# The Effects of Gender Grouping and Learning Style on Student Curiosity in Modular Technology Education Laboratories

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## Abstract

This study investigated whether in a modular technology education (MTE) classroom, gender groupings and learning styles predicted degree of curiosity. Based on the assumption that gender grouping and learning style are factors that influence the degree of curiosity of both individuals and teams, it was hypothesized that a student's learning style (i.e., *Accommodating, Converging, Diverging*, and *Assimilating*) and gender grouping (*girl/girl, boy/boy,* and *girl/boy*) at the module would be essential elements to consider when measuring the degree of curiosity of learners in MTE classrooms.

During a meeting with the deputy superintendent and the technology education supervisor in a mid-sized, suburban public school district in Virginia, three MTE teachers from different schools were identified to participate in this study in the spring of 2004. The sample for this study consisted of middle school students (*n* = 116; 22 girls and 94 boys, grades 6–8) enrolled in technology

education classes using Synergistic Systems™ modules. Students completed three consecutive MTE activities. This study was conducted in the technology education classroom in three different middle schools. Schools were classified as School A, B or C. Students selected technology education as an elective subject.

Kolb's *Learning Style Inventory (LSI), Version 3* was used to identify students' preferred learning style. The *My Point of View* (MyPOV) instrument adapted by Brusic and based on Leherissey's instrument, the *State Epistemic Curiosity Scale* (SECS), was used to measure individual degree of curiosity. The MyPOV instrument was administered three times; once after each module. Data was analyzed using a multiple linear regression analysis.

Descriptive statistical analysis revealed that boys (81%; $n$ = 94) continue to outnumber girls (19%; $n$ = 22) in technology education classrooms. Participants ($n$ = 101) preferred the following learning styles as identified by the LSI: Accommodating (35%), learning from "hands-on" experience, followed by Diverging (25%), preferring to brainstorm ideas, Assimilating (24%), interested in abstract ideas and concepts, and Converging (17%), rather deal with technical tasks and problems.

Mean curiosity scores for students were analyzed by school. Results revealed scores from School B were lower than students at Schools A and C as measured by the MyPOV instrument. Mean curiosity scores for students were also analyzed by gender, learning style, and gender grouping. Statistics revealed that scores for girls were higher than boys. An independent-samples $t$-test was done to evaluate the difference between the means of the genders. According to the analyses, the tests were not significant, $t(108) = .932$, $p = .353$ (Score 1), $t(110) = 1.282$, $p = .202$ (Score 2), and $t(104) = 1.564$, $p = .121$ (Score 3).

Overall scores for girl/girl groupings were higher than girl/boy and boy/boy groupings, and scores for girl/boy groupings were higher than boy/boy groupings. A one-way analysis of variance was conducted to evaluate whether the gender grouping means differed significantly from each other. According to the analyses, the *F*-tests revealed no significant differences in gender groupings, $F(2, 97) = 1.65$, $p = .198$ (Score 1), $F(2, 95) = .50$, $p = .608$ (Score 2), and $F(2, 92) = 1.84$, $p = .165$ (Score 3). Additionally, curiosity scores for students by learning styles showed that participants that preferred to deal with technical tasks and problems or Converging had the highest scores followed by Assimilating, Accommodating and Diverging.

A multiple regression analysis was conducted to test if there was a significant relationship between the pairing of students of different gender groupings and different learning styles in the prediction of degree of curiosity. The *F*-tests revealed that the linear combination of gender groupings and learning styles for the three schools were not significantly related to degree of curiosity, $R^2 = .09$, adjusted $R^2 = .04$, $F(5, 86) = 1.65$, $p = .155$ (Score 1), $R^2 = .09$, adjusted $R^2 = .04$, $F(4, 79) = 1.84$ , $p = .130$ (Score 2), and $R^2 = .02$, adjusted $R^2 = -.03$, $F(4, 73) = .382$, $p = .821$ (Score 3). The *t*-tests analyses indicated that the Converging learning style, $t(79) = 2.06$, $p =.043$, in Score 2 was the only significant predictor variable with this sample. Although it seems that learning style and gender grouping might predict degree of curiosity in MTE laboratories, this assumption was not supported by this study.

# DEDICATION

This dissertation is dedicated to my family:

Parents: Helen & John King
John Porter, Sr.

Sisters: Kay & Marie
Brothers: Jr. & Mac

Nieces: Jordan, Asia, & Inde
Nephew: C.J.

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# Contents

# List of Figures

## List of Tables

# CHAPTER 1: INTRODUCTION

Throughout history, the major responsibility for schools has been to prepare students for the future. As educators have pursued this goal, they have developed different philosophies regarding how students learn. Dewey (1938) suggested that education prepares students to handle future responsibilities and be successful in life by acquiring knowledge and skills through instructional content. In Dewey's view, textbooks represent the wisdom of the past, while teachers are the keepers of order and the communicators of knowledge and skills – but most importantly, the glue through which pupils connect with the material. While Dewey's principles regarding students' learning abilities still prove pertinent, roles of today's educators are more diverse. Although teachers are still taxed with preparing their pupils for the future, no longer are their lessons confined to the textbook and the traditional classroom. Many must incorporate technological content into their curriculum.

The growth and development of technology continues revolutionizing our modes of communication and learning with no indication of slowing down (Wright & Lauda, 1993). In addition, it has the power to "extend the human potential for controlling and modifying" (Wright & Lauda, 1993, p. 3) virtually any environment. According to Wright and Lauda (1993), technology is "a body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made (modified) environment" (p. 3). In response to such unabated development and limitless potential, and to the fact that technology now pervades nearly every facet of our everyday lives, for better *and* for worse, modern educators must take steps to prepare future generations of students with the ability to understand and use technology. Technology education makes possible such preparation; it provides a formal framework within which students can develop and sharpen their abilities to use, manage, and understand technology (International Technology Education Association, 1996). Quite simply, technology education grounds them in the theories, principles, and practices that enable them to actively learn content in order to solve larger, and more far-reaching, technological problems.

Many educators have aggressively promoted technology education for grades K-12. However, due to academic requirements already in place or other mitigating factors, such as a lack of facilities or administrative support, many students still do not have the opportunity to enroll in such coursework. As a result, many students continue to graduate from high school literate in the traditional sense of the term, but highly illiterate with regard to technology. Consequently, the need still exists to nurture students with this knowledge base at each level of their educational experience so that “all . . . can be guaranteed a basic familiarity with technology and can be encouraged to think critically about technological issues” (Pearson & Young, 2002, p. 6).

Two complementary documents already have set the standard for developing a technologically literate population. The first, *Technology for All Americans: A Rationale and Structure for the Study of Technology* (International Technology Education Association, 1996), provides major tenets to assist educators in helping students become technologically literate and sets the foundation for the second document, *Standards for Technological Literacy* (International Technology Education Association, 2000), which defines what students should know and be able to do in order to be considered *technologically literate*. The 20 *Standards* that are the focus of the second work delineate proposed outcomes of a technology curriculum in grades K-12; they provide a consistent guide for educators and a framework they can use to develop individualized curricula and programs.

One event has helped bring the topic of technological literacy to the forefront of the national educational debate. On January 17, 2002, the National Academy of Engineering and the National Research Council released a report, *Technically Speaking: Why All Americans Need to Know More about Technology* (Pearson & Young, 2002). This document promoted a broader understanding of the importance of technological literacy in the United States, and suggested how it can be accomplished. In modern-day America, the authors argue, many adults and children live in a "microwave era" with "a poor understanding of the essential characteristics of technology, how it influences society, and how people can do and do affect its development" (Pearson & Young, 2002, p. 1). For American society to achieve this desired technological literacy, such education must begin early and be promoted throughout students' entire preparatory education from grades K-12.

Where the study of technology is concerned, the bottom line is simple: it is essential that all users of technology develop a basic knowledge of its workings so they can make more informed choices regarding it. To assist students to learn and understand this vital content, some technology education programs incorporate modular technology education (MTE) as the method for helping students to become technologically literate. In addition, this instructional approach facilitates students, working in teams, opportunities to work through a series of computer guided learning activities with an emphasis on problem solving and applied, minds-on approach to learning about technology (Hill, 1997).

Synergistic Systems[TM] is a type of modular system. It is based on the following four main components:

1. Learning environment (students utilize work stations that stimulate real-life workplace);
2. Learner organization (students work together in pairs for seven day periods to complete educational activities in multiple forms of media);
3. Curriculum (modules direct students through many activities); and
4. Instructor enablement program (helps the teacher utilize the classroom to insure each student is able to receive an optimum learning experience). (Dean & Kittredge, 1997, pp. 188-189)

## Statement of the Problem

To help students become technologically literate, many educators are choosing as their instructional method *modular technology education* (MTE). According to Pullias (1997), most MTE approaches provide an organizational structure that rotates student teams from one learning station to another and leads them through hand-held activities. Pullias suggests that under this method students can become technologically literate, but he emphasizes that the delivery of technological knowledge in a modular environment is difficult.

Grouping students in cooperative learning teams has long been a popular method for enhancing academic achievement as it enables them, in Slavin's (1991) words, "to help one another master academic material" (p. 71) and "not to do something as a team, but learn something as a team" (p. 73). Group interaction, collaboration, and cooperation are often encouraged in technology education programs (Savage & Sterry, 1990). This situation (activity, content, and culture) is thus in part a social practice that "involves the whole person in a relationship with specific activities and social communities" (Lave & Wenger, 1991, p. 53). Through this instructional process, students can build on previous and current knowledge to become more technologically literate.

Many questions remain about the value and methodology of MTE laboratories. For example, Petrina (1993) argues that the modular approach to technology education is not sensitive to gender, racial, military, labor, and class biases in modern technology. Additionally, the discipline of technology is historically somewhat biased. The typical technology education classroom is by no means reflective of the United States' population that is 50% female. Traditional social expectations about gender behaviors also come into play. For the most part, girls are still encouraged into female-dominated classes (e.g., home economics and family and consumer sciences), while boys are encouraged into the male-dominated classes (e.g., industrial technology and technology education).

Some questions are basic: *Are these modules accommodating the learning styles of all students? As learners work in pairs, are they getting the education and skills needed to survive in a technologically literate world? Is MTE meeting the* *needs of our technological society?* Other questions, though, are more pointed: *How does MTE account for differences in gender and learning styles, among other factors? How do its practitioners ensure that no bias exists in its methodology, as existed, for example, in certain standardized testing methodologies?*

*Justification for Study*

Much of the current MTE research has focused on teachers (see for example, Brusic & LaPorte, 2000, 2002; Reed, 2000). This study will focus on middle school students with regard to issues of gender groupings and learning styles. If MTE is the method many educators use to help all students become technologically literate, researchers must spend more time studying the attributes of individuals learning in these instructional settings.

Previous studies that examined teachers in MTE settings explored issues relating to the acceptance of MTE (deGraw & Smallwood, 1997), perceptions regarding MTE (Brusic & LaPorte, 2002), modular labs vs. conventional labs (Brusic & LaPorte, 2000), and teachers' learning style and laboratory preference (Reed, 2000). The small number of studies that have focused on students examined students' mental processes (Hill, 1997), and cognitive style, gender, motivation, and MTE achievement (Weymer, 1999).

The teamwork aspect of MTE was supported by Dean's paradigm that students not only learn by communicating with teachers but by each other (Dean & Kittredge, 1997). Studies have promoted team learning (Brusic & LaPorte, 2000; Phelps, 1990), especially for females (DeBarthe, 1997; Mosher, 1996). In addition to teamwork, other important factors of MTE laboratories such as learning style, gender grouping, and cooperative learning need to be examined in order to provide insight into students' learning technological content in these settings.

Students' attitudes toward group work have shown to differ significantly depending on learning style (Gardner & Korth, 1998). Other researchers have also examined individuals' learning styles (Loo, 2002; Phelps, 1990; Reed, 2000; Sutliff & Baldwin, 2001; Weymer, 1999), specifically, gender being an indicator of learning style (Fox & Ronkowski, 1997; Philbin, Meier, Huffman, & Boverie, 1995). The *Learning Style Instrument (LSI), Version 3* developed by Kolb has been established as a creditable tool to measure how one learns to understand new information (Kolb, 2000). Studies on gender grouping (Dalton, 1990; DeBarthe, 1997; Fitzpatrick & Hardman, 2000; Underwood, Underwood, & Wood, 2000) have also shown an effect on cooperative learning.

Curiosity level has been found to be a significant indicator of learning (Arnone, 1992; Olson 1986) and performance (Leherissey, 1971b). In addition, the integration of technological activities and science instruction has influenced students' curiosity (Brusic, 1991). Studies have also shown that prior knowledge (Carlin, 1999), grade level (Alberti, 1993; Arnone, 1992), and gender (Alberti, 1993) influence students ability to learn. The *My Point of View* (MyPOV) instrument adapted by Brusic (1991) and based on Leherissey's (1971a) *State Epistemic Curiosity Scale* (SECS) has been tested to be a viable instrument that measures individual differences in curiosity.

## Significance of Study

This study was the result of the limited research done on students learning technological content in modular technology education classrooms. Major components of this instructional method are it is designed to accommodate students' learning styles and students working cooperatively in pairs (Synergistic Systems, n.d.). According to Pullias (1997), students can become more technologically literate in MTE settings. Other statements have also been made about the value of MTE (see for example, Daugherty & Foster, 1996; Gloeckner & Adamson, 1996), highlighting the pros and cons associated with this modular approach to technology education.

## Purpose of Study

The purpose of this study is to determine whether in a MTE classroom, gender groupings and learning styles predict degree of curiosity. Based on the assumption that gender grouping and learning style are factors that influence the degree of curiosity of both individuals and teams, it was hypothesized that a student's learning style (i.e., *Accommodating, Converging, Diverging*, and *Assimilating*) and gender grouping (*girl/girl, boy/boy,* and *girl/boy*) at the module would be essential elements to consider when measuring the degree of curiosity of learners in MTE classrooms.

## Hypothesis

In order to determine whether gender groupings and learning styles predict the degree of curiosity of middle school students in MTE classrooms, the following null hypothesis was tested:

$H_{o:}$ There is no significant relationship between the pairing of students of different gender groupings (girl/girl, boy/boy, and girl/boy) and different learning styles (i.e., *Accommodating, Converging, Diverging,* and *Assimilating)* in the prediction of degree of curiosity.

## Definitions

The following definitions prove pertinent to an understanding of the focus of this study:

1. **Collaborative or cooperative learning:** "Involves students working together with other students or a facilitator, in groups of two or more, looking for understanding, solution, or creating a product" (Mosher, 1996, p. ii).
2. **Curiosity:** According to Maw & Maw (1961, pp. 197-198), individuals exhibit curious behavior when they:
    1. React positively to new, strange, incongruous or mysterious elements, in the environment by moving toward them, exploring them, or manipulating them.
    2. Exhibit a need or a desire to know about themselves and their environment.
    3. Scan their surroundings seeking new experiences.

4. Persist in examining and exploring stimuli in order to know more about them.

3. **Learning style:** “The way we prefer to absorb and incorporate new information” (Kolb, 2000, p. 1).
4. **Middle school:** Instruction of educational material to students in grades six, seven, and eight in a formal setting.
5. **Modular technology education:** Facilitates students, working in teams, opportunities to work through a series of guided learning activities with an emphasis on problem solving and applied, minds-on approach to learning about technology (Hill, 1997).
6. **Team:** A number of people working together toward a common goal.
7. **Teamwork:** An educational practice to group students in a team setting to enhance their academic achievement through cooperative learning (Slavin, 1991).
8. **Technological literacy:** “The ability to use, manage, assess, and understand technology” (International Technology Education Association, 2000, p. 9).
9. **Technology:** “A body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made (modified) environment” (Wright & Lauda, 1993, p. 3).

