

# **The Relationship Between Learning Style and Conventional or Modular Laboratory Preference Among Technology Education Teachers in Virginia**

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## **(Abstract)**

This study investigated the relationship between the laboratory environments and the learning styles of middle school technology education teachers in the Commonwealth of Virginia. Based on the assumption that a strong relationship between teaching and learning styles exists, it was hypothesized that teacher preference for one type of laboratory over another (conventional or modular) may be an issue of learning style.

A random sample (n=195) was drawn from the entire population (as identified by the Virginia Department of Education in 1998) of public middle school technology education teachers (N=392). Randomly selected teachers were mailed a cover letter, demographic questionnaire, postage-paid return envelope, the *Learning Type Measure* (LTM) instrument, and one dollar for taking the time to complete and return the instrument. The LTM instrument, demographic questionnaire and Bernice McCarthy's research on the 4MAT System of Leadership and Instruction were used to describe the laboratory environments and the teaching and learning styles of the respondents. Data collected were compared using contingency tables and Pearson's Chi-square analysis.

Eighty-three (42.5%) of the middle school teachers responded and sixty-five of the instruments (78%) were usable. The findings indicate that respondents were overwhelmingly male (94%) and had considerable teaching experience ( $\bar{x} = 17.4$ ). Sixty-percent of respondents taught in a modular laboratory and forty-percent taught

in a conventional laboratory. Of the four learning styles identified by the LTM (Imaginative, Analytic, Common Sense, and Dynamic), respondents overwhelmingly (69.2%) rated themselves as Common Sense learners. Common Sense learners as teachers encourage practical applications, are interested in productivity and competence, like technical things, use hands-on activities, and try to give students the skills they will need to be economically independent in life. These findings are consistent with previous research involving the personalities and learning styles of industrial arts/technology educators.

The self-perceived learning styles of respondents were significantly different when compared to McCarthy's findings for secondary teachers and administrators in general. However, the learning styles of respondents in conventional laboratories were not significantly different than the learning styles of respondents in modular laboratories. Though it seems logical that learning style might explain laboratory preference, this notion was not supported by this study.

To  
Montessa Lynn Reed...  
friend, wife, keeper of my heart.

## **Modular Technology Education**

"...discussion about the pro's and cons [of modular technology education] has become a moot point. Like it or not, modules are here and probably are not going anywhere soon. As a profession, I think we are better off looking at how classroom teachers and teacher educators work with the concept of modular TE.

...first-hand experience showed me the awesome influence modular programs have on students, the community, and on getting TE "out of the basement." At the same time, however, I saw many great teachers become sheep following the commercial shepherd. This is what we need to focus on. Many vendors point out the flexibility of their programs but we all know that any great program, modular or traditional, relies on great teachers. How do we focus our pre-service and in-service training for modular [lab] teachers?"

Philip A. Reed

March 4, 1999

Posting to the International Technology Education Association's (ITEA) Listserv  
*Changing Industrial Arts to Technology Education*

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# Chapter 1. Nature of the Study

## Overview

Laboratory instruction has long been a cornerstone of technology education pedagogy. Bennett (1926) noted that the French realized the potential for technical laboratory instruction within general education in 1865. By the 1880's, the United States also realized the benefits of the laboratory for technical instruction in general education (Anderson, 1926). Despite these early roots and the continued practice of utilizing laboratory instruction within technology education, there is little research to support this teaching method (McCrary, 1987). The paradigm shift from industrial arts to technology education has only heightened the need for research on laboratory instruction.

When the American Industrial Arts Association (AIAA) changed its name to the International Technology Education Association (ITEA) at the 1985 San Diego conference, concerns over content and facilities resulted. Dean (1997) noted the bewilderment:

I saw confusion and concern among my friends in the field. What is technology education? There was a whole group of teachers in complete disarray. They were being told to teach a content area with no definition and warned that the old content had fallen out of favor. They were being told to change and how to change, but again, the ability to transfer this theory into the average teacher's classroom was in doubt (p. 76).

After the 1985 conference, Max Lundquest and Mike Neden created a laboratory in Pittsburg, Kansas to reflect their vision of the new technology education paradigm. According to Dean (1997), the laboratory at Pittsburg Middle School was the beginning of modular technology education (MTE). Since the middle of the 1980's, MTE has grown considerably. Brusick and LaPorte (1999) found that almost half of

the technology education teachers in Virginia teach in some type of modular lab. Despite such research, opinions concerning the merit of MTE dominate the field of technology education, especially commercially created packages. To help teachers, administrators, and teacher educators better understand laboratory instruction within technology education, this study will describe the learning styles of modular and conventional laboratory teachers in the Commonwealth of Virginia. This study will also highlight the need for technology educators to understand their learning style and how it influences their teaching style.

## Statement of the Problem

The problem investigated in this study was to determine if technology education teachers who teach in modular laboratories have different learning styles than technology teachers who teach in conventional laboratories. Based on the assumption that a strong relationship between teaching and learning styles exists, it was hypothesized that teacher preference for one type of laboratory over another (conventional or modular) may be an issue of teaching and learning style.

## Importance of the Study

This study was the result of conflicting research, leadership, and opinion within the field of technology education concerning middle school instruction. Particular confusion is in the implementation of modular technology education (MTE) laboratories. Among these conflicts, Foster and Wright (1996) showed that selected leaders in technology education favor the use of modular technology education laboratories at the middle school level. In a second survey, however, deGraw and Smallwood (1997) found that seventy-seven percent of their sample disagreed with the elimination of large scale forming and shaping equipment even though they favored the scope of the modular approach. These findings, along with the many editorials and opinions written on MTE (see Petrina, 1993; Gloeckner and Adamson, 1996; Pullias, 1997; Starkweather, 1997; Rogers, 1998a), highlight some of the disagreement concerning laboratory instruction at the middle school level in technology education.

