and education of women.

4. Research aimed at discovering ways that education could encourage powerful communication skills in women would be valuable.

5. More studies on women's creativity are always needed.

6. More research could be conducted using men, and the teaching techniques which women prefer.

7. The average age of women in this study was 46 years. Although a recent AAUW report (1995) indicated that schools are still shortchanging girls in the areas of self-esteem, academic achievement, and aspirations and career goals, it would be interesting to compare younger and older women to see how things have changed.

Conclusion

There are a multitude of options for study of gender differences and similarities relating to creative thinking, teaching, learning and problem solving. Results from this study indicate that women need more hands-on opportunities in education, in less structured settings, with plenty of nurturing and self-esteem building exercises. These women indicated a need for self-direction and collaboration in order to make use of their greatest strengths and to prepare them to successfully compete in the world.

This research indicates that teachers are extremely important variables in

education. The inventors felt that teachers who are nurturing and who use creative techniques make positive differences in learners. We still have progress to make before gender discrimination is totally eradicated from education but it is something that must be addressed and not ignored. Teachers are ultimately the ones to implement the techniques and provide the information needed to bring about gender equity.

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APPENDICES

APPENDIX A

LETTER TO PATENT OFFICE

To: Jim Hirabayshi
U.S. Patent Office
FAX: (703) 306-2737

From: Jamie McCracken
3824 N. Airport Lane
Stillwater, OK 74075
(405) 372-0810
(405) 377-5284

Written Request For Information

I am requesting that the following information be sent:

1. Report of independent women inventors who hold utility patents from the year 1995. Please include her name, address, patent#, and title of invention (D Base Format), at a cost of $50.00.

2. Please run these names on mailing labels in random order at a cost of $.70 per page.

I understand the cost of the report and output cost for labels to be roughly $100.00. Your invoice will be paid upon receipt.

Dear Mr. Hirabayshi,

As I told you on the phone, I am doing my doctoral dissertation on women who invent. I appreciate the information regarding the woman at the University of Minnesota who is doing research on women inventors as well. I will contact her when my research is complete. I hope you will ask her to contact me. Thank you.

Best wishes,

Jamie McCracken
Doctoral Student
Oklahoma State University

APPENDIX B

PACKET SENT TO WOMEN INVENTORS

Female Inventor Project

Date

Dear

      You have been chosen to be a part of a study on women inventors. Congratulations on receiving your patent! I am a doctoral student in Occupational and Adult Education at Oklahoma State University and also a fellow woman inventor. I am conducting research on women inventors and need this data for my dissertation.

      Since you are obviously a very creative woman, your help will be sincerely appreciated. It will only require a few minutes of your time. Please complete the enclosed demographic information sheet, sign the consent form and take the creativity test for me. Just read and follow the directions. I will be happy to send you the results with your creativity score if you would include a self-addressed envelope when returning the materials. All information is confidential and will only be shared with you, if you send the self-addressed envelope.
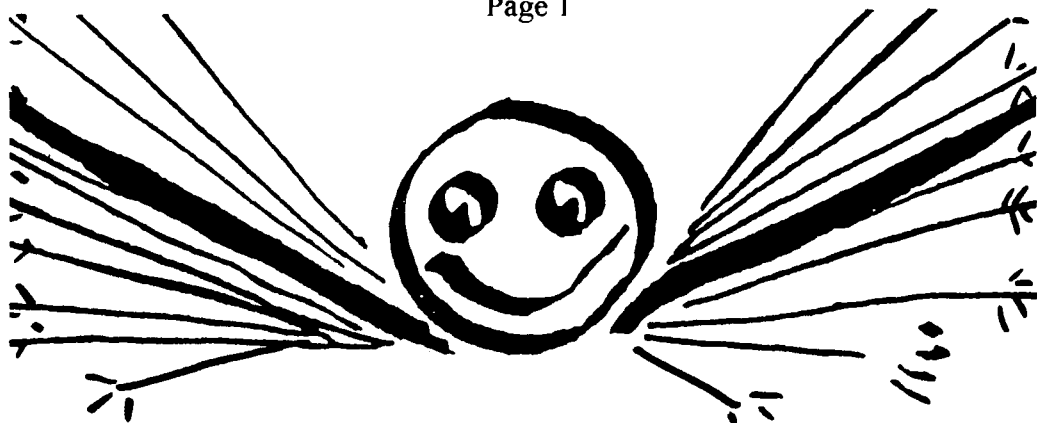
      As you probably know, studies of creative women are rare. So I sincerely hope you will take the creativity test and fill out the information sheets and return it all in the enclosed postage-paid envelope. Thank you very much for your help!