10. **Technology education:** "An educational program that assists people to develop an understanding and competence in designing, producing, and using technology products and systems, and in assessing the appropriateness of technological actions" (Wright & Lauda, 1993, p. 4).

## Assumptions

The following assumptions were made concerning this study:

1. Kolb's *Learning Style Inventory (LSI), Version 3* is an appropriate instrument for measuring middle school students' predominant mode of learning.
2. The *My Point of View* (MyPOV) test is an appropriate instrument for measuring middle school students' degree of curiosity.
3. Because the assignments (random and non-random) of students to groups did not control for gender pairing there was a chance that students were paired with the same partner for more than one module. This situation was unlikely, but could have occurred.

## Delimitations

The following delimitations were made concerning this study:

1. This study was delimited to learning style as indicated by the *Learning Style Inventory (LSI), Version 3.*
2. This study was delimited to curiosity as indicated by the *My Point of View* (MyPOV) instrument.

3. This study was delimited to middle school students studying technological knowledge in Synergistic Systems™ modular classrooms in a mid-sized, suburban public school district.
4. This study was delimited to middle school students who chose technology education as an elective in a mid-sized, suburban public school district. This research has value outside this study by providing educators and parents data that may be generalized to similar educational settings.
5. This study was delimited to a non-random sample. Participants may be paired according to their selected modular activity preference. As a result of the subjects selected, the interpretation of the findings and the conclusions are limited to similarly situated middle school students in a mid-sized, suburban public school district, and technology education programs utilizing Synergistic Systems™ Modules.

## Summary

Modular technology education is quickly being pushed to the forefront as the most popular method for delivering technological content. In this method, learners rotate in groups or teams through the classroom's technology activities, which are designed to provide the basic skills and knowledge necessary for our technological society (Synergistic Systems, n.d.). As a result of the predominance of the MTE method in some states, teachers, administrators, and other educators must take special care to evaluate the overall learning experiences of students in these settings to ensure all learners are receiving the education and skills needed to be technologically literate. This study will provide an additional source of information for educators by focusing on gender groupings and learning styles of students learning in MTE laboratories.

# CHAPTER TWO: LITERATURE REVIEW

*It's language that makes us human,*
*Literacy that makes us civilized,*
*Technology that makes us powerful*
*And it's being in community with*
*Others that makes us free*
(Adams & Hamm, 1990, p. 139).

*Technology Education*

Over the past two decades, several changes in technology education have occurred in educational programs. Beginning in 1985, many state programs changed the name of their *industrial arts* programs to *technology education*. Modular technology education (MTE) has been implemented at the middle and high school levels (Brusic & LaPorte, 2000, 2002; deGraw & Smallwood, 1997). Another important change in technology education involves teacher-preparation. The emergence of modules has caused an increase in the number of education programs preparing educators for MTE laboratories (Rogers, 1998). These new and innovative instructional approaches provide the foundation from which students can develop the skills they need to make more knowledgeable decisions about technology (Synergistic Systems, n.d.). To some educators, the MTE environment holds the key to the future of technology education (Daugherty & Foster, 1996; Gloeckner & Adamson, 1996), making it increasingly possible for more students to become technologically literate and thus able to contribute to the needs of our high-tech society. As a result of its presence in technology education, instructional modules have altered the way many students collectively learn and communicate with each other in the learning environment.

Martin (1995) identified several advantages to using teams in technology education classrooms. A team is a number of people working together toward a common goal. In such settings, students can:

(a) learn at higher levels of thinking and develop critical thinking skills in the cognitive domain;

(b) develop values and attitudes (affective domain) about important technology education topics;

(c) increase their motivation and social responsibility; and

(d) learn in much the same way as other people who work in business, industry, government, and other agencies. (p. 437)

Additionally, the team-based focus of MTE greatly impacts on the classroom environment (Dobrauc, Harnish, & Jerich, 1995). With their emphasis on real-world experience and group interaction, such modules successfully bring students into the world of technology. For example, in the "Flight" module created by Synergistic Systems™, students work together to comprehend and explain the concept of aerodynamics. These "real-life" examples not only explain the mechanics of flight but also explore the social effects that airline disasters can bring. Such successes notwithstanding, much remains to be studied with regard to the makeup and methodology of MTE laboratories, particularly the emphasis on teamwork.

*Teamwork*

Educational theorists have long recognized the value of teamwork to the learning process. Vygotsky (1978) emphasized the importance of social interaction in the learning process when he stated that "[e]very function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological), and then inside the child (intrapsychological)" (p. 57). Although many MTE curricula group students in pairs, research into the effects of such teamwork is actually quite limited. One thing we do know, however, is that many factors can affect the dynamics and success of a team. For example, Denton (1990) suggested that teams should be small, no more than two or three students, because the smaller size increases opportunities for members to work together cooperatively. While children generally prefer to work with their friends, educators must encourage them to work alongside students with whom they would not normally interact.

These are not, however, the only parameters that affect a team. Gender and race are other important dynamics to a group's success (Rosser, 1998). If the significance of these variables is understood, then learning may be enhanced for all students, especially individuals of color. Furthermore, if the attributes of teamwork are ignored, group work may hinder learning (Rosser, 1998). As Rosser (1998) notes, "assigning an African American woman to a group consisting only of white men clearly constitutes isolation" (p. 6). If educators do not fully comprehend the impact that gender and race can have on group dynamics, many teams may not reach their goals. Before we can completely understand the effects of gender and race on group work, however, we must offer strong support for the principles behind the creation of the MTE laboratory methodology.

## Modular Technology Education Laboratories

### *Classroom Environment*

After observing how education was practiced in conventional classrooms, some educators began to realize the need for a new paradigm to govern the teaching of educational content. In essence, methods that educate "students for the future they would live" (Dean & Kittredge, 1997, p. 27) are needed in academic settings. Classrooms were no longer a fun environment which encouraged learners to achieve their goals (Dean & Kittredge, 1997), but centered on the teacher as the guiding force to educate students. The traditional learning environment had rows of desks with the teacher positioned in front of the learners. Consequently, as rapid changes in society take place, educational systems must continue to provide classrooms in which "the excitement – the fun and the seriousness – of learning" (Dean & Kittredge, 1997, p. 28) is still encouraged in students.

Harvey Dean, President of Pitsco, a major technology education materials supply company, made one such assessment in the 1980s after realizing that the traditional instructional delivery system could not fully prepare students to deal with emerging technologies (Dean & Kittredge, 1997). He created a new paradigm that involved students learning not just from teachers, who would be viewed more as encouragers and facilitators, but also from each other. In Dean's view, such an instructional approach was necessary because children are different, society is ever changing, and the changes and challenges faced by our children grow more diverse by the day. He believed that the benefits of such an approach could flow over into students' other daily activities (Dean & Kittredge, 1997).

With this vision in mind, Dean helped create a modular instructional system to give students "a new, better, different kind of education" (Dean & Kittredge, 1997, p. 41). This new educational method advocated that students are active learners and problem-solvers. During the 1970s, Max Lundquest, Mike Neden, and Terry Salmans helped design this innovative teaching approach to increase students' interest in the subject, thereby increasing their motivation to complete tasks.

The methods of instruction were derived from the following observations of students' learning:

1. Because children are active learners, they like to learn by searching for answers and solving problems, not by passively having facts poured into their heads.
2. Because children are great communicators, they learn well in teams by teaching one another.
3. Because many of today's children are "cable-ready," they are effectively engaged by a multimedia approach-software, video, audio, graphics and text. (Dean & Kittredge, 1997, pp. 54-55)

Michael Neden (1990) chose Dean's modular system (see Dean & Kittredge, 1997) as a template to provide elements of technology education for use in a total learning package. As a result of his work done on Synergistic Labs, he designed the Delta County Technology Project for a Colorado middle school, which aimed to create and implement a technology education program at the secondary level that emphasizes the essential components of a broad, yet student-oriented, pedagogy (Neden, 1990). Compared to Dean's modular system (see Dean & Kittredge, 1997), Neden's system, called Modular Learning, also, promoted the essential elements of hands-on activities, student-centered learning, problem-solving situations, and students being responsible for their own learning. Neden's modular program had workstations for two students that supported self-directed, individualized instructional approaches to learning technological material. The modular concept focused simultaneously, within a given time frame, on several technology topics such as electricity, robots and electronics.

The next phase of the Delta County Technology Project involved implementing a model at the high school level. Neden (1990) also suggested that on the secondary level such systems should:

- promote student responsibility for learning,
- be knowledge-based,
- facilitate interdisciplinary opportunities, emphasizing the transferability of knowledge and skills from one discipline to another and the application of basic knowledge to some useful purpose,
- be activity oriented, with emphasis on "hands-on" experiences,
- provide the tools and equipment of the times to expand the resource capabilities for all students,
- provide the best learning environment possible, including equipment, room décor and innovative student management techniques, and

facilitate group and individual problem-solving situations, critical and analytical thinking, and opportunities for interpersonal relationship development. (p. 25)

*Research on Modular Technology Education Laboratories*

Despite the popularity of the MTE learning environment, limited research has been conducted on the method (see for example, Brusic & LaPorte, 2000, 2002; deGraw & Smallwood, 1997; Harnisch, Gierl, & Migotsky, 1995; Hill, 1997; Reed, 2000; Weymer, 1999). Likewise, the majority of such studies have focused on teachers (see for example, Brusic & LaPorte, 2000, 2002; deGraw & Smallwood, 1997; Reed, 2000). In one study, deGraw and Smallwood (1997) conducted a survey to determine how well teachers in Kentucky accepted MTE instruction. Surveys were mailed to secondary school technology education teachers ($N$ = 120). Of the forty-seven (40%) teachers (24 high school, 19 middle school, and 4 taught at both middle and high school) who responded, they found middle school teachers accepted modular instruction more readily than did high school teachers and teachers who taught at both middle and high school. The age of the teacher, teacher's years of experience, school setting and teacher attitude did not seem to be significant factors in the results. However, professional involvement had a significant difference on the level of acceptance; teachers who were very involved professionally were much more likely to value MTE. Although deGraw and Smallwood's study revealed that the results of teachers' acceptance of MTE instruction varied, it was stated that MTE is being adopted in the southern state of Kentucky to better prepare students for a technological society.

In a Virginia study, Brusic and LaPorte (2000) conducted a survey to determine how many Virginia Technology Education (VTE) teachers worked in modular labs as compared to conventional labs, and to ascertain the perceptions of Virginia Modular Technology Education (VMTE) teachers toward MTE laboratories, the majority of which are located in middle schools. Surveys were mailed to all technology education teachers ($N$ = 963) identified by the Virginia Department of Education, with a response rate of 492 surveys (51.5%).

Brusic and LaPorte's (2000) study revealed several significant findings. First, 51% of VTE teachers are teaching in conventional labs, 25% in modular labs, and 24% in both types. Second, over half of the MTE teachers reported that they could teach 60-79% of the Virginia technology education curriculum in the MTE laboratory, while 41% of the teachers currently teach in Synergistic Systems™ labs. Results also revealed that 36% of teachers felt that they are more capable of promoting cooperative learning, problem-solving, and self-directed learning in MTE labs. The findings of this study suggest that MTE is gradually being accepted in schools as a better instructional approach to address students' needs to learn technological content.

Building on the framework of their previous study, Brusic and LaPorte (2002) compared the perceptions of Virginia MTE teachers (from the 1999/2000 study) regarding MTE with those of teacher educators and vendors/developers. For this subsequent survey, Brusic and LaPorte mailed new surveys to technology teachers ($N$ = 152) who were identified as members of the Council on Technology Teacher Education (CTTE) and who worked with technology education students in programs identified in the *Industrial Teacher Education Directory* (Bell, 2001-2002). Of the 107 instruments (70.4%) that were returned, 87 were usable. Modified surveys were also mailed to 11 nationally recognized MTE laboratory vendors/developers but due to the low response, these data were excluded from the study.

Brusic and LaPorte (2002) reported several preliminary findings and conclusions. Teacher educators and Virginia MTE teachers agreed, for example, that the most significant advantage of MTE is that a greater population of students (e.g., women, minorities, gifted, and special needs) find such labs appealing and interesting. However, there was not complete agreement between both groups on the most significant advantage of MTE programs for teachers. Teacher educators felt that the delivery of content, which is more reflective of current technology in MTE labs, was significant. But, Virginia teachers placed more emphasis on the teaching of universal skills and abilities such as problem-solving and critical thinking.

While teacher educators and Virginia MTE teachers agreed that the major frustrations and challenges of implementing such programs involved prohibitive startup and maintenance costs, they disagreed on the attributes such labs should possess. For example, teacher educators found the following drawbacks to exist in most labs: (a) they are not better overall; (b) they are not consistent with their values, past experiences, and needs; (c) their results were not readily visible to others; and (d) they were not more educationally sound and more developmentally appropriate to students.

Virginia was again the focus of a study by Reed (2000), who investigated the relationship between laboratory environments and the learning styles of the state's middle school technology education teachers. The *Learning Type Measure* (LTM) instrument, which describes individual learning styles (Imaginative, Analytic, Common Sense and Dynamic), was mailed to a random sample of technology teachers ($n$ = 195) as identified by the Virginia Department of Education in 1998. Of the eighty-three (42.5%) instruments returned, sixty-five (78%) were usable.

Reed's study (2000) revealed several interesting findings about teachers and administrators. Respondents were mostly men (94%). While 60% ($n$ = 39) of the teachers taught in a modular laboratory, only 40% ($n$ = 26) taught in a conventional laboratory. Over half of respondents (69.2%) identified themselves as common sense learners, who like technical things and use hands-on activities. Reed found no significant differences between the learning styles of (a) conventional laboratory and modular laboratory respondents; and (b) laboratory preference and learning style. A significant difference was found, however, in the cross-tabulation of the learning styles of middle school technology teachers with the learning styles of secondary teachers and administrators ($N$ = 2,367). Reed found that, in comparison to secondary teachers nationwide, technology education teachers exhibited distinct learning styles.

A few researchers have focused on technology education students in MTE labs themselves. Harnisch, Gierl, and Migotsky (1995) investigated middle school students learning technological content in Synergistic Systems™ Labs in American schools during the 1994-95 school year. The researchers used the following six methods to collect data on the participants: (1) Shadowing of dyads, (2) Interviewing the shadowed students and their parents, (3) Focus groups, (4) Supplemental activities, (5) Surveys, and (6) Critique of Synergistic modules.

The Harnisch, Gierl, and Migotsky (1995) study revealed that students liked and disliked certain aspects of the Synergistic modules. While some participants were unhappy with some of the module contents, many felt the best parts of the labs were the hands-on tasks and the use of high-tech material. In addition, many teachers supported the Synergistic Lab and felt students enjoyed the module environment because it required hands-on work in a multimedia environment that was self-directing and interesting. Although this research study promoted the educational success of the Synergistic Systems™ pedagogy, it was supported by Synergistic Systems™, which may have resulted in some researcher bias (Isaac & Michael, 1995).

Utilizing Halfin's (1973) early research on the mental process used by practicing technologists as a foundation for his own study, Hill (1997) developed a technique to assess the mental processes of students involved in the "solving activities" aspect of modular technology modules. As part of his procedure, that focused on three pairs of students (i.e., male/male high school, male/male middle school, and male/female middle school), Hill studied written materials and instructions for two activities, then observed students completing the activities. Observers noted that students communicated with each other frequently about pertinent topics. Agreement was also reached by researchers regarding the mental processes that accompanied the completion of tasks. Hill concluded that, in order to ensure quality instruction in the MTE environment, specific knowledge is needed to analyze such processes to assure students are following the basic steps that result in learning outcomes specific to that activity.