Despite emerging research investigating the differences between conventional laboratories and modular laboratories, the amount of opinion written on the subject far outweighs the amount of scholarly research. This study is intended to supplement the research concerning middle school laboratory instruction in three ways. First, this study highlights the importance for classroom teachers to know their own learning style and how it influences their teaching style. Second, teacher educators can benefit from this research by understanding how teaching and learning styles influence laboratory preference. When shared with future teachers, this knowledge can help with decisions concerning career goals, instructional approaches, and understanding students. Third, state and local supervisors can use these research findings when conducting in-service training or when designing and renovating laboratories.

The importance for teachers to understand their own learning style and how it affects their teaching style is clearly highlighted by Kuchinskas (1979). Classroom teachers who know their preferred learning style tend to use a variety of teaching methods to reach a wider range of student learning styles (Dunn and Dunn, 1979; Cornett, 1983; Marshall, 1991). Teachers who are not aware of their preferred learning style tend to teach to the style in which they learn the best. Teaching within one's comfort zone often excludes other learning styles and can frustrate many students.

Teacher educators also have a tremendous influence on the teaching methods of secondary technology teachers. Rogers (1998a) suggested that many teacher education programs are not preparing teachers for the type of laboratory environment they will typically face upon graduation. By incorporating teaching and learning style research into teacher education programs, however, pre-service teachers would have the flexibility to adapt to many different teaching situations when they begin their career in the classroom. Hopefully, this research will enlighten teacher educators and beginning teachers to the potential of teaching and learning style research. The importance for teachers to feel comfortable in their work

environment is advocated by many learning and teaching style researchers (see Simon and Byrum, 1977; Myers and Myers, 1980; Lawrence, 1982).

Burke and Wagner (1999) claimed that newer conventional laboratories are the most successful programs because they are based on local vision. This study was designed to add to the limited research on laboratory instruction within technology education. State and local supervisors can use this study as one tool to create programs based on research from classroom teachers instead of sales pitches and commercial packages. Supervisors can also help in-service teachers realize that teaching and learning style research creates awareness about individuality and aids in flexible learning environments.

## Hypotheses

The following hypotheses were developed from the problem statement and the review of related literature. The null form of these hypotheses is presented in chapter three.

H<sub>1a</sub>: Middle school technology education teachers who teach in modular laboratories have different teaching and learning styles from those who teach in conventional laboratories.

H<sub>2a</sub>: Middle school technology education teachers generally have different teaching and learning styles from secondary teachers in general.

## Definitions of Terms

The following operational definitions were assigned to the terms in this study by their intended meaning or by their meanings in the context of their cited references:

1. **Conventional technology education laboratory:** For the purpose of this study, a conventional technology education laboratory is any laboratory not identified as modular (see definition of modular technology education laboratory below).

- 2. Learning style:** "The composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment. It is demonstrated in that pattern of behavior and performance by which an individual approaches educational experiences. Its basis lies in the structure of neural organization and personality which both molds and is molded by human development and the learning experiences of home, school, and society" (National Association of Secondary School Principals in Keefe and Ferrell, 1990, p. 59).
- 3. Middle school:** A formal instructional environment consisting of sixth, seventh and eighth grade-levels.
- 4. Modular technology education laboratory:** "A modular laboratory is completely (or nearly completely) organized such that students rotate among content modules in which all of the instructional materials and equipment are provided, requiring minimal assistance or instruction from the teacher. Modular laboratories may be purchased from vendors such as Lab 2000<sup>®</sup> or Synergistics<sup>®</sup>, or they may be developed by the teacher" (Brusic and LaPorte, 1999).
- 5. Teaching style:** "A set of attitudes and actions that open a formal and informal world of learning to students. The powerful force of the teacher's attitude toward students as well as the instructional activities used by the teacher shape the learning/teaching experience and require of the teacher and student certain mediation abilities and capacities" (Butler, 1984, p. 3).
- 6. 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 and Lauda, 1993, p. 3).

7. **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 and Lauda, 1993, p. 4).
8. **Technology education teacher:** A person employed to teach technology education courses at the middle school level in the public schools of Virginia.

## Procedures and Instrumentation

A random sample was drawn from the entire population (as identified by the State Department of Education in 1998) of middle school technology education teachers in the Commonwealth of Virginia. Randomly selected teachers were mailed a cover letter (Appendix B), demographic questionnaire (Appendix C), postage-paid return envelope, the *Learning Type Measure* instrument (Appendix D), and one dollar for taking the time to complete and return the instrument.

The *Learning Type Measure* instrument (LTM) is published by About Learning, Incorporated of Wauconda, Illinois (formerly named Excel, Inc.). The LTM instrument is well grounded within learning style research and McCarthy's (1981) research on the 4MAT System of leadership and instruction (Excel, 1998). The underlying theories behind the *Learning Type Measure* instrument, along with the issues of validity and reliability are presented in chapter three.

Data collected from the LTM were compared using Pearson's Chi-square analysis. The learning styles of the modular laboratory teachers were compared to the learning styles of the teachers in conventional laboratories. Both groups of technology educators were also compared to McCarthy's (1987) national findings of secondary teachers and administrators.

## Assumptions

The following assumptions were made concerning this study:

1. The *Learning Type Measure* (LTM) instrument effectively measures learning style.
2. Measurement of a teacher's learning style is an effective method of determining teaching style.
3. The *Learning Type Measure* (LTM) instrument will be as valid and reliable in this study as it has been shown to be in previous studies.
4. Middle school technology teachers are capable of selecting a preferred laboratory environment (conventional or modular) even if they do not have teaching experience in both laboratory environments.