                    Best wishes,

                    Jamie McCracken, Inventor
                    3824 N. Airport Lane
                    Stillwater, Oklahoma 74075
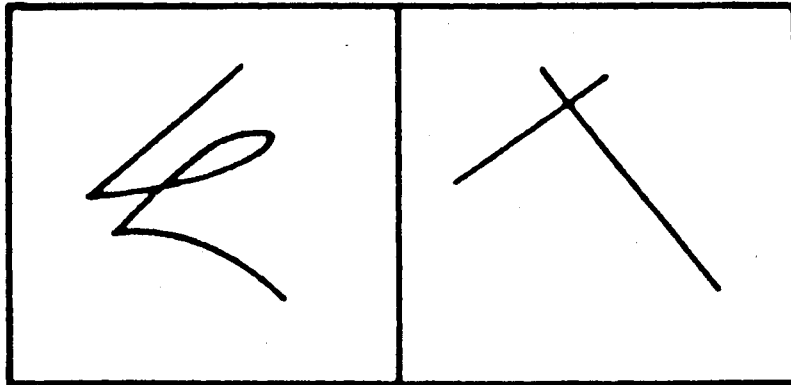   (405) 372-0810

Enclosures

JUST SUPPOSE you could walk on air or fly without being in an airplane or similar vehicle. What problems might this create? List as many as you can.

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

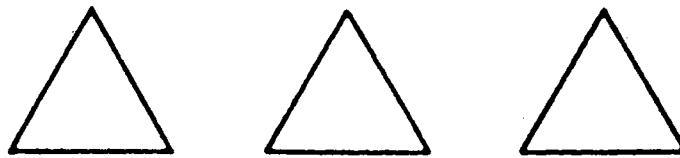7. _____

8. _____

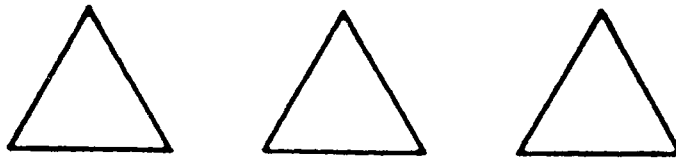9. _____

10. _____

Make some pictures from the incomplete figures below. Try to think of pictures that others will not think of. Make your pictures communicate as interesting and as complete a story as possible. Make up titles for your pictures.

See how many objects of pictures you can make from the triangles below just as you did with the incomplete figures above. Be sure to make up titles.

CONSENT FORM

I, _____, voluntarily agree to be in the study.

I understand that:

1) I will be asked to take the "Brief Demonstrator - Torrance Test of Creative Thinking".

2) I will also be asked complete an information and education questionnaire.

3) I understand that all information will be kept strictly confidential and my name will not be given out or used in any way.

4) I understand that no one will see any personal information on me, except the researcher.

5) I understand that if I want to see my creativity score, I may include a self-addressed envelope and the researcher will send me the results and THEN destroy information which would use my name in any way.

6) I know I don't have to be in the study and nothing at all will happen to me if I am not in the study.

7) I can call Dr. Jim Gregson at (405) 744-9200, if I want to know more about the study, or I can call Gay Clarkson, University Research Services, (405) 744-5700, or I may call the researcher Jamie McCracken directly, at (405) 372-0810.

I have read this form and choose to be in the study. I can ask questions now about the study if I don't understand.

Date:_____

Signature:_____

<u>Demographic / Educational Information Sheet</u>

Directions: Please check the appropriate box for each question.

1. Age

_____ 1-10   _____21-30   _____41-50   _____61-70   _____80+

_____11-20   _____31-40   _____51-60   _____71-80

2. Ethnicity

_____African/American   _____Hispanic

_____Asian/Pacific Islander   _____Native American

_____Caucasian   _____Other_____

3. Current Education Level

_____Grades 1-6   _____GED

_____Grades 7-12   _____High School Diploma

_____Bachelors (in what field?)_____

_____Masters (in what field?)_____

_____Doctorate (in what field?)_____

_____Other (please explain)_____

APPENDIX C

SECOND LETTER SENT TO REQUEST FURTHER PARTICIPATION

Date

Name
Address
City, State, Zip

Dear Ms._____

I would like to once again express my appreciation for your participation in my doctoral study on women who invent. In this final phase of the study, I would like to conduct a telephone interview with you that should take no longer than 30 minutes. From the information I collect during the interview, I would like to learn how you feel your educational experiences impacted, therefore helped or hindered, your creativity. Specifically, I would like for you to share with me two experiences or stories. One of these stories should focus on some experience you had in formal education (e.g., k-12, college, vocational-technical education), while the other story should focus on an experience you had in an informal setting (e.g., parenting, books, community education programs). This information should help to promote a deeper understanding of how women's creativity could be enhanced.

Enclosed are two additional sheets. One sheet contains additional information regarding the results of your creativity scores. I hope that you find it interesting and meaningful. It is a small token of my appreciation for your valuable contributions to this study.

The other enclosure is a form that I would like for you to complete so that we can arrange a good time for the telephone interview. I am asking you to complete this form as soon as possible so that we can finalize the best time for the interview to be conducted. I would like to have all the interviews conducted by the end of May so I need to schedule the interviews as soon as possible.

Again, I greatly appreciate you giving up some of your valuable time for this study. As another token of my appreciation, I would be more than happy to provide you a summary of this study in report form. If you would like a copy of this report, please indicate this on the Women Inventor Information Form. I look forward to receiving this information from you and speaking with you over the phone in the near future.