Weymer (1999) completed a study on 78 male and 64 female sixth graders to establish the relationship between cognitive style, gender, verbal ability, quantitative ability, prior knowledge, motivation, and MTE achievement, as well as to determine whether MTE better suits specific individuals. He used the *Group Embedded Figures Test* (GEFT) to gather data on cognitive style. In addition, he used pre- and post-tests to collect data on student achievement scores, a multiple regression analysis and a t-test to determine relationships between variables. The study revealed several findings. There were significant relationships between cognitive style and post-test achievement scores, but no significant relationships between gender and achievement scores. As a result of his study, Weymer determined not only that many students "got lost" in the modules, but also that this group of learners had problems sorting information in order of importance. Results from Weymer's study reveal that not all students will achieve high levels of knowledge using MTE modules.

## Learning Theories and Styles

The education of students in the United States has resulted in many theories and philosophies related to teaching and learning. For example, John Dewey (1938) felt that humans could best be educated by the scientific method, a philosophy embedded in traditional educational styles. Even faced with the emergence of progressive education based on the philosophy of learning by experience, Dewey

(1938) still held to his beliefs that traditional education offered many different experiences and that learning was dependent upon the quality of the experience, which had two aspects: “There is an immediate aspect of agreeableness or disagreeableness and there is its influence upon later experiences” (Kolb, 1984, p. 16).

Dewey developed a *scientific experiential model* (see Figure 1) to describe how learning develops the impulses, feelings, and desires of concrete experience into a higher-order purposeful action (Kolb, 1984, p. 23). Purposes are formed in the following pattern:

1. observation of surrounding conditions,
2. knowledge of what has happened in similar situations in the past, and
3. judgment, which puts together what is observed and what is recalled to see what they signify (Dewey, 1938, p. 69).

Additionally, he integrated experience and concepts, observations, and action. According to Dewey’s theory, the impulse of experience gives movement to ideas and ideas direct impulse. Delaying immediate action results in observation and judgment to occur, and action must take place before purpose can be achieved.

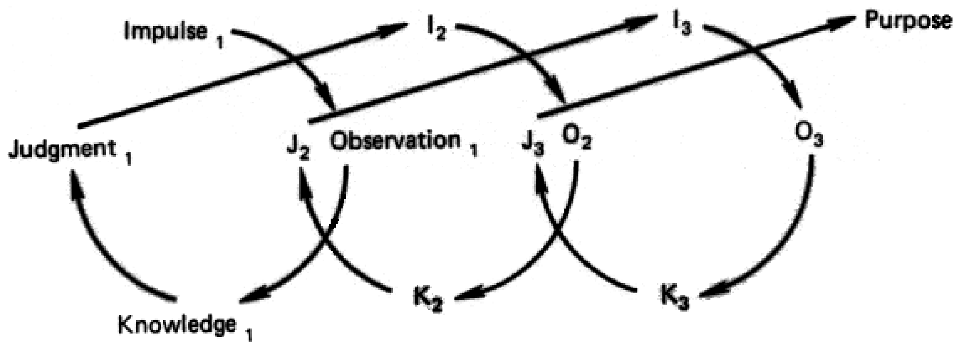


*Figure 1.* Dewey's Model of Experiential Learning (Kolb, 1984, p. 23).
Kolb, David A., Experimental Learning: Experience as the Source of Learning and Development 1/e©1984, Figure 2.2. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, New Jersey.

In addition to Dewey's scientific experiential model of learning, two additional models of the experiential learning process have been developed that have relevance to this study (Kolb, 1984). Kurt Lewin developed the Lewinian Experiential Learning Model (see Figure 2), a four-stage cycle process based on integration of the *here-and-now concrete experience* and *feedback processes* into a goal-directed learning process (Kolb, 1984, p. 21). The four stages are (1) concrete experience, (2) observations and reflections, (3) formation of abstract concepts and generalizations, and (4) testing implications of concepts in new situations. Concrete experience is the foundation for observation and reflection. Observations enable one to generalize new actions, and these implications guide new experiences. In Lewin's view, human beings are able to totally share an experience.

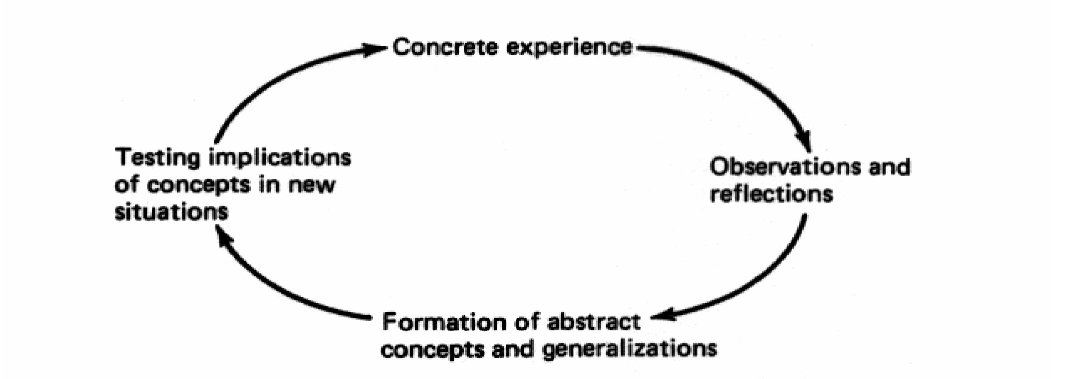


*Figure 2.* The Lewinian Experiential Learning Model (Kolb, 1984, p. 21).
Kolb, David A., Experimental Learning: Experience as the Source of Learning and Development 1/e©1984, Figure 2.1. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, New Jersey.

Jean Piaget based his learning model shown in Figure 3 (Kolb, 1984, p. 25) on similar beliefs to those held by Dewey and Lewin. Piaget felt that the learning process was a constant cycle of interaction between the individual and the environment. Interactions take place between two key processes*: accommodation of concepts to experiences in the world* and *assimilation of events and experiences from the world into existing concepts*. The result, in Piaget's terms, was cognitive growth. Piaget developed the following four major stages of cognitive growth:

1. Sensory-motor stage (0 – 2 years), learning is by *feeling, touching, and handling*.

2. Representation stage (2 – 6 years), learning is through the *manipulation of observations and images*.

3. Concrete Operations stage (7 – 11 years), learning is through *inductive reasoning.*

4. Formal Operations stage (12 – 15 years), learning is through *deductive reasoning.* (Kolb, 1984, pp. 23-24)

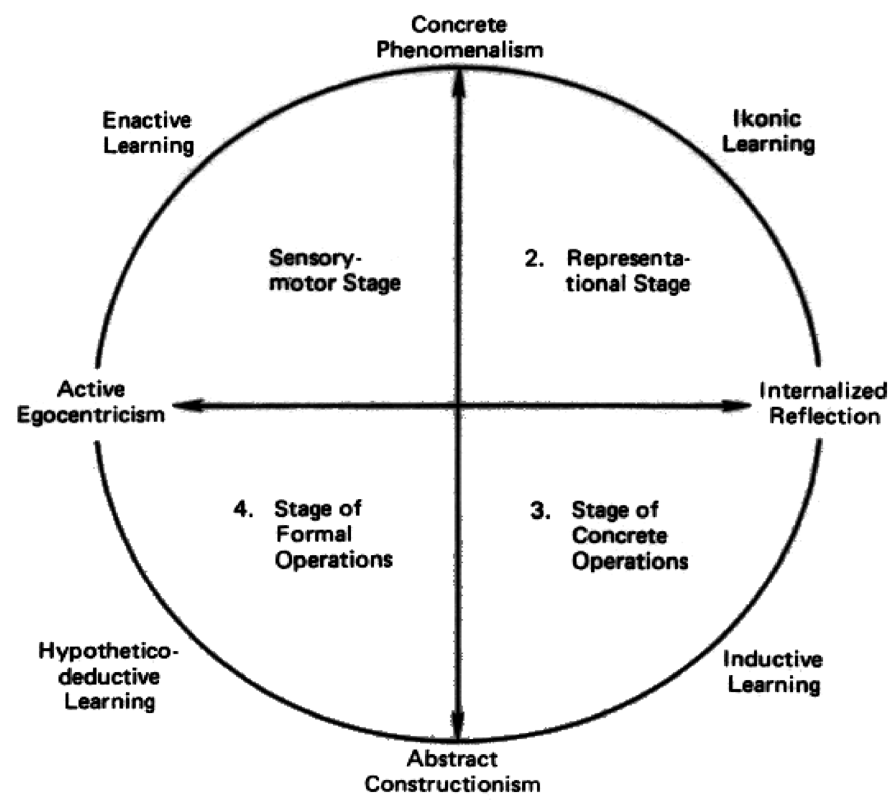


*Figure 3.* Piaget's Model of Learning and Cognitive Development (Kolb, 1984, p. 25).

Kolb, David A., Experimental Learning: Experience as the Source of Learning and Development 1/e©1984, Figure 2.3. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, New Jersey.

The connection between learning models and learning styles is crucial to the successful design of any curriculum. The failure of educators to recognize students' unique learning needs could result in environments not conducive to learning. In addition, differences in level and type of learning are determined by students' learning history and the quality of instructional setting (Keefe, 1987). An awareness of different learning styles opens the door to personalized education; in it, educators see the power to analyze, motivate, and assist students to become actively involved in their own education (Keefe, 1987).

Learning style theories help explain the way one acquires knowledge. For example, supported by the learning models of Dewey, Lewin, and Piaget, David A. Kolb (1984) formed the learning model (see Figure 4) from the combination of acquiring experience and transforming it to knowledge. He developed the *Learning Style Inventory* (LSI) based on experiential learning theory that combines cognitive and socio-emotional factors to facilitate learning (Kolb, 1984). According to Kolb

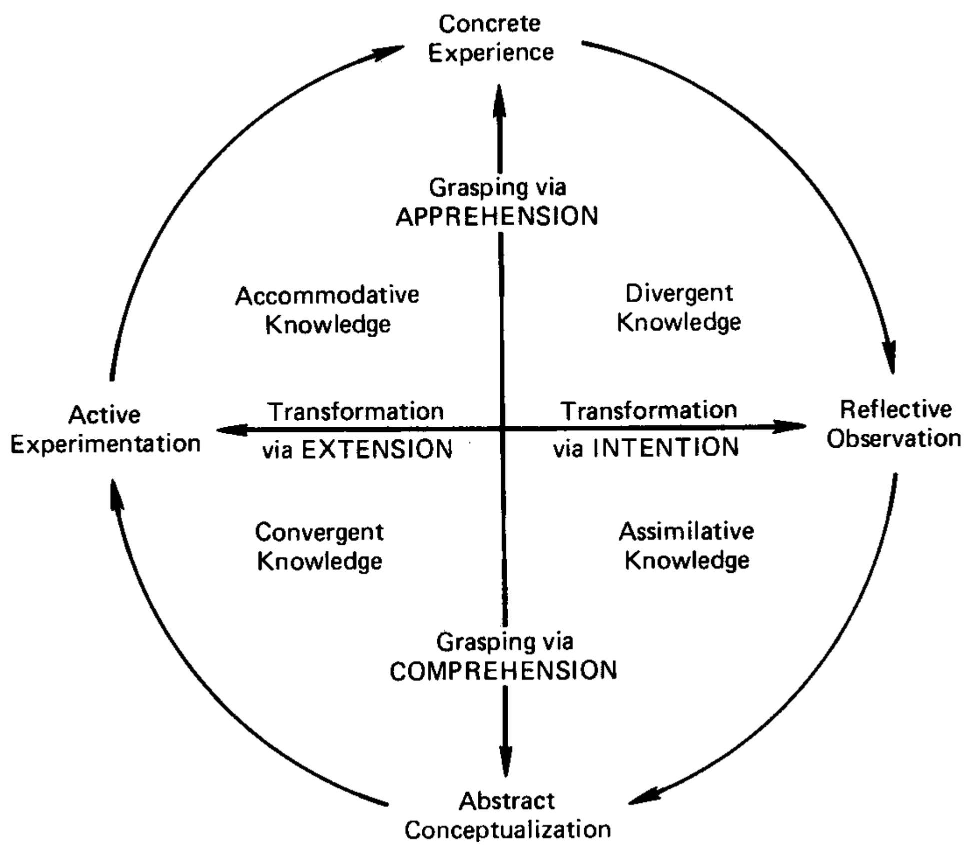


*Figure 4.* Structural Dimensions Underlying the Process of Experiential Learning and the Resulting Basic Knowledge Forms (Kolb, 1984, p. 42).

(1984), experiential learning is the process whereby knowledge is gained through experience, and there are four distinct stages to the learning cycle, as noted in Table 1.

Table 1

*Stages of Kolb's Learning Cycle* (Kolb, 1984, p. 5)

**Concrete Experience (CE)**
*Learning from feeling*
- Learning from specific experiences
- Relating to people
- Sensitivity to feelings and people
- Open-minded and adaptable to change

**Reflective Observation (RO)**
*Learning by watching and listening*
- Careful observation before making a judgment
- Viewing things from different perspectives
- Looking for the meaning of things

**Abstract Conceptualization (AC)**
*Learning by thinking*
- Logical analysis of ideas
- Systematic planning
- Develop theories and ideas to solve problems
- Acting on an intellectual understanding of a situation

**Active Experimentation (AE)**
*Learning by doing*
- Ability to get things done
- Risk taking
- Influencing people and events through action

As shown in Figure 4, Kolb's (1984) model of experiential learning forms two opposite modes: (1) *active experimentation* (AE) and *reflective observation* (RO);

and (2) *abstract conceptualization* (AC) and *concrete experience* (CE). The combinations of these four learning modes create four learning style types, shown in Table 2: *Converger, Diverger, Assimilator*, and *Accommodator*. Learning styles identified by the LSI by Kolb (2000) were changed in 1999 from accommodator, converger, diverger, and assimilator to accommodating, converging, diverging, and assimilating. This indicated individual behavior may change in different learning situations.

Table 2

*Kolb's Four Learning Style Types in the Learning Style Inventory* (Kolb, 1985, p. 7)

| |
|---|
| *Converger* – abstract conceptualization combined with active experimentation; rather deal with technical tasks and problems than with social and interpersonal issues |
| *Diverger* – concrete experience combined with reflective observation; enjoy situations that call for generating a wide range of ideas, as in a brainstorming session |
| *Assimilator* - abstract conceptualization combined with reflective observation; less focused on people and more interested in abstract ideas and concepts |
| *Accommodator* - concrete experience combined with active experimentation; learn from "hands-on" experience, act on "gut" feelings rather than on logical analysis |

## Learning Style Preference

Each learning mode identified by Kolb (1985) helps measure learning with accuracy, but does not totally explain an individual's learning style. Due to the diverse learning situations that occur in classrooms, each person's style may reflect a combination of the four modes (concrete experience, reflective observation, abstract conceptualization, and active experimentation). According to Kolb (1985), effective learning utilizes not just a combination of all stages in the cycle, but also a greater reliance on selected skills and steps that meet individual needs.

According to Smith and Kolb (1986), the LSI's experiential learning theory "provides a model of learning that is consistent with the structure of human cognition and the stages of human growth and development. It conceptualizes the learning process in a way that allows users to identify differences among individual learning styles and corresponding learning environments" (p. 95). Additionally, the LSI is supported by research based on the experiential learning theories of Dewey, Lewin, and Piaget (Kolb, 1984).