## Delimitations

The following delimitations were made concerning this study:

1. This study was delimited to learning style as indicated by the *Learning Type Measure* (LTM) instrument.
2. This study was delimited to public middle school technology education teachers in the Commonwealth of Virginia.

## Summary and Organization of the Study

This study represents one step toward a better understanding of laboratory instruction at the middle school level in technology education. Although the *Standards for technological literacy: Content for the study of technology* (Technology for All Americans Project, 2000) will help clarify the field's knowledge base, it will

raise questions concerning implementation strategies. Already there is a need within technology education to better understand current instructional practices.

The need for research on current laboratory instruction was clearly outlined in this opening chapter. First, there is a considerable amount of conflict within the literature concerning laboratory methods at the middle school level, particularly methods concerning commercially created curriculum packages and materials. Second, teaching and learning style research can help in-service teachers use a variety of instructional methods to reach their students. Third, teacher educators can utilize learning style research to help pre-service teachers understand the need for flexible teaching methods in the laboratory. This awareness can help prospective teachers with the diverse students and instructional environments they will face when they become full-time classroom teachers.

The primary purpose of this study was to investigate a possible relationship between the teaching and learning styles of middle school technology education teachers and their laboratory environments. In addition, the teaching and learning styles of technology education teachers were compared to secondary teachers in general. In chapter one, researchable hypotheses and a list of related terms were presented. Clearly defined delimitations and assumptions were also presented to establish the parameters of this research project.

Chapter Two is a comprehensive review of related literature. Emphasis is on the underlying principles of teaching and learning style theory as well as the relationships between these two variables. A review of recent research on middle school laboratory instruction within technology education is also provided.

The research methods and procedures are presented in Chapter Three. Research hypotheses are presented along with information on the population, sample, and instrumentation reliability and validity. Data collection procedures and statistical analysis procedures conclude the third chapter.

The findings, conclusions, and recommendations of this study are presented in chapters four and five. The results of statistical tests performed on the collected data are reported in relation to the research questions and hypotheses. Finally, in Chapter Five, conclusions are drawn and recommendations for further research are presented.

## Chapter 2. Review of Literature

### Overview

Throughout history, philosophers and educators have pondered the nature of teaching and learning. Through Socratic dialogue, the ancient Greeks sought to explain how the physical world should be perceived. During the scientific revolution of the sixteenth century, Francis Bacon and other natural philosophers developed the scientific method of investigation. In the seventeenth century, John Locke introduced his theory of the *tabula rasa*, which depicts the mind as a blank slate that is developed through experience. During the last half of the nineteenth century, however, E. L. Thorndike grew tired of theories that were not grounded in research (Hilgard and Bower 1975). And Henson and Borthwick (1984) claimed that most educational research prior to 1950 focused on the learner and content, not the teacher. Despite the long history of educational theories and philosophies, many views about teaching and learning still differ greatly. Currently, there are conflicting views concerning middle school instruction in technology education.

This review focuses on four areas that shaped and influenced middle school technology education in the United States. First, the underlying theories of learning and instruction that have shaped middle school instruction are reviewed. Second, the concepts of teaching and learning style that have emerged, predominantly during the last thirty years will be reviewed. Of special interest to this study is the research of Bernice McCarthy because of the twelve theories she synthesized into one teaching and learning style model (McCarthy, 1979, 1980, and 1987). Third, the recent evolution of technology education laboratories, both conventional and modular, will be reviewed. Finally, research concerning laboratory instruction in technology education is presented.

## Underlying Theories of Learning and Instruction

Theories of learning and instruction are almost as old as civilized humans. A comprehensive historical review of these theories, however, is beyond the scope of this research. Instead, this review will focus on the dominant theories since the beginning of modern education in the United States, particularly those theories of the twentieth century. According to Urban and Wagoner (1996), the modern school system in the United States began after the Civil War.

Despite different periods of development and different levels of acceptance, all of the theories presented still maintain an influence on education to some degree. This phenomenon is best explained through T. S. Kuhn's (1996) concept of *paradigms*:

...the early developmental stages of most sciences have been characterized by continual competition between a number of distinct views of nature, each partially derived from, and all roughly compatible with, the dictates of scientific observation and method (p. 4).

This developmental stage is referred to as the pre-paradigm period and demonstrates how education has yet to agree upon one paradigm of learning and instruction.

Rather than arbitrarily discussing the theories that influence middle school instruction, three classifications developed by Mayer (1992) will be used: learning as response acquisition, learning as knowledge acquisition, and learning as knowledge construction. In a similar classification system, Skinner (1972) labeled theories as physiological, "mental" events, and those that represent the Conceptual Nervous System (CNS).

## **Learning as Response Acquisition**

According to Mayer (1992), learning during the first half of the twentieth century "was viewed as a mechanistic process in which successful responses are automatically strengthened and unsuccessful responses are automatically weakened, or more correctly, associations are strengthened or weakened according to environmental feedback." The research supporting this type of learning, according to Mayer, is grounded in the response learning of animals. In education, drill and practice activities characterize theories in the learning as response acquisition metaphor. The goal of instruction is to increase or strengthen the number of correct behaviors given by the student. This focus has led many educators to classify this type of learning as behaviorism or representative of the behaviorist movement (Mayer, 1992).

Rothstein (1990) credited John Watson for introducing behaviorism in its modern form. Watson felt that responses could be predicted by observing events called stimuli. When people are observed in the environment, behaviorists could note changes from their interactions with stimuli. Behaviorists, according to Watson, also seek to control an individual's behavior by manipulating stimuli. Rothstein (1990) noted that early behaviorists focused on observable behaviors but "neobehaviorists" were more concerned with cognitive processes.