Sincerely,
Jamie McCracken
Doctoral Student in Occupational & Adult Education
Oklahoma State University

Description of Results of Your Creativity Test

(Comparing your score to average "norm" score)

       The Brief Torrance Tests of Creative Thinking (B-TTCT) measures four creative thinking (divergent thinking) skills: (1) fluency, (2) flexibility, (3) originality, and (4) elaboration. These four creative thinking abilities are described below:

       Fluency - Torrance (1979) identified fluency as the generation of multiple ideas, alternatives or solutions. There is considerable evidence that the more ideas we have the more likely we are to find a useful solution or answer. Brainstorming is an excellent technique for strengthening fluency, the imagination and communication skills (Torrance, 1979; Goff, 1991; Goff, 1992).

       Flexibility - Flexibility is the ability to look at situations or problems from different perspectives (Torrance, Wu, & Ando, 1980). Flexible thinking provides for shifts in thoughts, detours in thinking to include differing points of view, alternatives, approaches and perspectives of a situation.

       Originality - Originality is the ability to make due with what you have (Goff, 1992). Original ideas are often described as unique, wild, or unconventional. According to Torrance, (1995), original ideas are statistically infrequent because of the discomfort involved in being in a minority of one. Original thinkers must often face skepticism and ridicule. One way of facilitating originality is to be respectful of unusual ideas or alternatives (Torrance, 1995).

       Elaboration - Elaboration is the ability to embellish ideas with details. It involves planning what must be done, who will do each task, when, how, the cost, and other details needed to bring the idea to life (Torrance, 1979).

Your Creativity Scores:

Composite Score: Norms score:_____   Your score:_____
(Your overall creativity score)

Fluency Score: Norms score: _____   Your score:_____
Flexibility Score: Norms score:_____   Your score:_____
Originality Score: Norms score:_____   Your score:_____
Elaboration Score: Norms score:_____   Your score:_____

Note: the norms score is the average score. You can see if you have scored below average, average, above average or well above average. If you have scored low or high on an area, perhaps it is because of an educational experience you have had.

PLEASE RETURN THIS PAGE NOW

Women Inventor's Research Project

Name_____

Age_____

Phone_____

Name of
Invention_____

I agree to be interviewed by the researcher, Jamie McCracken, regarding one experience I have had in formal and one experience I have had in informal education and how I felt each impacted my creativity.   A good day and time to call me about setting up the interview would be:

Day of Week_____ Time of Day_____

Please send me a copy of the report_____

Thank you!

Jamie McCracken, Investigator
Women Inventor's Research Project
3824 N. Airport Lane
Stillwater, OK 74075
PHONE (405) 372-0810   FAX (405) 377-5284

APPENDIX D

COPY OF OKLAHOMA STATE UNIVERSITY I.R.B. FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 08-22-96   **IRB#:** ED-97-007

Proposal Title: A PSYCHOMETRIC EVALUATION OF THE TORRANCE TESTS OF CREATIVE THINKING FOR USE WITH ADULTS: A VALIDITY STUDY INVOLVING FEMALE INVENTORS.

Principal Investigator(s): James Gregson, Jamie McCracken

Reviewed and Processed as: Exempt

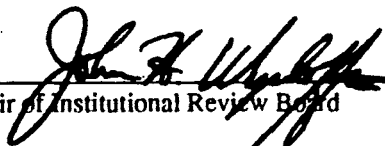**Approval Status Recommended by Reviewer(s):** Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: _____   Date: August 27, 1996
Chair of Institutional Review Board

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N

VITA

Jamie Louise McCracken

Candidate for the Degree of

Doctor of Education

Thesis: WOMEN WHO INVENT: EXAMINING THE IMPACT OF FORMAL
AND INFORMAL EDUCATION ON THEIR CREATIVITY

Major Field: Occupational and Adult Education

Biographical: Personal Data: Born in Stroud, Oklahoma, On October 22, 1954, the
daughter of Jim and Pauline McCracken.

Education: Graduated from Davenport High School, Davenport, Oklahoma in May 1972;
received Bachelor of Science degree in Elementary Education from Oklahoma
State University, Stillwater, Oklahoma in July 1976. Completed the requirements
for the Master of Science degree with a major in Applied Behavioral Studies in
Education at Oklahoma State University in December 1985. Completed the
requirements for the Educational Specialist degree with a major in Adult Education
at The University of Georgia, Athens, Georgia in May 1991. Completed the
requirements for the Doctor of Education degree from Oklahoma State University,
Stillwater, Oklahoma with a major in Occupational and Adult Education in
December 1997.

Experience: Raised on a farm near Davenport, Oklahoma; employed as an elementary
school teacher and school counselor from 1976 through 1985. From 1985 to 1991,
attended graduate school and worked as a graduate assistant at The University of
Georgia, Department of Educational Field Experiences. Have worked as an
entrepreneur inventing and marketing new products from 1991 to present.

Professional Memberships: Adult Education Research Association, Association of
Teachers of Creativity of American Colleges and Universities.