In order to better assess the effects of students' individual learning styles, Sutliff administered the *Learning Style Inventory* (LSI) developed by Kolb (1985) to his junior level computer-aided drafting (CAD) students ($N = 13$) in the Industrial Technology program at Eastern Illinois University (Sutliff & Baldwin, 2001). A high number of the students' scores fell outside the 60% circle for active experimentation and abstract conceptualization. Sutliff's study thus revealed two complementary facts: (1) it is useful for teachers to use a learning style instrument to gauge students' needs, and (2) the majority of students' learning styles can be accommodated if teaching methods were directed at the two dominant modes of learning.

In his study, Smith (1974) utilized two computer simulation games, *The Management Game* and *The Beef Breeding Game*, to determine whether students (1) could use them to learn concepts and facts, and (2) possessed common cognitive learning style components associated with successful performance on objective tests in such games. Undergraduate students (*N* = 138) enrolled in either Psychology or Industrial Education at Iowa State University volunteered to participate in Smith's study and were subsequently divided into experimental and control groups. The results of Smith's study indicate that individuals can use computer simulation games to learn cognitive concepts and facts, and that individual cognitive learning style traits can be associated with achievement on such specific games. In conclusion, Smith felt that in order for students to capitalize on their unique skills and abilities, a full understanding of learning style and how it interacts with individual methodologies is paramount (Smith, 1974).

Martinez (1987) completed another study on learning styles of seventh-grade Native American students on three Indian reservations in New Mexico: Jicarilla Apache Reservation of Dulce (*n* = 37), the Zuni Pueblo Indian Reservation of Zuni (*n* = 88), and the Navajo Indian Reservation of Magdalena (*n* = 9). Martinez's primary purpose was to uncover primary learning preferences for project, drill/recitation, peer teaching, discussion, teaching games, independent study, programmed instruction, lecture, and simulation modalities. Renzulli and Smith's (1983) *Learning Style Inventory* (LSI), developed in 1978, was used to identify students' preferences in nine general instructional modalities. The responses were based upon a five-point Likert-type scale. Martinez discovered that of the nine learning styles assessed, peer teaching, teaching games, and programmed instruction were the preferred learning style of all three tribal groups, with discussion stimulation and drill/recitation being the least preferred. As assessed by the LSI, students also had no dramatic learning style preferences, although when grouped, they preferred an instructional style that stressed teacher cooperation rather than teacher domination.

In 2000, Yoon examined the learning styles, goal accomplishment styles, gender, and academic achievement of Korean middle school geography students. She administered Kolb's *Learning Style Inventory*, the *Goal Orientation Index*, and the *Teaching Methods Questionnaire* (*n* = 791; 463 girls and 328 boys) and found that students' learning styles and goal accomplishment styles were significant indicators of predicting geography academic achievement. Gender did not predict academic achievement. Other variables that may have influenced the results of Yoon's study were environmental factors (school teaching methods and educational settings) (Yoon, 2000).

Philbin, Meier, Huffman, and Boverie (1995) completed a survey on gender and learning styles by administering Kolb's LSI to their friends, colleagues and acquaintances. Subjects (*N* = 72) included 45 women and 25 men, between 21 to 60+; ethnic groups included 48 White, 2 Black, 16 Hispanic, 5 Native American, and 1 "other." Educational levels ranged from high school to graduate school and 41 of the 72 respondents were enrolled in a class. The majority of participants (*n* = 33) indicated the Assimilator style. Results revealed that gender was an indicator of learning style in this study (Philbin, Meier, Huffman, & Boverie, 1995).

Fox and Ronkowski (1997) also used Kolb's *Learning Style Inventory* in another study. They administered the LSI to students (*n* = 260) enrolled in eleven political science courses offered at Union College in 1985. There were more assimilators (1/3 women and less than 15% male) than any other learning type, who preferred personal involvement in learning. This result is consistent with other findings (see for example, Loo, 2002; Philbin, Meier, Huffman, & Boverie, 1995). A small significant difference was found in students' majors as well. Social science students, political science and non-political science majors had similar learning styles. In contrast, physical science and engineering students were typically convergers and divergers. In student class level, a large number of juniors and seniors identified themselves as convergers and assimilators, who favored abstraction over concrete experience. Findings in this study indicated that gender, major, student classification, and course level are factors that affect student's learning style preference.

Loo (2002) also administered Kolb's LSI to students. The undergraduates ($n = 437$) were divided by gender, hard majors (accounting, finance, and management information systems) and soft majors (general management and marketing), and by major. Loo found students had a preference for the assimilator learning style (35.4%). There was no gender difference, but a significant difference was found in the hard-soft majors which included a higher number of women in the soft majors (general management and marketing) and a higher number of men in the hard majors (accounting, finance, and management information systems). Loo's study revealed that academic major does affect learning style.

## Cooperative Learning

There is belief that cooperative learning strategies improve students' interpersonal relationships and help them develop skills more effectively (Slavin, 1991). Cooperative or collaborative learning "involves students working together with other students or a facilitator, in groups of two or more, looking for understanding, solution, or creating a product" (Mosher, 1996, p. ii). Murray (1994) outlines the following four theories that are based on aspects of cooperative learning:

1. Social learning theory (teamwork), pupils will work hard on those tasks for which they secure a reward and will fail to work on tasks that yield no reward or yield punishment.
2. Piagetian Theory (conflict resolution), a social interaction where two pupils disagree about a problem and work together until they can agree or come to a common answer.
3. Vygotskian Theory (community collaboration), human mental functions and accomplishments begin in social relationships that transform into a group's common perspectives and solutions to problems as they are arrived at through debate, argument, negotiation, discussion, compromise, and dialectic.
4. Cognitive Science Theory (tutoring), the teacher coaches the pupil to develop skills and roles of the task that the individual will inevitably master. (pp. 7-10)

Cooperative learning strategies date back to Dewey's (1904) child-centered progressivism in the 1900's, and then were promoted as a new instructional approach in classrooms in the 1960's and 1970's. Throughout the 1990's, researchers (see for example, Chalupa, Sormunen, & Charles, 1997; Chizhik, 1999;

DeBarthe, 1997; Denton, 1992; Gardner & Korth, 1998; Mosher, 1996; Phelps, 1990) continued to investigate the attributes of cooperative learning to determine its effectiveness. According to Slavin (1991), cooperative learning has been stated as

> (a) a means of emphasizing thinking skills and increasing higher-order learning;
> (b) an alternative to ability grouping, remediation, or special education;
> (c) a means of improving race relations and acceptance of mainstreamed students; and
> (d) a way to prepare students for an increasingly collaborative work force. (p. 71)

Many educators also use this method to emphasize critical thinking skills and increase higher order learning, as in the improvement of racial relations (Slavin, 1991). In fact, teamwork has been used successfully on all educational levels, from elementary school through college. Teamwork is an educational practice to group students in a team setting to enhance their academic achievement through cooperative learning (Slavin, 1991). Some studies (see for example, Phelps, 1990; Slavin, 1991) validate that it is suitable for all types of students (i.e., high and low achievers, boys and girls), that it has positive effects on inter-group relations, and that it can be successful in urban, rural, and suburban elementary and secondary schools populated by a number of diverse ethnic groups.

Research on teamwork increased in the late 1980s and early 1990s, and numerous educators have established the value of this learning strategy. For example, Denton (1992) discovered that physical layout of the room influenced groups' success rates in his case study of 7th through 12th grade student-teams. He examined a variety of populations, peer groups, teacher-designated groups, and heterogeneous mixtures. Student groups performed better and remained focused when they were separated from each other and remained seated.

Phelps (1990) considered such variables as learning preference, gender, and friendship development to determine whether cooperative team learning could improve students' levels of achievement, in his study of eighth graders ($N = 107$) in four midwestern social study classrooms. Classroom teachers using the Jigsaw II cooperative team learning strategy grouped students heterogeneously under *cooperative* and *non-cooperative* conditions. The group and traditional classroom strategies were used. The *Group Embedded Figures Test* (GEFT) was used to measure their learning preferences. Also, the *Friendship Pattern Survey* (FPS) was utilized to assess levels of friendship that developed among the students. In addition to the test and survey, 40 students were interviewed concerning their attitudes toward cooperative learning and classroom instruction, academic achievement, and friendship development.

Although pre- and post-tests revealed no significant differences in achievement between cooperative learning team students and those in non-cooperative classrooms, Phelps' (1990) interviews revealed that students felt they learned more when working cooperatively. Findings also showed that in the cooperative team learning setting, positive friendship pattern development was found, while the non-cooperative classroom setting measured negative development.

Thus, while no difference was found in achievement levels as a result of this study, other variables strongly suggested that cooperative teaming provides a more conducive learning environment for middle school students.

Another study, conducted by DeBarthe (1997) at a private, four-year liberal arts college, examined the effects of gender grouping (*single-gender* vs. *mixed-gender*) in cooperative learning group structures, as well as the interaction of the structure on the educational activity. DeBarthe's study population included 17 females and 37 males students between the ages of 17 to 28 (79% were either 19 or 20), all enrolled in two sections of an introductory accounting course. In the study, the instructor created groups of four students, either all male, all female, or evenly split according to gender, who were asked to use cooperative learning activities, positive interdependence structures, appropriate team formation, individual accountability, social skills, and group process. The control groups used loosely structured group processes such as "group work," where students were simply given a task and told to complete it together.

Based on gender groupings, DeBarthe discovered that while men showed no differences in learning between the control and experimental groups, women did exhibit slightly higher levels of learning in the latter. Although the *treatment by gender by group composition interaction* was not significant, the *gender by group composition interaction* was significant. Results also revealed that females in mixed-gender groups reported higher levels of group process than did females in single-gender groups, including cooperation, competence, and task motivation. DeBarthe's study thus revealed that cooperative learning structures do benefit females.

In her 1996 study of 99 undergraduate and graduate students enrolled in Psychology, Sociology, and Adult Education classes at the University of Alaska – Anchorage, Mosher (1996) investigated the gender and ethnic characteristics of students who preferred collaborative learning. With regard to gender, her findings are similar to those of DeBarthe (1997). Mosher determined that 78% of minority women preferred collaborative learning, while only 50% of their male counterparts did. Other results indicate that 32% of students studied believed teamwork was the most important skill for success, while 25% identified persistence as the least important.

Chalupa, Sormunen, and Charles (1997) conducted another teamwork study. They investigated 150 subjects from six colleges enrolled in business communications, office supervision, and information technology courses at a midwestern university. Both pre- and post-tests were administered in this study, at the beginning and ending of the semester, respectively. Of the 110 complete responses, findings revealed that on the pre-test 61% of the students reported a "Just OK" attitude about previous group work experience, compared to 39% who reported a "Mostly Positive" experience. While women did not show a significant change from pre-test to post-test ($n$ = 34, 61% and $n$ = 39, 70% respectively in the "Just

OK" category), men on the other hand revealed a significant change in attitude toward the "Mostly Positive" group experience (*n* = 21, 39% and *n* = 30, 56% respectively).

Clearly, such studies indicate that one's ability to work effectively in teams is a major indication of potential academic, as well as workplace, success. In fact, more universities are turning to this approach as they prepare students for careers. In their lengthy study, Gardner and Korth (1998) explored selected students' motivation, attitudes toward group work, learning preference, valuation of others' styles, and educational activities over the span of four years. Their subjects (*N* = 178) were graduate students (76% female) at a private mid-western university, and information was collected during the first semester of an organizational behavior course. On the second day of the course, learners were given the *Learning Style Inventory* (LSI) developed by Kolb (1985) and were surveyed regarding their attitudes toward group work, measured by a Likert scale, which ranges from 5 *(all the time)* to 1 *(never)*.

In this study, students reported the following learning styles: 35% perceived themselves as accommodators, 27% as assimilators, 21% as divergers, and 16% as convergers. Significant differences were found between assimilators and the other learning styles for individual and group learning. There were no changes in preferences for individual and group learning between accommodators, divergers, and convergers preferring to learn in groups and assimilators learning through individual means. Results did, however, show students' attitudes toward group work differed significantly depending on their preferred learning style.

Research has also indicated that, ethnic minority students and females are less likely to participate in collaborative group work perhaps because of their perceived lower status. Chizhik (1999) considered the mediating effects of task structure (*single-answer* vs. *variable-answer*) on the relationship between status characteristics of participants (race and gender), their interpersonal perceptions and participation within collaborative groups, and the relationship between participation and achievement. The twelve groups of high school students were each made up of one black female, one black male, one white female, and one white male. Participants were videotaped as they worked on two mathematics tasks (variable-answer and single-answer). Findings revealed that variable-answer tasks provided a more equitable environment for teamwork than single-answer tasks. In addition, Chizhik (1999) reported that African-American students were ignored more than European-American students on single-answer tasks, and European Americans showed higher achievement than African-Americans on the single-answer task. Clearly, results indicate that group dynamics influences achievement, particularly with regard to types of tasks and ethnic/gender status (Chizhik, 1999).

In 2000, Laatsch-Lybeck compared the effects of cooperative and individual learning on the achievement and teamwork attitudes of medical technology students at the baccalaureate level. The population consisted of students ($N$ = 216) who used the individual learning method ($n$ = 107) and the cooperative learning method ($n$ = 109). Groups were heterogeneous, consisting of three or four members, and they utilized the Student Teams-Achievement Divisions (STAD) method developed by Slavin (1995), which emphasizes cooperative learning of material but also makes each learner individually accountable. The researcher designed pre- and post-tests to measure achievement in the class. A questionnaire to measure teamwork was also created.

While combined results at two institutions revealed a significantly higher achievement mean for cooperative learning students, at eight of the participating institutions, Laatsch-Lybeck (2000) found no statistically significant difference between individual learning and cooperative learning. The analysis of students' attitudes toward the course itself resulted in some individual institutions showing a difference between the two learning methods. In addition, the grouping of learners by ethnicity or gender resulted in no significant differences in either achievement or in attitudes, regardless of learning method. The results of this study suggest that there is no difference between achievement and teamwork attitudes among cooperative or individual learners.

The growing emphasis on teamwork as a successful teaching mechanism has resulted in a number of new programs emphasizing the technique. For example, the computer technology-based elementary school program Project CHILD (Computer Helping Instruction and Learning Development) at Florida State University (Butzin, 1997) was the model used for the subsequent TEAMS (Technology Enhancing Achievement in Middle School) approach. The interdisciplinary TEAMS program, which involves the study of mathematics, science, social studies, and language arts, involves both small-group activities and whole-group lessons that teachers can use with other texts, various software programs, and related instructional materials. TEAMS was first put into practice on the sixth grade level at a Tallahassee, Florida middle school, then was modified and implemented at both the sixth and seventh grade levels (Reiser & Butzin, 2000). In their program, Reiser and Butzin utilized TEAMS to focus on three key concepts: interdisciplinary instructional teams, active learning strategies, and the use of technology as an instructional tool.

## Gender Grouping

Grouping practices are based on the assumption that children will gain socially and academically from teamwork endeavors. However, research completed by Bennett and Cass (1988) in Britain revealed that while children work in groups, they do not always work *as a group*. To examine the effect of group composition on group interaction processes and to understand pupils' understanding of tasks required in-group decision-making, Bennett and Cass studied nine groups of 11 and 12 year-old children in an urban middle school, with each group consisting of three members. Each student was told about the assigned task, and then the group had to agree on final decisions. Bennett and Cass found that mixed groups showed more interaction in speech and individual utterance than did homogeneous groups. There were no significant differences in gender. Although girls spoke more, they were outnumbered in most groups.