Pavlov's classical conditioning is one of the early theories of behaviorism but is still one of the most recognized. Pavlov's research on the digestive process of dogs won him the 1904 Nobel Prize and, according to Gredler (1992), is important for two reasons. First, Pavlov proved that the natural relationship between a stimulus and a response could be altered. In early experiments, Pavlov observed that dogs would not salivate until they were fed. As the experiments progressed, the dogs salivated before being fed and eventually would salivate when they heard the footsteps of the lab technicians bringing in the food. Pavlov classified the footsteps as an unconditioned stimulus because they elicited the dogs' salivation. Salivation was referred to as the unconditioned response (Gredler, 1992). Pavlov used the term "unconditioned" because the stimulus and reflex both occurred without training.

Second, Pavlov proved that laboratory research had the incredible potential to discover new knowledge. Pavlov's second set of experiments sought to see how training could elicit the reflex response. A conditioned stimulus, which has no effect on the desired reflex, was introduced at the same time as the unconditioned stimulus. Pavlov would ring a bell or tuning fork (conditioned stimulus) when the dogs were fed (unconditioned stimulus) and soon noticed that the dogs would salivate even when the bell was rung and no food was presented. From this conditioned stimulus, the dogs' salivation could now be controlled and was known as a conditioned response (Rothstein, 1990). Pavlov successfully showed that the natural relationship between a stimulus and a response could be altered.

Historically, educators have turned to Pavlov's classical conditioning theory when designing instruction and explaining the actions of students. Educators, however, have tried to understand not only reflex behavior, but the more complex phenomena of how behaviors are acquired. These educators are classified as neobehaviorists and are highlighted by the work of E. L. Thorndike and B. F. Skinner (Rothstein, 1990).

Thorndike established a theory known as classical conditioning to help explain how new behaviors are acquired. Thorndike personally referred to his animal experiments as instrumental conditioning and connectionism to reflect the voluntary behavior demonstrated by his subjects. Thorndike's experiments would confine an animal or food in a latched container to determine if the animals could solve a problem through reasoning. His experiments with cats showed significant promise because the animals repeatedly slid a bolt to receive the food. Thorndike called this phenomenon of repeating a satisfying behavior the *law of effect* (Rothstein, 1990).

The operant conditioning research of Skinner went deeper than the law of effect to find other relationships between stimuli and responses. Skinner used rats in his experiments and developed a clever device that became known as the Skinner box. The rat would be locked in the Skinner box but could press a built-in lever to receive

a pellet of food. After the rat learned how to operate the lever and receive food, Skinner would supply the pellets only under certain conditions. The rats soon developed the ability to distinguish which conditions were related to food and which were not.

Unlike Thorndike's experiments, Skinner demonstrated how subjects learn to respond to stimuli. In one famous experiment, for example, a tone would be sounded before the lever was pressed. Food would be delivered only when the rat would activate the lever after hearing the tone. The hungry rats quickly demonstrated knowledge of the correct response because they would only press the lever after the tone was sounded. Thus, the rats became conditioned to activate the lever when the tone was present and conditioned not to activate the lever in absence of the stimulus (Rothstein, 1990).

Skinner's work led to the concepts of positive and negative reinforcement. According to Skinner (1953), positive reinforcement occurs when a certain behavior is followed by a desired stimulus. Negative reinforcement on the other hand, occurs when the reduction or removal of an undesired stimulus strengthens a behavior. Skinner's work on positive and negative reinforcement continues to have a tremendous impact on education. His later research dealing with teaching machines is of primary interest to this study and will be discussed further in the section dealing with the teaching and learning environment.

Despite the monumental breakthroughs of Skinner's early work, the shortcomings of operant conditioning and behaviorism are apparent. Primarily, learning involves much more than behavioral change. Current theories of learning involve cognitive, affective, and psychomotor domains of learning. The cognitive domain became the focus of researchers who were concerned with the limitations of behaviorist theory. These theories deal with the un-observable processes in education and, according to Mayer (1992), classify learning as knowledge acquisition, not response acquisition.

## **Learning as Knowledge Acquisition**

Mayer (1992) cited the cognitive revolution of the 1950's and 1960's as the beginning of the learning as response acquisition metaphor. During this period, research shifted from laboratory studies on animals to laboratory studies involving human subjects. Psychologists involved in cognitive research attempt to explain how knowledge was acquired instead of how to elicit desired responses. Within this cognitive metaphor, the learner is the processor of information and the teacher is the dispenser of information.

Gestalt psychology is often cited as one of the roots of cognitive theory (Mayer, 1992). Developed in Germany during the early 1900's by Wolfgang Köhler, Kurt Koffka, and Max Wertheimer, Gestalt psychology claims that people learn things by arranging them in patterns and viewing the relationships between the items. One of the criticisms of Gestalt psychology, however, is the fact that some classifications can become oversimplified. Researchers are also critical that Gestalt psychologists do not specify the conditions under which a given law will determine perception. For these and other reasons, Gestalt principles are generally not directly applied in educational settings (Rothstein, 1990). Kurt Lewin's field theory, however, uses Gestalt principles to look at student's behavior from the student's own perspective.

Lewin devised the name field theory from a similar concept in physics called the "field of forces." In physics, the field of forces theory explains how metal filings are arranged when placed near a magnet. In field theory, Lewin claimed that positive and negative forces called valences direct human actions. Lewin stated that students engage in certain behaviors that they are attracted to but tend to shy away from negative valences. By understanding what attracts students, Lewin claimed that educators can help students concentrate and succeed in school (Rothstein, 1990).