In 1990, Dalton investigated the effects of locus of instructional control and gender pairing arrangements on learner achievement, attitudes, and interaction during an interactive video science lesson. The sample consisted of fifth and sixth grade students ($N$ = 98; 54% male, 46% female) from a small midwestern suburban school district, with a large number of white subjects, but also several blacks, Asians, and Hispanics. Learners were randomly selected from five elementary science classes, randomly assigned to one of two lesson control treatments (*lesson control* or *learner control*), and then paired with a partner of either the same or opposite sex (female/female, male/male, or female/male). During the lesson, students were assessed on (a) performance, (b) instructional efficiency, (c) attitudes, and (d) frequency of management, social task, and content interactions. Dalton's (1990) study revealed that gender pairing significantly affected instructional time, efficiency, and attitude toward content. No significant difference was found in the two-way interaction between gender and gender pairing or treatment and gender pairing, or in the three-way treatment of gender pairing. Males preferred the learner control condition, while females favored the lesson control condition. The results of this study suggest that heterogeneous gender pairing does affect cooperative learning.

Underwood, Underwood, and Wood (2000) studied children ($N$ = 81) between the ages of 9 and 11 who worked on a computer-based language problem-solving task in single-gender (girl/girl and boy/boy) and mixed-gender pairs (boy/girl), as well as those who worked alone. In this study there were 10 boy/boy pairs, 10 girl/girl pairs, 10 boy/girl pairs, 11 individual boys, and 10 individual girls. Paired subjects completed individual and paired practice sessions. In addition, observations were made on task discussions, and data was collected on the number of key presses, the duration of turn by each member of a pair, and time of keyboard sharing.

The research team utilized two analyses of variances to test the data from paired children. The factors included grouping (boy/boy, boy/girl, and girl/girl) and seating arrangement (left or right of the keyboard). There was no significant difference between groups on measures of task performance (*letters attempted* and *letters correct*). Reading ability did predict performance in grouping and seating arrangement. A single-factor analysis of variance test revealed no individual gender differences for the number of letters attempted or letters correct. The results of two analyses of variances comparing pairs and individuals showed an effect of pairing and a small effect of gender. Pairs entered more letters on the keyboard than did individuals, and boys entered more letters than girls. There was no interaction effect between these factors. Consistently, pairs outperformed individuals in entering correct letters. This analysis reveals no effect of gender and no interaction.

In 2000, Fitzpatrick and Hardman compared the styles of seven and nine-year-old children ($n$ = 120) working on a language-based computer and non-computer tasks in same or mixed gender pairs. Matched pairs consisted of 10 boy/boy, 10 girl/girl, and 10 boy/girl. A 2x3x2 repeated measures factorial design was used to analyze the two tasks (computer and non-computer), gender pairs (girl/girl, boy/boy, and boy/girl), and student ages (7 and 9 years). In both groups, for both tasks, mixed gender pairs showed more assertiveness and less collaborative interaction than did same gender pairs. When collaboration broke down, boys on the computer task and girls on the non-computer task were more dominating in mixed gender pairs, whereas in the same gender pairs, participants were equally assertive.

## Curiosity

Curiosity has been hypothetically linked to the learning process. Adams, Carlson, and Hamm (1990), stated that "learning starts with curiosity, moves toward students' interpretation of the subject's meaning in their lives, and is then connected to other areas of knowledge" (p. 7). Berlyne (1960) proposed curiosity as a scientific study in his book, *Conflict, Arousal, and Curiosity*. His theory of curiosity differentiated between perceptual and epistemic curiosity. According to Berlyne (1960), perceptual curiosity refers to the "states of high arousal that can be relieved by specific exploration and in which, therefore, specific exploratory responses are likely to occur" (p. 195). Epistemic curiosity refers to learning knowledge from responses, i.e., observation, thinking, and consultation (Berlyne, 1960).

Maw and Maw (1961) developed a definition of curiosity from their research with middle school children. They believed that individuals exhibit curious behavior when they:

1. React positively to new, strange, incongruous or mysterious elements, in the environment by moving toward them, exploring them, or manipulating them.
2. Exhibit a need or a desire to know about themselves and their environment.
3. Scans their surroundings seeking new experiences.
4. Persists in examining and exploring stimuli in order to know more about them. (pp. 197-198)

Curiosity has been used in studies to examine students' ability to learn. Alberti (1993) investigated the relationship between curiosity and cognitive development. His study involved students (*n* = 53 third graders, 25 boys and 28 girls; *n* = 50 fifth graders, 28 boys and 22 girls) completing a novelty task involving familiarization sequences. Different levels of material incentives (highly valued and moderately valued) were used as rewards to measure the participants' degree of curiosity. Scores were taken from the *Stanford Achievement Test* for the third graders and the *Comprehensive Test of Basic Skills* for the fifth graders to measure each subject's cognitive ability. Additionally, the *Cognitive Skills Index*, a measure of abstract cognitive ability, was administered to the fifth graders to obtain supplementary cognitive ability scores. Teachers also rated each child's curiosity using a four-item Likert-type rating scale. After the task was completed 18 participants were eliminated due to extreme scores.

Although no significant differences were found between grade or gender effects, and the interaction of grade and gender for novelty, Alberti (1993) did find significant differences in main effects in gender and grade by gender interaction for achievement scores. Simple main effects on gender in each grade were analyzed revealing a significant gender effect. Girls scored higher in the third grade, and boys scored higher in the fifth grade. Results of this study suggest that gender and grade level influence scores on achievement tests.

Like other researchers (see for example, Alberti, 1993; Arnone, 1992; Brusic, 1991; Olson, 1986), Carlin (1999) examined students at the secondary level. The purpose of her study was to investigate (a) differences in cognitive learning after a zoo field trip, (b) if the trip had an affect on epistemic curiosity, (c) epistemic curiosity roles in learning, (d) the effect of gender, race, prior knowledge and prior visitation to the zoo on learning and epistemic curiosity, (e) participants' preference for type of zoo animals, and (f) if a prior trip to the zoo influences previous knowledge. The sample included fourth and fifth grade children (*n* = 96, 25 African American, 2 Hispanic, 1 Asian, 1 mixed race, and 67 Caucasian students).

Carlin (1999) found no significant differences between curiosity and gender, race, prior knowledge, and prior visitation. Although t-tests did not indicate a significant difference between pre-test and post-test cognitive scores and curiosity levels, students identified more animals after their visit to the zoo than before the trip. In addition, a multiple regression analysis determined the relationship between post-test cognitive performance and prior knowledge was significant. Chi-square tests revealed preferences for types of animals and preference for animals by gender. Carlin's (1999) study revealed that prior knowledge may influence an individual's cognitive ability.

Another study, this one conducted by Olson (1986) at a junior high school, measured students trait curiosity, the level of curiosity that each individual experiences; and state curiosity, the response an individual receives from an incident that occurs (Naylor, 1981). She developed the *Trait-State Curiosity Inventory* to evaluate curiosity types. The participants were middle school students (*n* = 509, 247 seventh graders and 262 eighth graders). Additional data were also collected from teacher evaluations of student curiosity, students' GPA, and the gender of students.

Olson (1986) found positive correlations between the following analyses: (a) teacher evaluations and student responses on the trait-state curiosity measures, (b) GPA and student responses on the total trait-state curiosity measure, and (c) the gender of the students and their responses on the perceptual curiosity subtests of the trait-state curiosity measure. The findings of this study revealed that academic performance and gender affect curiosity.

Leherissey (1971a) developed the *State Epistemic Curiosity Scale* (SECS) to assess the level of curiosity in students motivated by educational content. She used the SECS in a research study to determine the effect of stimulating students' state epistemic curiosity within a computer-assisted instruction (CAI) task (Leherissey, 1971b). In addition, Leherissey investigated if curiosity would reduce anxiety and improve performance. Anxiety was measured by the *State-Trait Anxiety Inventory* developed by Spielberger, Gorsuch, and Luschene (1970). The subjects were female undergraduates ($N$ = 152) enrolled in psychology and education classes.

Leherissey (1971b) found significant relationships between curiosity and anxiety. Students with high curious levels had lower anxiety levels and performed better than low curious students on the CAI task. This study indicates that curiosity levels affect performance on a computer task.

In her study, Brusic (1991) examined the effect of integrating technological activities with science instruction, and determined whether a student's curiosity prior to studying a subject affected their achievement. She adapted the *My Point of View* (MyPOV) instrument to measure curiosity and a science test on changing forms of energy. The MyPOV instrument was based on Leherissey's (1971a, 1971b) SECS. The participants were fifth-grade students ($n$ = 123, 60 girls and 63 boys) in

Virginia who were randomly assigned to treatment and control groups. The treatment groups participated in two technological activities related to science; the control groups were taught science experiments by the teacher.

A significant difference was found between students' curiosity in the treatment and control groups in the Brusic (1991) study. Students' scores in the treatment group were significantly higher than students' scores in the control group. Results also showed that no significant differences were found between groups in science achievement and the relationship between students' curiosity and achievement. Brusic (1991) concluded that integration of technology and science may influence students' curiosity, but not their achievement.

Curiosity has also been used in studies to investigate individual differences in children in a computer-based interactive learner control environment. In an art education study, Arnone (1992) used the following two treatments: (1) learner control without advisement and (2) learner control with advisement. Primary grade students ($n = 39$ first graders, 25 girls and 14 boys; $n = 32$ second graders, 15 girls and 17 boys) participated in the treatments.

Although Arnone (1992) found significant differences between grade level and the two treatments (No Advisement and Advisement), and achievement scores with high curious students performing better in both learner control conditions, no significant difference was found among the different treatments. Consistent with Alberti's (1993) finding, Arnone's study revealed grade level did affect achievement scores. Curiosity level was also found to influence learning.

## Summary

Changes in the field of technology education have occurred in educational programs. The limited research studies on MTE involving teachers (Brusic & LaPorte, 2000, 2002; deGraw & Smallwood, 1997; Reed, 2000) and students (Harnish, Gierl, & Migotsky, 1995; Hill, 1997; Weymer, 1999) have not fully explored all relationships that influence modular instructional approaches in technology education. For example, cooperative learning (Phelps, 1990), learning style preference (Gardner & Korth, 1998), and gender grouping (Dalton, 1990; DeBarthe, 1997) are all variables that affect learning and have not been explained in MTE laboratories.

Theorists argue that curiosity influence learning (Berlyne, 1960; Maw & Maw, 1961). Numerous studies have examined the relationship between curiosity and cognitive performance (Alberti, 1993; Brusic, 1991; Carlin, 1999, Leherissey, 1971b), and some have found significant findings linking the two variables (Arnone, 1993; Leherissey, 1971b; Olson, 1986). Many researchers have studied curiosity in first through fifth grade students, but limited studies have been done at the middle school level.

In chapter 2, experiential learning theories developed by Dewey, Lewin, and Piaget (Kolb, 1984) that support the MTE paradigm that individuals learn through experience were presented. This instructional approach promotes that students enjoy “hands-on” experiences, learn in teams, and are self-directed and active learners. Although MTE is the instructional method many middle and high schools use to help all learners become technologically literate, the researcher has found limited studies that examine this approach and students' learning styles. Research shows that individuals have different learning styles and knowing these preferences educators are able to provide and develop instructional approaches and settings conducive to students' ability to learn.

# CHAPTER THREE: METHODOLOGY

The purpose of this study is to determine whether gender groupings and learning styles predict the degree of curiosity of middle school students in modular technology education (MTE) classrooms in a mid-sized, suburban public school district in Virginia. To test this problem statement, the following null hypothesis was developed from the review of literature on MTE laboratories, learning style theories, gender groupings, and curiosity:

$H_{o:}$ There is no significant relationship between the pairing of students of different gender groupings (girl/girl, boy/boy, and girl/boy) and different learning styles (i.e., *Accommodating, Converging, Diverging*, and *Assimilating)* in the prediction of degree of curiosity.

## Research Design

For this study, as shown in Figure 5, a quasi-experimental design was used to conduct a one-shot case study (Campbell & Stanley, 1963). According to Campbell and Stanley (1963), the purpose of quasi-experimental design is to estimate the conditions of the experimental setting where the control and/or manipulation of the examined variables are not possible. This design was selected because, given the parameters of the present study, a randomized assignment of subjects to groups was not feasible (Campbell & Stanley, 1963). Other drawbacks of the design were absence of a control group and no causal inferences may be drawn (Campbell & Stanley, 1963).

| Treatment | Post-test |
|---|---|
| X | O |

*Figure 5.* The One-Shot Case Study Design (Campbell & Stanley, 1963, p. 6).

**Population and Sample**

During a meeting with the deputy superintendent and the technology education supervisor in this mid-sized, suburban public school district in Virginia, three MTE teachers from different schools were identified to participate in this study. The sample for this study consisted of middle school students (*n* = 116; 22 girls and 94 boys, grades 6–8) learning technological content using Synergistic Systems™ modules (see Appendix A). The spring 2004 sample of students enrolled in technology education in the selected three schools is listed in Table 3. The Synergistic Systems™ MTE sample was selected, because the majority of MTE laboratories in Virginia are at the middle school level, and 41% of the teachers work in Synergistic Systems™ Laboratories (Brusic & LaPorte, 2000). Due to limited resources available for this study, a "convenience sample" was taken from three middle schools in Virginia. That is, every middle school student in this population did not have an equal chance of being selected in the sample (Pyrczak, 2001). As a result, the generalizability of the findings of this study is limited to middle school students who choose technology education among other elective options.

Table 3

*Spring 2004 Target Population and Sample of Middle School Students Enrolled in Technology Education in the Selected Virginia Middle Schools*

| *School* | *Target Population* | | *Sample* | |
|---|---|---|---|---|
| | Girls | Boys | Girls | Boys |
| School A | 14 | 47 | 14 | 44 |
| School B | 5 | 64 | 3 | 37 |
| School C | 5 | 33 | 5 | 13 |
| Total | 24 (14%) | 144 (86%) | 22 (19%) | 94 (81%) |

*Variables*

The independent variables in this study are *gender groupings* and *learning styles* as identified by the *Learning Style Inventory, Version 3*. The dependent variable is *degree of curiosity* as measured by the *My Point of View* instrument. Consistent with the work of other researchers, such as Dalton (1990), Fitzpatrick and Hardman (2000), and Underwood, Underwood, and Wood (2000), the gender combinations of students in the two-member teams included girl/girl, boy/boy, and girl/boy. Through problem-solving and hands-on guided modular activities, the pairs work together to actively learn technological material. Degree of curiosity is the score students earned on the *My Point of View* (MyPOV) instrument.

*Internal Validity*

Due to the fact that total randomization was not plausible for this study, circumstances may threaten internal validity. Conditions that may produce confounding effects in a research study are history, maturation, selection and mortality (Campbell & Stanley, 1963). History refers to altering events that may take place, in addition to the treatment (Campbell & Stanley, 1963). Maturation occurs as the subjects change over time. To reduce the effects of history and maturation, students were given a limited amount of time (7-10 days) to complete a modular activity. It should be noted that the effects of selection and statistical regression may threaten internal validity by causing extreme scores to regress toward the mean (Ary, Jacobs, & Razavieh, 1996).

## Instrumentation

Kolb's *Learning Style Inventory (LSI), Version 3* was used to identify students' preferred learning style. The self-administered inventory, a 12-item multiple-choice assessment instrument for ages 12 and older (see for example, Yoon, 2000), was selected because it is based on the experiential theories of Dewey, Lewin, and Piaget (Kolb, 1984). The inventory "was created to help people understand the learning process and their learning—that different people have different ways of learning, and that *per se*, those ways are neither good nor bad" (Smith & Kolb, 1986, p. 4).

The LSI measures how much reliance an individual has on the four different learning modes: *Concrete Experience* (CE), experiencing; *Reflective Observation* (RO), reflecting; *Abstract Conceptualization* (AC), thinking; and *Active Experimentation* (AE), doing (Kolb, 2000). The norms for the *Learning Style Inventory, Version 3* for groups with a high school or less education are listed in Table 4 (Kolb, 2000).

Table 4

*Norms for the Learning Style Inventory, Version 3 for Groups with a High School or less Education* (Kolb, 1985, p. 68)

| *Learning Modes* | *Group Percentages* |
|---|---|
| Abstract | .48 |
| Concrete | .52 |
| Active | .39 |
| Reflective | .61 |

Additional norms for the sample in Table 4 include the learning modes AC – CE, mean = 4.06 and AE – RO, mean = 1.8. To complete the LSI Version 3, participants (1) rank the ending score in each sentence with a "*4* for the sentence that describes how you learn best, down to a *1* for least like the way you learn"; (2) add the 12 numbers in each of the four columns; (3) subtract learning modes (AC-CE; AE-RO) to get two combination scores; and (4) mark and plot combination scores to find the dominant learning style (Kolb, 1985). Besides identifying an individual's learning style type, the LSI Version 3 outlines the strengths of developing learning style skills, and how to apply what one knows about their learning style to other situations (i.e., solving problems, working in teams, and resolving conflict).

The *Facilitator's Guide to Learning* by Kolb (2000) helps the administrator to use the LSI Version 3 to understand individual learning styles. Kolb introduces the Experiential Learning Model which is a description of the learning cycle. He outlines how people learn, discusses the development and evolution of the LSI, and summarizes learning strengths and preferred learning situations that were found in learning style research. Technical specifications for the LSI Version 3 are also described in the guide.

Researchers have done critiques of the *Learning Style Inventory, Version 3.* For example, Cecil R. Reynolds, Professor of Educational Psychology, at Texas A&M University states that the LSI Version 3 may be a useful instrument, but the *Facilitator's Guide to Learning* by Kolb (2000) has some limitations. He believes data analyses were made to develop the LSI Version 3, but the findings and technical characteristics were described in general statements which may cause some confusion in determining the validity of the learning style scores. As a result of his review, he feels the LSI Version 3 provides little guidance to the user (Reynolds, n.d.).

David Shum, Senior Lecturer of Psychology, at Griffith University, Brisbane, Australia also agrees with Reynolds that the *Facilitator's Guide to Learning* (Kolb, 2000) that accompanies the LSI Version 3 does not provide adequate and suitable evidence to support the validity of the instrument. He points out that details of some variables are not presented. Although Shum is disappointed with the lack of data available in the manual, he does highlight that evidence is provided to support the reliability of the instrument. Additionally, he believes the strength of the LSI Version 3 is the ease of the tool to be administered, scored, and interpreted by users in a short period of time. Although this learning style instrument has some inadequacies, Shum sees the LSI Version 3 as being a popular instrument in educational literature that has the potential to be a useful tool (Shum, n.d.).

*Validity.* Validity is a vital characteristic of any measuring instrument. According to Ary, Jacobs, and Razavieh (1996), an instrument has validity if it measures what it is intended to measure. Validity is classified into the following categories: content, criterion-related, and construct validity.

Content validity demonstrates how well the content of the instrument measures the conditions of collected results (Isaac & Michael, 1995). It has been established in the LSI through the research of Kolb (1976 and 1981) and Smith and Kolb (1986). Throughout his research, Kolb undertook many studies in various disciplines — the arts, education, business, engineering, physical sciences, and social sciences — that revealed two facts: (1) learning styles affect the learning process, and (2) experimental learning techniques are not preferred by everyone.

The criterion-related validity, which is demonstrated by comparing the test scores with one or more external variables to measure observed behavior (Isaac & Michael, 1995), has been established in the LSI by its comparison to the Myers-Briggs Type Indicator (MBTI). Correlations between individual scores on the LSI and MBTI helped indicate the validity of the relationships between Carl Jung's personality types and the learning styles (Kolb, 1984). Based on Jung's work, Katherine Briggs and Isabel Briggs Myers developed the *Myers-Briggs Type Indicator* (MBTI), which "measures" personality and constructs eight personality preferences divided into four bi-polar scales (Hirsh & Kummerow, 1990). The indicator assesses an individual's orientation toward a personality type. The four scales and eight preferences measured by the MBTI include Extraversion-Introversion (EI), Sensing-Intuition (SN), Thinking-Feeling (TF), and Judging-Perceiving (JP), as shown in Table 5.

Table 5

*Four Scales and Eight Preferences Measured by the Myers-Briggs Type Indicator* (Hirsh & Kummerow, 1990, p. 4)

| *Scale* | *Description* | *Key Activity* |
|---|---|---|
| (EI) Extraversion-Introversion | How a person is energized | Energizing |
| (SN) Sensing-Intuition | What a person pays attention to | Attending |
| (TF) Thinking-Feeling | How a person decides | Deciding |
| (JP) Judging-Perceiving | Lifestyle a person adopts | Living |

Margerison and Lewis (1979) compared the LSI and MBTI of managers holding MBAs ($n$ = 220) and found a significant relationship between the two sets (LSI and MBTI) of test scores. Furthermore, comparing the LSI to the MBTI produced the following consistent correlations: the sensing type is associated with the accommodative learning style, the intuitive type falls in the assimilative quadrant, and the feeling personality type is divergent in learning style, and thinking types are convergent (Margerison & Lewis, 1979).

Construct validity is evaluated by examining qualities that a test measures by determining the degree of explanatory concepts or constructs which are based on performance (Isaac & Michael, 1995).

*Reliability.* In addition to validity, a measurement instrument must possess reliability, which "refers to the accuracy (consistency and stability) of measurement by a test" (Ary, Jacobs, & Razavieh, 1996). The LSI was deemed reliable based on analyses of Cronbach's Alpha, in which scores are not simply right or wrong (Ary, Jacobs, & Razavieh, 1996). The reliability coefficient value ranges between 0 and 1. The higher the measure, the greater the consistency among items. As noted in Table 6, the reliability of the LSI on the four basic scales of CE, RO, AC, and AE, and two combination scores for abstract–concrete and active–reflective, show good internal reliability (Smith & Kolb, 1986).

Table 6

*Cronbach Alpha Scores on the Learning Style Inventory* (Smith & Kolb, 1986, p. 97)

| *Constructs* | *Cronbach's Standardized Scale Alpha* |
|---|---|
| Concrete Experience (CE) | .82 |
| Reflective Observation (RO) | .73 |
| Abstract Conceptualization (AC) | .83 |
| Active Experimentation (AE) | .78 |
| Abstract - Concrete (AC – CE) | .88 |
| Active - Reflective (AE – RO) | .81 |

Split-half reliability is an internal-consistency measure of reliability that requires one administration of a test. According to Ary, Jacobs, and Razavieh

(1996), split-half "artificially splits the test into two halves and correlates the individuals' scores on the two halves" (p. 281). The correlation coefficient between the two halves must be calculated into a reliability estimate. The Spearman-Brown procedure, based on the assumption that the two halves are parallel, refers to the estimated reliability of the entire test (Ary, Jacobs, & Razavieh, 1996). Comparisons were made between the original LSI (OLSI) and the revised LSI. The strong correlations are listed below in Table 7 (Smith & Kolb, 1986):

Table 7

*Comparisons Between the Original Learning Style Inventory (1976) and the Revised Learning Style Inventory (1985)* (Smith & Kolb, 1986, p. 98)

| *Constructs* | *Split-Half Reliability 6 OLSI + 6 New Items (Spearman-Brown)* | *Correlation between OLSI and Total LSI 1985** |
|---|---|---|
| Concrete Experience (CE) | .81 | .89 |
| Reflective Observation (RO) | .71 | .87 |
| Abstract Conceptualization (AC) | .84 | .92 |
| Active Experimentation (AE) | .83 | .92 |
| Abstract-Concrete (AC – CE) | .85 | .92 |
| Active-Reflective (AE – RO) | .82 | .93 |

* All significant at $p < .001$

In addition to using the LSI Version 3 to gather data for this research study, the *My Point of View (MyPOV)* instrument adapted by Sharon Brusic (1991) was selected because it measures individual degree of curiosity. The MyPOV instrument was based on Barbara Leherissey's (1971a) instrument the *State Epistemic Curiosity Scale* (SECS). The self-administered MyPOV, a 20-item multiple-choice assessment instrument for fifth graders, was used to collect data on the dependent variable, degree of curiosity.

The *My Point of View* instrument was developed to assess curiosity (Brusic, 1991). To complete the MyPOV, participants mark the answers that fits how their feel. If they Agree, mark *1*; if they Do Not Agree, mark *2*. Higher scores indicate higher curiosity; lower scores indicate lower curiosity.

*Validity.* The validity of the MyPOV instrument has been established from Leherissey's (1971a) SECS instrument. The SECS was validated and had high content and construct validity. The MyPOV questionnaire was evaluated by a panel of five experts with expertise in educational measure, science education, technology education, or fifth grade teaching.

*Reliability.* The MyPOV instrument was deemed reliable based on statistical analyses. A field test was conducted in two fifth-grade classes at the same school. After the teachers administrated the tests, Brusic interviewed the students and teachers to receive feedback on the measures. Based on the field test responses from teachers' recommendations, students' comments, and the statistical analyses of students' tests, adjustments were made to the tests. Noted in Table 8 are the statistical results from the field test study (Brusic, 1991). Brusic computed moderate to high reliability estimates from the field test.

Table 8

*General Statistical Results for MyPOV Instruments Used in the Field Test Study* (Brusic, 1991, p. 104)

| *Statistic* | *MyPOV Form A Pretest* | *MyPOV Form B Posttest* |
|---|---|---|
| No. of Students | 26 | 51 |
| Mean No. Right [1] | 15.31 | 14.33 |
| Total No. Possible | 20 | 20 |
| Mean No. Omitted | .00 | .02 |
| Standard Deviation | 2.414 | 3.984 |
| Reliability Estimate (KR-20) | .649 | .832 |
| Standard Error of Measure | 1.431 | 1.632 |

[1] On the MyPOV instrument, high curiosity answers were scored as correct; low curiosity answers were scored as incorrect. Corrections were made for negatively worded items.

## Data Collection

A sample of middle school students (*n* = 116) from a mid-sized, suburban public school district in Virginia was selected in the spring of 2004 for the study. This study was conducted in the technology education classroom in three different middle schools. Schools were classified as School A, B or C. Students selected technology education as an elective subject. During the semester (18 weeks), three or four rotations of sixth graders completed three or four MTE activities every six weeks. Seventh and eighth graders completed seven or eight MTE activities during one semester (18 weeks). Participant selection procedures were the same at Schools

A and B, but different at School C (explained later). The current schools' practices were consistent in each classroom. Teachers did not manipulate the Synergistic Systems$^{TM}$ MTE framework.

With the teachers' approval, the investigator explained the project to each classroom of students during the last ten minutes of one class period. If students wanted to participate in the project (only at School C), they were given a research packet with a letter explaining the study and the parental/guardian consent form. The principal and teacher required these procedures in accordance with general school policy. A bookmark was given to each student to give their parent/guardian as a token of appreciation. Students were told if they participated they would be eligible to be selected for a small football or Hokie Bird. The letter asked parents/guardians to complete the consent form and have their child return the parent/guardian form directly to their teacher in the envelope provided. Each day thereafter the teacher prompted students to return their form, reminding them to remind their parents/guardians that by returning their form their child would be eligible to be selected for a small football or Hokie Bird.

If students wanted to participate in the project at Schools A and B, they were allowed to complete the instruments without parental/guardian consent. Administrators waived the requirements to retain consent because the instruments used in this study are functionally equivalent to standardized tests, which schools already have parental/guardian permission to administer. These students were also told if they participated they were eligible to be selected for a small football or Hokie Bird.

*Participant Selection-School A.* The MTE teacher at School A had 4 classes of students and 17 modules. The participants in this study were selected from the $2^{nd}$ ($8^{th}$ graders), $3^{rd}$ ($6^{th}$ graders), $4^{th}$ ($8^{th}$ graders), and $6^{th}$ period ($7^{th}$ and $8^{th}$ graders) classes. There were 58 students (44 boys and 14 girls) who elected to participate in this study. The teacher keyed the learners' names into the Synergistic Systems™ *On Schedule* computer program, which tracks the MTE activities the students had previously completed. Students were paired by this computer program and assigned to MTE activities. The program did not control for gender pairing and as a result there was a chance that students were paired with the same partner for more than one module. This situation was unlikely, but could have occurred due to the program's algorithm for the assignment of students to groups.

*Participant Selection-School B.* The MTE teacher at School B had 3 classes of students and 14 modules. Participants in this study were selected from the $6^{th}$ and $7^{th}$ period classes ($8^{th}$ and $7^{th}$ graders, respectively). There were 40 students (37 boys and 3 girls) who elected to participate in this study. The teacher keyed the learners' names into the Synergistic Systems™ *On Schedule* computer program, which tracks the MTE activities the students had previously completed. Students were paired by this computer program and assigned to MTE activities. The program did not control for gender pairing and as a result there was a chance that students were paired with the same partner for more than one module. This situation was unlikely, but could have occurred due to the program's algorithm for the assignment of students to groups.

*Participant Selection-School C.* The MTE teacher at School C had 3 classes of students and 15 modules. Participants in this study were selected from the 3rd period class of 7th graders. There were 18 students (13 boys and 5 girls) who elected to participate in this study. Before learners started the MTE activities, the teacher asked them to rank the modules from one to fifteen, with one being the MTE activity the student "wanted to do most." Students could not select a MTE activity they had already completed. The teacher keyed the students' names and their MTE activity rankings into the Synergistic Systems™ *On Schedule* computer program, which then assigned students in pairs to the various modules taking into account their selected MTE activity preference. However, there was no guarantee that students would be assigned their top choices. Only one pair of learners could complete a certain modular activity per rotation. Because girls and boys discussed their preference for modular selection with each other, and given that the computer program did not randomize gender pairing, there was possible bias resulting in the overrepresentation of girl/girl and boy/boy gender pairs. The program did not control for gender pairing and as a result there was a chance that students were paired with the same partner for more than one module. This situation was unlikely, but could have occurred due to the program's algorithm for the assignment of students to groups. Data were only collected from those students in School C who returned the parent/guardian form. Therefore, it is possible that data were only collected from one student in the gender pair.

*MTE Activity Procedures*

The participant selection process resulted in the following pairing of students: (1) first modular activity – 5 pairs of girl/girl, 12 pairs of girl/boy, and 34 pairs of boy/boy; (2) second modular activity - 3 pairs of girl/girl, 16 pairs of girl/boy, and 35 pairs of boy/boy; and (3) third modular activity - 5 pairs of girl/girl, 12 pairs of girl/boy, and 38 pairs of boy/boy. Students in each school completed a MTE activity in 7-10 days. After completing each MTE activity, the Synergistic Systems™ *On Schedule* computer software assigned students a new MTE activity with a new partner. The researcher followed the data collection procedures in Appendix B to collect data from each student using the LSI Version 3, to determine students' learning style, and the MyPOV instrument to measure students' individual degree of curiosity. Administration of the instruments took place in a separate location within the learners' classroom.

After students completed one of three consecutive MTE activities, the investigator administered the LSI Version 3. Each question was read aloud. Administration time took approximately 15 minutes. After students completed each MTE activity, the researcher administered the MyPOV instrument. Each question was read aloud. Each administration took approximately 10 minutes. Prior to administering the instruments, the researcher told the students that if they needed additional help to complete the instruments, she would be available after the allotted time to answer any questions. The researcher scored the instruments.

## Data Analysis

To make quality inferences from the data, frequency data which categorizes results and descriptive statistics (*means* and *standard deviations*) were used to describe the scores. Means are arithmetic averages of the scores, while standard deviations represent the variance in the original units as a measure of dispersion from the mean. A significance level of .05 was used for all statistical tests.