A third cognitive theory of learning that has gained widespread acceptance in education is the information-processing model. Information processing involves concepts from psychology, linguistics, information theory, and computer science and

attempts to understand human thought processes. The main concept of information processing theory relies on the notion that humans are complex organisms that sense, store, encode, and retrieve information much like a computer. Information processing researchers investigate the mental processes of humans from original stimulus (input) to the final response (output) (Rothstein, 1990).

In summary, the learning as knowledge acquisition metaphor attempts to explain the cognitive process of learning. Cognitive theory, like behaviorist theory, however, can not explain all of the complexities of the teaching and learning environment. Cognitive theory is often cited for oversimplifying the education process and can not be easily implemented in the classroom (Rothstein, 1990). Student interaction in the classroom is vital to effectively understand the teaching and learning environment.

### **Learning as Knowledge Construction**

According to Mayer (1992, p. 407), the learning as knowledge construction metaphor began when "researchers moved from studying the learning of abstract materials in artificial settings to studying subject-based learning in more realistic situations." This change in philosophy views the learner as the constructor of knowledge instead of a recipient of knowledge. This theory of learning is often called the constructivist framework or constructivism. Fosnot (1996) and Mayer (1992) both view constructivism as the dominant theory of learning currently being studied and accepted in education. Like other theories of learning, however, constructivism has deep historical roots in the field of psychology, most notably with the work of Jean Piaget and Lev Vygotsky.

Jean Piaget's work in education spans more than fifty years but the last ten to fifteen years of his career are of particular interest to constructivist theory. During this time, Piaget focused on the process that allowed new knowledge constructions or perspectives to be created (Fosnot, 1996).

Piaget felt humans were constantly changing physically and cognitively. Piaget believed that a process called equilibration uniquely links physical and cognitive

development. In *Equilibration of Cognitive Structures*, Piaget explained that "knowledge proceeds neither solely from the experience of objects nor from an innate programming performed in the subject but from successive constructions" (1977, p. v). In summary, Piaget felt that the growth process of an individual occurred through the development of structures and was constantly "under construction."

Russian psychologist Lev Vygotsky also believed that learning was developmental but distinguished two types of knowledge construction. Vygotsky called the concepts outlined by Piaget "spontaneous." Spontaneous concepts, according to Vygotsky, are developed naturally by children because they emerge "from the child's own reflections on everyday experience" (Kozulin, 1986). Scientific concepts, on the other hand, are developed in the structured activities of the classroom. These activities impose formal abstractions and logical constructs upon the child. Because of these imposed constructs, Vygotsky's main research question was "What facilitates the learning that moves the child from spontaneous concepts to scientific concepts?" (Fosnot, 1996, p. 18).

Vygotsky's attempt to understand how children move from spontaneous concepts to the systematic, scientific concepts of adult reasoning led him to the development of a model known as the zone of proximal development or "zo-ped." Tharp and Gallimore list the four stages of the zone of proximal development. The first stage of the zone of proximal development is where child performance is assisted by more capable others. Adults or more capable peers assist because the child cannot function as an independent agent. In stage two, the child can perform a set task without assistance from others but the performance is not fully developed or automatized. Stage three is where the performance is automatized and the student begins to emerge from the zone of proximal development. Deautomatization of performance leads the individual back through the zone of proximal development. This is when a task is mastered but the student uses the new knowledge to assist others and ask for assistance when difficulties arise (Tharp and Gallimore, 1988).

Some constructivists find Vygotsky's work controversial, especially the relationship between spontaneous and scientific concepts. In addition to creating the zone of proximal development, however, Vygotsky also conducted many experiments on speech development and dialogue. Both Vygotsky and Piaget analyzed dialogue and created the foundations of what researchers call social constructivism (Shambaugh and Magliaro, 1997). There are other forms of constructivism such as the radical constructivism of von Glaserfeld (1984). It is important to remember that whatever the classification, all constructivism "construes learning as an interpretive, recursive, building process by active learners interacting with the physical and social world" (Fosnot, 1996, p. 30).

### **Summary**

This section has discussed the foundations for theories of learning as response acquisition, knowledge acquisition, and knowledge construction. These foundations are important to this study because of their influence on instructional design and methodology in technology education. Instructional designers often advocate using a mixture of the three learning theories in order to utilize the strengths of each theory while minimizing the weaknesses (Shambaugh and Magliaro, 1997). Behaviorist theory, for example, is often used for classroom management and discipline because of the positive research on reinforcers. Cognitive theory, on the other hand, can help with the development of instructional aids and student assessment techniques such as standardized testing. Finally, constructivism allows for creativity and insures that the learning is relevant to the learner. These foundations, however, are only one part of teaching and learning at the middle school level. The next section covers a second issue, theories and models of learning styles.

## Theories of Learning Styles

Theories concerning learning styles are as plentiful and diverse as the underlying theories of learning and instruction. Cornett (1983) and the National Association of Secondary School Principals (1982) identified and reviewed over thirty instruments used to assess learning styles. And there are far more theories about learning styles than there are instruments to measure them. Curry (1990a, 1990b) claimed that there are three general problems with learning style theory: confusion in definitions, weakness in reliability and validity of measurements, and identification of relevant characteristics in learners and instructional settings.

Although Curry (1990a, 1990b) has pinpointed some of the problems involved with the organization of learning style theory, noted theorist Pat Guild (Brandt, 1990) has developed an uncomplicated classification scheme. Guild believed that learning style theories fall into three categories: those that focus on the individual, those that focus on curriculum development, and those that are diagnostic/prescriptive (Brandt, 1990). Notwithstanding that classification systems are highly subjective, Guild's classification system will be used to review the dominant learning style theories identified in the literature.