A multiple linear regression analysis was used to test how well the independent or predictor variables (gender groupings and learning styles) predicts the dependent or criterion variable (degree of curiosity). This analysis predicts or estimates scores on a Y variable based on knowledge of scores on an X variable (Green, Salkind, & Akey, 2000). The predictor variables are students' different gender groupings (girl/girl, boy/boy, and girl/boy) and different learning styles (i.e., Accommodating, Converging, Diverging, and Assimilating). The criterion variable is the participants' scores on the MyPOV instrument.

The variables form a regression equation where one variable is able to predict another (Green, Salkind, & Akey, 2000) and shape a three dimensional best fit plane. The equation also includes (1) a regression coefficient, the rate of change of Y when X changes 1 unit; and (2) a regression constant, point where the regression plane crosses the dependent variable (Y) axis. The Statistical Package for the Social Sciences (SPSS) computer software was used to analyze the data.

Other important components of the multiple regression analysis are the *F*-test and *t*-test (Green, Salkind, & Akey, 2000). The *F*-test determines the strength of the regression model. While the *t*-test assesses whether the independent variables predict the dependent variable.

*Testing the Null Hypothesis.* A multiple linear regression analysis was used to test:

$H_{o:}$ There is no significant relationship between the pairing of students of different gender groupings (girl/girl, boy/boy, and girl/boy) and different learning styles (i.e., *Accommodating, Converging, Diverging*, and *Assimilating)* in the prediction of degree of curiosity.

This hypothesis was answered with the following regression equation:

$Y = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3 + B_4 X_4 + B_5 X_5$. Where Y = Degree of curiosity score; $B_0$ = regression constant; $X_1$ = Assimilating; $X_2$ = Converging; $X_3$ = Diverging; $X_4$ = boy/boy pair; and $X_5$ = girl/boy pair. The variables gender groupings and learning styles were dummy coded into dichotomous variables so that they could be entered into the regression model and interpreted. The result was one less dummy variable than the number of categories (Hedderson & Fisher, 1993).

## Summary

The *Learning Style Inventory, Version 3,* scores on the *My Point of View* (MyPOV*)* instrument, and a multiple linear regression analysis were used to determine whether gender groupings and learning styles predict degree of curiosity of middle school students in MTE classrooms in a mid-sized, suburban public school district in Virginia.

# CHAPTER FOUR: FINDINGS

## Overview

This study was designed to determine whether in a modular technology education (MTE) classroom, gender groupings and learning styles predict degree of curiosity. Based on the assumption that gender grouping and learning style are factors that influence the degree of curiosity of both individuals and teams, it was hypothesized that a student's learning style (i.e., *Accommodating, Converging, Diverging*, and *Assimilating*) and gender grouping (*girl/girl, boy/boy*, and *girl/boy*) at the module would be essential elements to consider when measuring the degree of curiosity of learners in MTE classrooms. A multiple linear regression analysis was used to investigate this premise.

## Demographics

Middle school students (*n* = 116) enrolled in technology education in three different schools participated in this study. Ninety-four (81%) of the students were boys and twenty-two (19%) were girls as shown in Table 9. In addition, students were situated in a mid-sized, suburban public school district in Virginia. The technology education programs utilized Synergistic Systems™ Modules.

Table 9

*Spring 2004 Sample of Middle School Students Enrolled in Technology Education in the Selected Virginia Middle Schools (n = 116)*

| *School* | *Gender* | |
|---|---|---|
| | Girls | Boys |
| School A | 14 | 44 |
| School B | 3 | 37 |
| School C | 5 | 13 |
| Total | 22 (19%) | 94 (81%) |

In Chapter 2, four learning styles taken from the *Learning Style Inventory* (LSI) developed by Kolb (1984) were outlined. Briefly, *Convergers* rather deal with technical tasks and problems. *Divergers* prefer to generate ideas, as in a brainstorming session. *Assmililators* are interested in abstract ideas and concepts. *Accommodators* learn from “hands-on” experience (Kolb, 1985). Depending on the learning situation, behavior may change (Kolb, 2000).

To identify the type of learners participating in this study, descriptive statistical analyses were done. The results of this study revealed that, of the one hundred and one participants who completed the LSI, only 17 (17%; 4 girls, 13 boys) would rather deal with technical tasks and problems or are Convergers. There were 25 subjects (25%; 6 girls, 19 boys) who preferred to brainstorm ideas or are Divergers. Only 24 participants (24%; 2 girls, 22 boys) were interested in abstract ideas and concepts or are Assmililators. The remaining 35 subjects (35%; 8 girls, 27 boys) learned from "hands-on" experience or are Accommodators. These data were summarized in Table 10.

Table 10

*Participants learning style by gender (n = 101)*

| *Learning Style* | *Gender* | |
|---|---|---|
| | Girls | Boys |
| Accommodating | 8 (8%) | 27 (27%) |
| Converging | 4 (4%) | 13 (13%) |
| Diverging | 6 (6%) | 19 (19%) |
| Assimilating | 2 (2%) | 22 (22%) |
| Total | 20 (20%) | 81 (80%) |

To determine the degree of curiosity of learners participating in this study, descriptive statistical analyses were done. Subjects completed the MyPOV three times; once after each module. The results of this study revealed that, the mean curiosity scores for students at School B were lower than students at Schools A and C. Of the participants who completed the MyPOV, frequencies, means, and standard deviations of the scores by school are presented in Table 11.

Table 11

*Frequencies, Means, and Standard Deviations for Students' Curiosity Scores by School*

| *School* | *Score 1* | | | *Score 2* | | | *Score 3* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SD* | *n* | *M* | *SD* | *n* | *M* | *SD* |
| School A | 56 | 11.55 | 2.51 | 57 | 10.79 | 2.36 | 54 | 10.74 | 2.80 |
| School B | 36 | 8.97 | 3.33 | 37 | 8.27 | 2.62 | 34 | 8.06 | 3.18 |
| School C | 18 | 11.44 | 1.98 | 18 | 10.61 | 2.48 | 18 | 10.94 | 2.65 |
| Total | 110 | 10.69 | 2.96 | 112 | 9.93 | 2.71 | 106 | 9.92 | 3.15 |

Note: A higher mean score indicates higher curiosity.

To determine the degree of curiosity of learners in this study by gender, gender grouping, and learning style, descriptive statistical analyses were done. The results of this study revealed that the curiosity scores for girls were higher than boys, overall scores for girl/girl groupings were higher than girl/boy and boy/boy groupings, and scores for girl/boy groupings were higher than boy/boy groupings. Additionally, scores for students by learning style showed that participants that preferred to deal with technical tasks and problems or Converging had the highest scores followed by Assimilating, Accommodating and Diverging. Of the students who completed the MyPOV, frequencies, means, and standard deviations of the scores by gender, gender grouping, and learning style are presented in Tables 12, 13, and 14, respectively.

Table 12

*Frequencies, Means, and Standard Deviations for Students' Curiosity Scores by Gender*

| *Gender* | *Score 1* | | | *Score 2* | | | *Score 3* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SD* | *n* | *M* | *SD* | *n* | *M* | *SD* |
| Girl | 20 | 11.25 | 2.97 | 22 | 10.59 | 2.86 | 20 | 10.90 | 2.90 |
| Boy | 90 | 10.57 | 2.96 | 90 | 9.77 | 2.67 | 86 | 9.69 | 3.17 |
| Total | 110 | 10.69 | 2.96 | 112 | 9.93 | 2.71 | 106 | 9.92 | 3.15 |

Note: A higher mean score indicates higher curiosity.

An independent-samples *t*-test was done to evaluate the difference between the means of the genders. According to the analyses, the tests were not significant, $t(108) = .932$, $p = .353$ (Score 1), $t(110) = 1.282$, $p = .202$ (Score 2), and $t(104) = 1.564$, $p = .121$ (Score 3).

Table 13

*Frequencies, Means, and Standard Deviations for Students' Curiosity Scores by Gender Grouping*

| *Gender Grouping* | *Score 1* | | | *Score 2* | | | *Score 3* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SD* | *n* | *M* | *SD* | *n* | *M* | *SD* |
| Girl/girl | 5 | 12.00 | 2.12 | 3 | 9.33 | 1.16 | 5 | 12.20 | 1.79 |
| Boy/boy | 34 | 10.39 | 2.88 | 35 | 9.85 | 2.72 | 38 | 9.49 | 3.10 |
| Girl/boy | 12 | 11.29 | 2.57 | 16 | 10.40 | 2.94 | 12 | 10.00 | 3.43 |
| Total | 51 | 10.75 | 2.78 | 54 | 10.00 | 2.76 | 55 | 9.74 | 3.15 |

Note: A higher mean score indicates higher curiosity.

A one-way analysis of variance was conducted to evaluate whether the gender grouping means differed significantly from each other. According to the analyses, the *F*-tests revealed no significant differences in gender groupings, $F(2, 97) = 1.65$, $p = .198$ (Score 1), $F(2, 95) = .50$, $p = .608$ (Score 2), and $F(2, 92) = 1.84$, $p = .165$ (Score 3).

Table 14

*Frequencies, Means, and Standard Deviations for Students' Curiosity Scores by Learning Style*

| *Learning Style* | *Score 1* | | | *Score 2* | | | *Score 3* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *n* | *M* | *SD* | *n* | *M* | *SD* | *n* | *M* | *SD* |
| Accommodating | 35 | 11.14 | 2.17 | 34 | 9.59 | 2.39 | 33 | 10.09 | 2.81 |
| Converging | 17 | 11.88 | 2.83 | 17 | 11.41 | 2.58 | 17 | 10.82 | 3.03 |
| Diverging | 25 | 9.84 | 3.38 | 24 | 9.21 | 2.62 | 20 | 9.70 | 3.21 |
| Assimilating | 24 | 11.04 | 2.82 | 24 | 10.25 | 2.85 | 23 | 9.74 | 3.55 |
| Total | 101 | 10.92 | 2.81 | 99 | 9.97 | 2.66 | 93 | 10.05 | 3.11 |

Note: A higher mean score indicates higher curiosity.

## Data Analysis

To determine whether gender groupings and learning styles predict the degree of curiosity of middle school students in modular technology education (MTE) classrooms in a mid-sized, suburban public school district in Virginia, the following null hypothesis was tested:

$H_{o:}$ There is no significant relationship between the pairing of students of different gender groupings (girl/girl, boy/boy, and girl/boy) and different learning styles (i.e., *Accommodating, Converging, Diverging*, and *Assimilating)* in the prediction of degree of curiosity.

The predictors were gender groupings (*girl/girl, boy/boy,* and *girl/boy*) and learning styles (i.e., *Accommodating, Converging, Diverging*, and *Assimilating)*, while the criterion variable was the degree of curiosity.

A multiple regression analysis was conducted to evaluate how well gender groupings and learning styles predicted degree of curiosity. Of the several types of regression procedures, the pairwise deletion option was used in the analysis. This process calculates cases that include both variables in the correlation coefficient even if it has missing data on another variable in the matrix (Fox, 1992). According to the regression analyses for the three schools, the *F*-tests revealed that the linear combination of gender groupings and learning styles were not significantly related to degree of curiosity, $R^2 = .09$, adjusted $R^2 = .04$, $F(5, 86) = 1.65$, $p = .155$ (Score 1), $R^2 = .09$, adjusted $R^2 = .04$, $F(4, 79) = 1.84$, $p = .130$ (Score 2), and $R^2 = .02$, adjusted $R^2 = -.03$, $F(4, 73) = .382$, $p = .821$ (Score 3). The sample multiple correlations coefficients were .30 (Score 1), .29 (Score 2), and .14 (Score 3). Indicating that approximately: (1) 9% of the variance of degree of curiosity in each of the Score 1 and 2 samples can be accounted for by the linear combination of gender groupings and learning styles, and (2) 2% of the variance of degree of curiosity in the Score 3 sample can be accounted for by the linear combination of gender groupings and learning styles. When examining whether the independent variables predicted the dependent variable, the *t*-tests revealed that the Converging learning style, $t(79) = 2.06$, $p =.043$, in Score 2 was the only significant predictor variable with this sample. See Table 15 for the relationships between gender groupings and learning styles in the multiple regression analyses.

Table 15

*Summary of Multiple Regression Analyses for Variables Predicting Degree of Curiosity for the Three Schools*

| Variable | *B* | *SE B* | β |
|---|---|---|---|
| Module 1 | | | |
| Assimilating | .09 | .82 | .01 |
| Converging | .88 | .91 | .11 |
| Diverging | -1.22 | .81 | -.18 |
| Boy/boy pair | -1.36 | 1.43 | -.22 |
| Girl/boy pair | -.38 | 1.48 | -.06 |
| Module 2 | | | |
| Assimilating | .65 | .77 | .10 |
| Converging | 1.79 | .87 | .25 |
| Diverging | -.42 | .77 | -.07 |
| Girl/boy pair | .40 | .63 | .07 |
| Module 3 | | | |
| Assimilating | -.33 | .97 | -.05 |
| Converging | .78 | 1.08 | .09 |
| Diverging | -.36 | .96 | -.05 |
| Girl/boy pair | .46 | .89 | .06 |

Note: Accommodating and girl/girl pair have a standardized mean of 0 and a standard deviation of 1.

The model summary in Table 15 interprets the coefficients of the variables relative to the learning style Accommodating and gender grouping girl/girl. The Score 1 analysis resulted in Assimilating making .09 curiosity points more, Converging making .88 points more, and Diverging making 1.22 points less than Accommodating. Boy/boy pairs made 1.37 curiosity points less and girl/boy pairs made .38 points less than girl/girl pairs.

The Score 2 analysis resulted in Assimilating making .65 curiosity points more, Converging making 1.79 points more, and Diverging making .42 points less than Accommodating. Girl/boy pairs made .40 curiosity points more than girl/girl pairs. The variable boy/boy was excluded from the analysis because of the extensive correlation between the independent variable girl/boy. Low correlations between the independent variables are sought (Green, Salkind, & Akey, 2000).

The Score 3 analysis resulted in Assimilating making .33 curiosity points less, Converging making .78 points more, and Diverging making .36 points less than Accommodating. Girl/boy pairs made .46 curiosity points more than girl/girl pairs. The variable boy/boy was excluded from the analysis because of the extensive correlation between the independent variable girl/boy. Convergers consistently scored higher points and Divergers consistently scored lower points. There were no consistencies in the gender groupings' points.

## Summary

The researcher presented the findings of the current study in this chapter. Descriptive statistical analysis revealed that boys (81%; $n$ = 94) continue to outnumber girls (19%; $n$ = 22) in technology education classrooms. The preferred learning styles of the participants (*n* = 101) were Accommodating (35%), learning from "hands-on" experience, followed by Diverging (25%), preferring to brainstorm ideas, Assimilating (24%), interested in abstract ideas and concepts, and Converging (17%), rather deal with technical tasks and problems.

Mean curiosity scores for students were analyzed by school. Results revealed scores from School B were lower than students at Schools A and C. Mean curiosity scores for students were also analyzed by gender, learning style, and gender grouping. Statistics revealed that scores for girls were higher than boys. An independent-samples *t*-test was done to evaluate the difference between the means of the genders. According to the analyses, the tests were not significant, $t(108) = .932$, $p = .353$ (Score 1), $t(110) = 1.282$, $p = .202$ (Score 2), and $t(104) = 1.564$, $p = .121$ (Score 3).