### **The Individual as the Focus of Learning Style Theory**

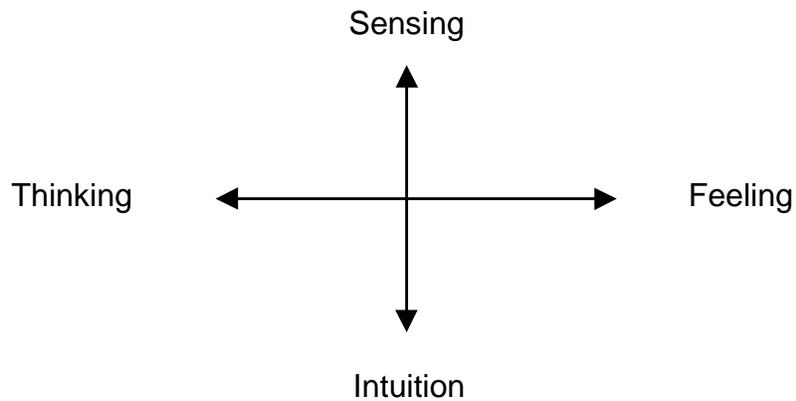
Guild claimed that personal awareness is an aspect that is common to all learning style theories but some theories emphasize it more than others (Brandt, 1990). Historically, the individual has been the cornerstone of learning style research. Carl Jung, the notable Swiss physician and psychologist of the early twentieth century, traced the history of individual differences back to the second century with the work of the Greek physician Claudius Galen (Jung, 1976). Many modern learning style researchers, however, cite Jung's work as the beginning of modern learning theory (Lawrence, 1982; Guild and Garger, 1985).

In 1921 Jung developed a theory called *Psychological Type* that stated there were three dimensions of personality structure. The first dimension involved the mental

process of perception and was categorized as either sensing or intuition. Jung believed that people either perceived information through the physical senses or through insight. Although Jung felt individuals favored one method of perception over the other, he firmly believed that everyone used both mental processes to some degree (Jung, 1971).

The second dimension of personality used by Jung deals with how people judge information once it is in consciousness. Like perception, judgement is sub-divided into two categories, thinking and feeling, which are also both used to differing degrees. Thinking is used to define a logical decision-making process while feeling is a term for making judgements on a personal level. Jung classified the mental processes of the perception dimension, sensing and intuition, as polar opposites and the mental processes of the judgement dimension, thinking and feeling, as polar opposites. Jung stated "the four functions are somewhat like the four points on a compass; they are just as arbitrary and just as indispensable" (Jung, 1971, p. 541). Figure 1 displays this concept graphically.

Jung's third dimension involved an individual's preference for introversion or extraversion. Lawrence (1982) credited Jung for inventing these terms which relate to how we act in the world and how we reflect. According to Lawrence, "extraverts often say 'When in doubt, act.' Introverts are more likely to say 'When in doubt, reflect on the matter more deeply.'" Jung felt that these two "general attitudes" were manifested through dominance of one of the four basic functions. Jung developed eight distinguishable "types" based on his two preferences and four basic functions. Based on his own reflections, however, Jung admitted that there were possibly more combinations of psychological types (Jung, 1971).



**Figure 1**

Jung's (1971) Dimensions of Perception (Vertical) and Judgement (Horizontal)

Jung never developed his theory of psychological type for practical use through instruments or models. Today, Jung's work provides little more than a historical background for those concerned with learning style theory. It is significant to note, however, the four quadrants created by Jung's dimensions of perception and judgement (Figure 1). Many of the theories that follow cite Jung and utilize quadrants to graphically represent their concept of learning style.

Researchers such as Isabel Briggs Myers and Gordon Lawrence have furthered Jung's work by expanding the number of psychological types to sixteen. Myers and Lawrence have also created practical instruments and guidelines for using learning style theory in education and for organizational management.

Briggs and Myers began working on an instrument in 1942 that was capable of measuring Jung's psychological types (Myers and Myers, 1980). Myers' and Briggs' research led them to believe that a fourth dimension which related to one's judgment and perception needed to be added to Jung's three dimensions (perception, judgement, and introversion/extraversion). The *Myers-Briggs Type Indicator* (MBTI)

uses a judgement/perception dimension and defines the four learning style preferences as follows:

	<u>Preference for</u>	<u>Affects a person's choice</u>
EI	Extraversion or Introversion	To focus the dominant (favorite) process on the outer world or on the world of ideas.
SN	Sensing or Intuition	To use one kind of perception instead of the other when either could be used.
TF	Thinking or Feeling	To use one kind of judgement instead of the other when either could be used.
JP	Judgment or Perception	To use the judging or the perceptive attitude for dealing with the outer world (Myers, 1981, p. 9).

The four dimensions of the MBTI are compiled to form an individual composite consisting of four letters (preferences). There are sixteen possible "people types." A comprehensive discussion of all sixteen people types as identified by the MBTI is beyond the scope of this research. There are many type tables and databases available that describe and interpret the findings of the MBTI (see Myers, 1980; Lawrence, 1982; McCaulley, 1985).

The initial work started by Katherine Briggs and Isabel Briggs Myers has created a significant following known as "type research." Type research includes interest areas

from the fields of Careers and Occupations, Counseling, Education, Management and Organizational Development, Psychological Theory, Religious Issues, and Research. Lawrence (1982) continued the work of Isabel Myers with a focus on the field of education. Lawrence's work is of special interest to this study for three reasons. First, Lawrence used the *Myers-Briggs Type Indicator* to measure teachers' "type." This study also assessed teacher's learning styles. Second, Lawrence highlighted the importance for teachers to understand how their learning style affects instruction. Lawrence primarily promoted the matching of student and teaching styles where this study promotes flexibility in teaching styles. Third, McCarthy (1979, 1980) assimilated Lawrence's work into her instructional model. Since McCarthy's *Learning Type Measure* instrument and instructional model has a direct influence on this research, it is important to understand Lawrence's work.

Lawrence used the *Myers-Briggs Type Indicator* (MBTI) to identify type preferences of teachers and how this influences teaching style. Lawrence has studied type preferences of educators across many grade levels and subject areas. According to Lawrence, the MBTI index of Thinking/Feeling (TF index) identified "thinkers" as those attracted to teaching mathematics, science and technical courses (Lawrence, 1982). Wicklein and Rojewski (1995), however, did not find any significant difference in the TF index of their sample of technology educators. Such inconsistencies highlight one of the main criticisms of MBTI-based research (Pittenger, 1993). Nevertheless, the work of Lawrence and other type researchers who use the MBTI continue to have a tremendous influence on teaching and learning style theory (see Cooper and Miller, 1991; Houtz, LeBlank, and Butera, 1994; Stuber, 1997; and Pankratius, 1997).

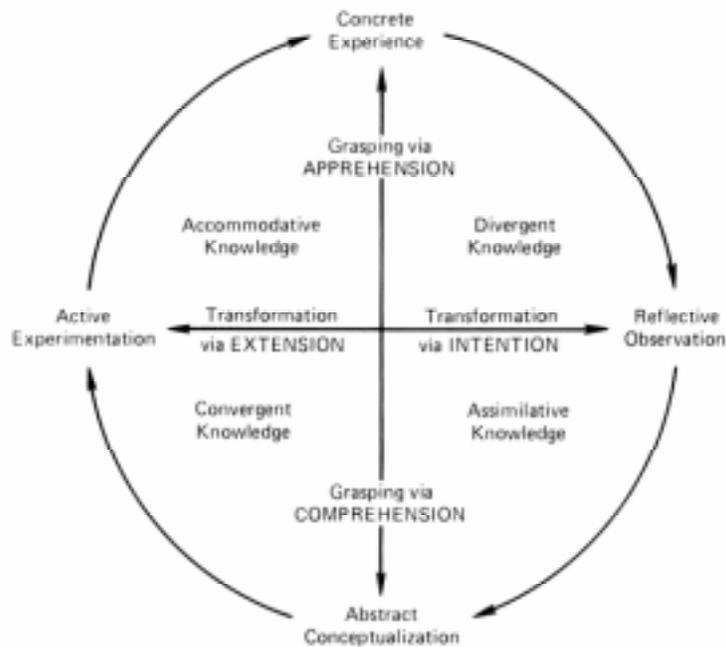
David A. Kolb is known for his influence on learning style theory and organizational psychology through the use of model formulation (McCarthy, 1987). The cornerstone of Kolb's model relied on experience-based learning. Kolb reviewed the work of Kurt Lewin, John Dewey, and Jean Piaget to create his theory of experiential learning. Although Kolb noted differences in their theories, he felt the similarities were too strong to be ignored. All three models involved a circular approach to learning and

started with the experience of the learner (Kolb, 1984). Kolb's research demonstrates a clear link between learning style research and the underlying theories of learning and instruction.

Kolb defined experiential learning as " the process whereby knowledge is created through the transformation of experience" (Kolb, 1984, p. 38). Kolb used this working definition to create his model of the experiential learning process. Figure 2 represents the main concepts behind Kolb's theory (Kolb, 1984, p. 42).

Similar to Jung (1971), the model of experiential learning involves two sets of polar opposites. Kolb believed humans "grasp experience" immediately in a concrete manner or abstractly in an indirect manner. Once an individual understands an experience, it can be added to other experience through reflective observation or active experimentation. The two methods used to grasp experience and the two ways this experience is transformed create four unique types of knowledge: divergent, assimilative, convergent, and accommodative.

Kolb's two methods of grasping information, two methods for transforming information and four types of knowledge helped him create an instrument that could be used to identify learning style preferences. Educators and organizational managers use the *Learning Style Inventory* to assess individual learning style. Kolb's depth of research, use of models and creation of the *Learning Style Inventory* make him one of the pioneers in learning style research.



**Figure 2**

Kolb's Process of Experiential Learning (Kolb, 1984, p. 42).

Like Kolb, Fischer and Fischer (1979) noted distinct learning styles based on observation, experience, and discussions with classroom teachers. Fischer and Fischer defined the following learning styles:

*Incremental Learners*-- These students proceed in a step-by-step fashion, systematically adding bits and pieces together to gain larger understandings.

*Intuitive Learners*-- The learning style of these students does not follow traditional logic, chronology, or a step-by-step sequence. There are leaps in various directions, sudden insights, and meaningful and accurate generalizations derived from an unsystematic gathering of information and experience.

*The Sensory Specialist*-- This student relies primarily on one sense for the meaningful formation of ideas.

*The Sensory Generalist*-- These students use all or many of the senses in gathering information and gaining insights.

*The Emotionally Involved*-- There are students who function best in a classroom in which the atmosphere carries a high emotional charge.

*The Emotionally Neutral*-- Some students function best in a classroom where the emotional tone is "low-keyed" and relatively neutral.

*Explicitly Structured*-- These students learn best when the teacher makes explicit a clear, un-ambiguous structure for learning.

*Open-Ended Structure*-- There are students who feel at home and learn best in a fairly open-ended classroom. The overall structure of the classroom is sufficiently visible, yet there is place within it for divergence, for exploration of relevant yet not explicitly preplanned phenomena (Fischer and Fischer, 1979, pp. 245-254).