Overall scores for girl/girl groupings were higher than girl/boy and boy/boy groupings, and scores for girl/boy groupings were higher than boy/boy groupings. A one-way analysis of variance was conducted to evaluate whether the gender grouping means differed significantly from each other. According to the analyses, the *F*-tests revealed no significant differences in gender groupings, $F(2, 97) = 1.65$, $p = .198$ (Score 1), $F(2, 95) = .50$, $p = .608$ (Score 2), and $F(2, 92) = 1.84$, $p = .165$ (Score 3). Additionally, scores for students by learning style showed that participants that preferred to deal with technical tasks and problems or Converging had the highest scores followed by Assimilating, Accommodating and Diverging.

A multiple regression analysis was conducted to test if there was a significant relationship between the pairing of students of different gender groupings (*girl/girl, boy/boy,* and *girl/boy*) and different learning styles (i.e., *Accommodating, Converging, Diverging*, and *Assimilating)* in the prediction of degree of curiosity. The *F*-tests revealed that the linear combination of gender groupings and learning styles for the three schools were not significantly related to degree of curiosity, $R^2 = .09$, adjusted $R^2 = .04$, $F(5, 86) = 1.65$, $p = .155$ (Score 1), $R^2 = .09$, adjusted $R^2 = .04$, $F(4, 79) = 1.84$ , $p = .130$ (Score 2), and $R^2 = .02$, adjusted $R^2 = -.03$, $F(4, 73) = .382$, $p = .821$ (Score 3). The *t*-tests analyses indicated that the Converging learning style, $t(79) = 2.06$, $p = .043$, in Score 2 was the only significant predictor variable with this sample.

# CHAPTER FIVE: SUMMARY, CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

## Summary

In this study gender groupings (*girl/girl, boy/boy*, and *girl/boy*) and learning styles (i.e., *Accommodating, Converging, Diverging*, and *Assimilating*) were assessed to predict degree of curiosity in a MTE classroom. The researcher examined middle school students in grades 6-8.

A quasi-experimental design was used to conduct a one-shot case study. In addition, two different instruments were used to collect data: (1) the *Learning Style Inventory (LSI), Version 3* developed by Kolb (2000), and (2) the *My Point of View* (MyPOV) instrument adapted by Brusic (1991) and based on Leherissey's (1971a) *State Epistemic Curiosity Scale* (SECS).

Participants (*n* = 116; 20 girls and 96 boys) in this study included students from a mid-sized, suburban public school district in Virginia and three MTE teachers from different schools. The students from seven classroom settings participated in MTE activities using Synergistic Systems™ modules. There were one class of 6$^{th}$ graders, one of 7$^{th}$ and 8$^{th}$ graders, two of 7$^{th}$ graders, and three of 8$^{th}$ graders. The students chose technology education among other elective options.

## Conclusions

The analysis of the relationships among the variables in this study revealed several interesting outcomes. Although all participants were from the same school system, findings revealed that mean curiosity scores for School B were lower than students at Schools A and C. This difference may indicate that other variables (teacher effect, school effect, and/or community setting) may have influenced the variance in the results.

As was expected, the participants preferred the Accommodating (35%) learning style, learning from "hands-on" experiences. This result was consistent with Harnnisch, Gierl, and Migotsky's (1995) study which revealed that students felt the best parts of the labs were the hands-on tasks. Overall the subjects in this sample had different learning styles. Other learning styles the students preferred were Diverging (25%), preferring to brainstorm ideas, Assimilating (24%), interested in abstract ideas and concepts, and Converging (17%), rather deal with problems. A small number of the participants were Convergers. This is a surprising result because modular technology education emphasizes problem solving to learn about technology (Hill, 1997). Although a few students preferred to deal with technical tasks and problems, Converging had the highest curiosity scores followed by Assimilating, Accommodating, and Diverging.

Descriptive data analyses in this study indicated that students with high degrees of curiosity scores in MTE classrooms tended to be girls, girl/girl groupings, and learners who preferred to deal with technical tasks and problems or Converging. Students with low degrees of curiosity scores tended to be boys, boy/boy groupings, and learners that preferred to brainstorm ideas or Diverging.

These results show that girls are curious about technology education. Furthermore, teachers and other educators should continue to encourage girls to enroll in technology education classes.

The following conclusions were drawn from the following research question:

1. Does the pairing of students of different gender groupings (girl/girl, boy/boy, and girl/boy) and different learning styles (i.e., *Accommodating, Converging, Diverging*, and *Assimilating)* predict degree of curiosity?

The *F*-tests revealed that the linear combination of gender groupings and learning styles for the three schools were not significantly related to degree of curiosity, $R^2$ = .09, adjusted $R^2$ = .04, $F(5, 86) = 1.65$, $p = .155$ (Score 1), $R^2$ = .09, adjusted $R^2$ = .04, $F(4, 79) = 1.84$ , $p = .130$ (Score 2), and $R^2$ = .02, adjusted $R^2$ = -.03, $F(4, 73) = .382$, $p = .821$ (Score 3). The *t*-tests indicated that the Converging learning style, $t(79) = 2.06$, $p =.043$, in Score 2 was the only significant predictor variable with this sample.

## Discussion

Participants in this study were selected from the same population of middle school students who chose technology education among other elective options. Although the researcher assumed that the learners were similar in the three data collection sites, results revealed that School B appeared to be different from Schools A and C. Mean curiosity scores for School B were lower than students at Schools A and C. In addition, the researcher did observe a high absentee rate and discipline problems at School B, but could not conclude that these two factors caused the lower scores. Although findings indicated a difference in schools, this study was not designed to look at between school differences.

The pairs worked well together, groups with a girl appeared to be more focused on their modular activities based on the researcher's personal observations. Boys appeared to spend less time on their tasks. Students seemed to enjoy the Robots and Flight Technology modules most. No observations were made to suggest the learners' least favorite modules or if girls or boys preferred certain modular activities. Personal conversations with the learners revealed that students enjoy working in teams, learning different types of technologies, and doing "hands-on" activities in a modular classroom.

## Recommendations for Further Research

The results of this study showed that gender grouping and learning style do not predict degree of curiosity in modular technology education laboratories. However, this study revealed that students learn differently, it appeared that girls have higher degrees of curiosity than boys as measured by the MyPOV instrument, girl/girl groupings have higher degrees of curiosity than girl/boy and boy/boy groupings, and girl/boy groupings have higher degrees of curiosity than boy/boy groupings in a MTE laboratory. Furthermore, to provide greater generalization of these results, the following recommendations are proposed:

1. This study should be replicated in other schools with more students, especially girls, and in different (rural, urban, and inner city) settings.

2. A quasi-experimental design was used in this study to conduct a one-shot case study. Additional research should be done on this population using another experimental research design with more control.
3. This study was delimited to students who chose technology education as an elective. This study should be replicated in school systems in which all students are required to take technology education.
4. Other variables may have influenced students' degree of curiosity in this study. Future studies might examine contextual effects to include teacher effects, school effects, absentee rate, discipline problems, and community setting on the measure of curiosity.

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# Appendix A: Synergistic Systems$^{TM}$ Modules

## Synergistic Systems$^{TM}$ Modules

Synergistic Systems$^{TM}$ modules (see Table 16) include the following foundation principles:

1. The system is student-centered; components (environment, curricula, etc.) designed to accommodate students' learning styles and how they can be encouraged to succeed.

2. The curriculum is module based; modules focus on concepts that are future relevant.

3. Students work cooperatively in pairs; cooperative learning is a foundational element in the system.

4. Modules are based on the Synergistic Module Framework; learning, information delivery, hands-on experience and classroom management may be attained consistently.

5. Learning occurs at self-sufficient workstations; everything the learning team needs is located in the learning environment (Synergistic Systems, n.d.).

Table 16

*Types of Synergistic Systems$^{TM}$ Modules* (Synergistic Systems, n.d.)

| | |
|---|---|
| • Applied Physics | • Engineering Bridges |
| • Audio Broadcasting | • Engineering Towers |
| • Biotechnology | • Flight Technology |
| • Career Explorations | • Graphic Communications |
| • Computer Graphics & Animation | • Research and Design |
| • Digital Imaging | • Robots |
| • Electricity | • Rocketry & Space |
| • Electronics | • Video Broadcasting |
| • Energy, Power & Mechanics | |

# Appendix B: Data Collection Procedures

## Data Collection Procedures

| No. | Task | Start Date | Finish Date |
|---|---|---|---|
| 1. | Meet with administrators, prospective teachers and principals to discuss details of the study, ask questions, and get their approval for students to participate in the project. | 6/2/03 | 6/25/03 |
| 2. | Submit Institutional Review Board (IRB) Form. | 1/04 | 1/04 |
| 3. | Prepare packets and order LSI forms. | 1/04 | 1/04 |
| 4. | Arrange dates for data collection in field sites | 1/04 | 5/04 |
| 5. | Students paired by computer program to modular activities. | 1/04 | 5/04 |
| 6. | During the last 10 minutes of one class period, the researcher explained the project to each classroom of students. Students agreeing to participate in the project (only at School C) were given a research packet with a letter explaining the study, the parental/guardian consent form, and a bookmark. The letter asked parents/guardians to complete the consent form and have their child return the form directly to their teacher in the envelope provided. Each day thereafter the teacher prompted students to return their form, reminding them to remind their parents/guardians that by returning their form their child would be eligible to be selected for a small football or Hokie Bird. Only students who returned the form participated in the study.<br><br>If students wanted to participate in the project at Schools A and B, they were allowed to complete the instruments without parental/guardian consent. These students were also told if they participated they were eligible for a small football or Hokie Bird.<br><br>All students received one free Virginia Tech pencil. Students who agreed to participate in the project were eligible to be selected for a small football or Hokie Bird. The participating teachers received one small Hokie Bird. | 2/04 | 4/04 |
| 7. | The drawing for prizes was conducted (teachers drew the names). | 2/04 | 5/04 |

| | | | |
|---|---|---|---|
| | After students completed one of three consecutive MTE activities, the LSI Version 3 was administered. Administration time approximately 15 minutes.<br><br>The MyPOV instrument was administered. Administration time approximately 10 minutes.<br><br>Each question was read aloud. Non-participants continued to work quietly on their MTE activity. | | |
| 8. | LSI, MyPOV and demographic data were input into SPSS. | 2/04 | 5/04 |
| 9. | After students completed second MTE activity, the MyPOV instrument was administered. Each question was read aloud. Administration time approximately 10 minutes. Non-participants continued to work quietly on their MTE activity. | 2/04 | 5/04 |
| 10. | After students completed third MTE activity, the MyPOV instrument was administered. Each question was read aloud. Administration time approximately 10 minutes. Non-participants continued to work quietly on their MTE activity. | 3/04 | 5/04 |
| 11. | Input MyPOV and demographic data. | 2/04 | 5/04 |
| 12. | Thank you letters sent to teachers and administrators. | 3/04 | 5/04 |
| 13. | Data were analyzed with SPSS. | 5/04 | 6/04 |

# Vita

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***EDUCATION***

*Doctor of Philosophy, Curriculum and Instruction*, September, 2004
Virginia Polytechnic Institute and State University, Blacksburg, VA
Dissertation: *The Effects of Gender Grouping and Learning Style on Student Curiosity in Modular Technology Education Laboratories*

*Master of Science, Adult Education*, 1996
North Carolina A&T State University, Greensboro, NC

*Bachelor of Science, Business Education*, 1988
East Carolina University, Greenville, NC

***TEACHING EXPERIENCE***

*Instructor*, Department of Graphic Communication Systems and Technological Studies, May 2000 – June 2000
North Carolina A&T State University, Greensboro, NC

- Taught an Advanced Photographic Imaging class
- Introduced students to principles, concepts, theories, and procedures of photographic imaging
- Prepared and delivered lectures
- Wrote examinations and graded assignments

*Teaching Assistant*, Faculty Development Institute (FDI), May 1999 - July 1999
Virginia Polytechnic Institute and State University, Blacksburg, VA

- Assisted faculty during workshops to communicate and learn the following skills/software: Blackboard, Photoshop, scanning, Microsoft Word, Eudora, creating PDF files and web pages

*Teaching Assistant (Practicum),* January 1996 - March 1996
Guilford Technical Community College, Greensboro, NC

- Helped students gain knowledge and master basic skills in reading and language
- Directed learning experiences with individuals and groups of adults
- Planned and designed curricula/need assessments
- Designed and implemented programs

## *PROFESSIONAL EXPERIENCE*

*Project Associate,* VA Tech Post-Baccalaureate Research and Education Program (VT-PREP)/Multicultural Academic Opportunities Program (MAOP), November 2003 – June 2004
Virginia Polytechnic Institute and State University, Blacksburg, VA

- Assisted in the development and oversight of the MAOP summer intern program
- Created reports on participants progress as needed and requested by directors
- Designed and carried out evaluation and assessment activities
- Assisted in preparing reports required for the PREP grant
- Participated in and helped coordinate activities for PREP and MAOP scholars in support of their academic progress and social adjustment
- Facilitated the transition of PREP participants to Virginia Tech
- Maintained close contact with PREP and MAOP students, providing mentoring, referrals, and support as needed
- Developed and maintained databases to track scholars participation, important partners and contacts
- Recruited scholars for VT-PREP and MAOP
- Helped facilitate a good work and learning experience for VT-PREP participants

*Graduate Assistant,* Multicultural Academic Opportunities Program (MAOP), August 1999 – November 2003
Virginia Polytechnic Institute and State University, Blacksburg, VA

- Developed and managed a network system to track former students and summer interns throughout their educational and career progress
- Contacted colleges and universities to recruit summer interns
- Assisted with summer research internship program - host 40 students, 10 weeks
- Assisted with mentor-mentee program – helped develop student programs
- Recruited students for graduate degree programs

*Summer Research Internship Coordinator,* Minority Academic Opportunities Program (MAOP), May 2002 - August 2002
Virginia Polytechnic Institute and State University, Blacksburg, VA

- Supervised graduate students
- Mentored 12 undergraduate interns from colleges and universities from around the country for a 10-week period
- Planned and coordinated student activities during the week and weekends for 30 student interns

*Graduate Assistant,* Technology Education Department, January 1999 – May 1999
Virginia Polytechnic Institute and State University, Blacksburg, VA

- Inputted data on modular technology education research from educational questionnaires

*Computer Lab Assistant,* Athletics Department, September 1998 – December 1998
Virginia Polytechnic Institute and State University, Blacksburg, VA

- Provided clients PC support in a laboratory environment

*Student Services Assistant,* School of Graduate Studies, November 1991 – December 1995
North Carolina A&T State University, Greensboro, NC

- Processed all graduate applications for admission
- Administered qualifying examination

### *HONORS AND AWARDS*

Chip & Susan Houston Scholarship, 2002
Paul D. Von Holtz Conference Incentive Award, 2001

### *GRANTS FUNDED*

Draper, S. R. (2004). *The Effects of Gender Grouping and Learning Style on Curiosity in Modular Technology Education Laboratories.* Council of Technology Teacher Education Research Incentive Grant. Reston, VA, $928.

Draper, S. R. (2003). *The Effects of Gender Grouping and Learning Style on Academic Achievement in Modular Technology Education.* Graduate Research Development Project (GRDP) Grant. Blacksburg, VA: Graduate Student Assembly, Virginia Tech, $500.

### *CERTIFIED TRAINING*

General Requirements for Applications in Commercial Offset Lithography (GRACoL), 2001

### *PROFESSIONAL MEMBERSHIPS*

Council on Technology Teacher Education (CTTE)
Epsilon Pi Tau, (EPT)
International Graphic Arts Education Association (IGAEA)
International Technology Education Association (ITEA)
Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS)

- Graduate Student Association (GSA) Representative, 2002 - 2003
- Member Executive Committee, MANRRS Region II Graduate Vice President, 2000 - 2001
- MANRRS National Student Officers Leadership Workshop, San Juan, Puerto Rico, 2000