In addition to these eight learning styles, Fischer and Fischer (1979) describe two broad categories of learners that they feel are too inclusive to be identified as learning styles. Damaged learners are physically normal but develop negative learning styles from social and environmental influences. Eclectic learners, on the other hand, develop one or more dominant learning styles but can often switch styles when needed. Despite Fischer and Fischer's (1979) reservations about utilizing their learning style research to guide classroom practitioners, McCarthy (1980) incorporated it into the 4MAT System of instruction.

The elementary level work of Simon and Byrum has also been assimilated into McCarthy's model. Simon and Byrum's (1977) teaching and learning style model is based on the way individuals communicate. School psychologist Paul Mok created a theory of "Communicating Styles" that he derived from the work of Carl Jung and his

professional experience. The four Communicating Styles outlined by Simon and Byrum include feelers, intuitors, thinkers, and sensors. The similarities to Jung's dimensions of perception and judgement are very apparent. Simon and Byrum define feelers as sensitive, caring and artistic while sensors are active, competitive, and react quickly to what they "sense" in the world. Intuitors are imaginative, innovative, and have far reaching ideas while thinkers are logical, orderly and accurate (Simon and Byrum, 1977).

Simon and Byrum's work is unique for two reasons. First, it was one of the earliest learning style theories that highlighted the importance of understanding both the teachers' and the students' learning style. Second, the issue of style flexibility for both students and teachers is addressed. "Style-flex means temporarily shifting your style to better match with other people's styles" (Simon and Byrum, 1977, pp. 61-62). On the other hand, Simon and Byrum's work is similar to other models because it is based on Jung's model and identifies four unique learning styles.

Keirsey and Bates' (1984) work on character and temperament types is also similar to other learning style theories. Keirsey and Bates train therapists and diagnosticians of dysfunctional behavior and have reviewed the work of Hippocrates, Jung, Kretschmer, Freud, Adler, Sullivan, and Maslow to develop four temperament types (Keirsey and Bates, 1984). The names of four Greek gods were used by Keirsey and Bates to explain their temperament types. Apollo, according to Keirsey and Bates, was commissioned to give man a sense of spirit and is "dedicated to helping others" (Keirsey and Bates, 1984, p. 66). Prometheus, on the other hand, focuses on science and technology. The style of Epimetheus is characterized by a sense of duty and the Dionysus style focuses on a sense of joy. These broad characteristics and the *Keirsey Temperament Sorter* are used to outline sixteen specific personality types that are very similar to the work of Briggs and Myers.

All of the research reviewed in this section has focused on personal awareness as the primary focus of learning style research. Similarities across disciplines and theories were highlighted. Models that utilize quadrants and four learning styles are

two notable similarities in the reviewed theories. The use of models, however, is not just limited to the theories concerned with personal awareness. In the next section, several learning style researchers use similar models to emphasize curriculum development as the primary focus of their work.

### **Curriculum Development as the Focus of Learning Style Theory**

Knowing that people learn in different ways, Guild's second classification groups theories that create models for providing instruction to all major learning styles (Brandt, 1990). Despite the fact that many learning style researchers often promote the need for teacher flexibility (see Ellis, 1979; Guild and Garger, 1985; Marshall, 1991; and Reiff, 1992), there are only a few researchers who have developed instructional models based on their learning style theories.

Bernice McCarthy's 4MAT System is a very well known and widely used instructional model. McCarthy developed the 4MAT System in 1980 as a result of her classroom teaching experience, her dissertation (McCarthy, 1979) and a conference she held in Chicago in 1979 (McCarthy, 1987). The uniqueness of the 4MAT System lies in the synthesis of twelve learning style theories from various disciplines and the incorporation of brain hemisphere research. The researchers McCarthy based her model on are listed below with their respective disciplines:

<u>Researcher</u>	<u>Discipline</u>
Fischer, B. B. & Fischer, L. (1979)	Education
Gregorc (1979)	Education
Hunt, V. (1964)	Education
Jung, C. (1971)	Psychology
Keirsey, D. & Bates, M. (1984)	Therapy Training
Kolb, D. (1983, 1984)	Organizational Psychology
Lawrence, G. (1982)	Education
Lotas, A. (in McCarthy, 1980)	Education
McCarthy, B. (1979)	Education
Merrill, D. W. & Reid, R. H. (1981)	Management Training

Simon, A. & Byram, C. (1977)            Education  
Wetzig, E. (in McCarthy, 1980)        Dance Training  
(compiled from McCarthy, 1980, pp. 27-33 & McCarthy, 1987, pp.  
26-33).

Because McCarthy's teaching and learning style model is a synthesis of twelve recognized learning style researchers, it was selected as the basis for this research.

McCarthy noted a similarity in the learning style theories that she researched. Almost all of the theories she researched defined two ways of perceiving information and two ways of processing information. Figures 1, 2, 4, and 5 add validity to her theory. Next, McCarthy took the strands from each of the theories and placed them into Kolb's model (see Figure 2). McCarthy was thereby able to develop composites of four different types of learners (McCarthy, 1987).

Type One learners, according to McCarthy, are imaginative learners. These learners perceive information concretely and process it reflectively. They need to be personally involved and their favorite question is *Why?* (McCarthy, 1987). McCarthy suggests that teachers give Type One learners *reasons* for learning (McCarthy, 1985).

McCarthy defines Type Two learners as analytic learners. These learners perceive information abstractly and process it reflectively. Type Two learners are interested in facts and their favorite question is *What?* (McCarthy, 1987). McCarthy recommends that teachers give them *facts* that will deepen their understanding (McCarthy, 1985).

Type Three learners are common sense learners. These learners perceive information abstractly and process it actively. Type Three learners are problem solvers that commonly ask *How?* (McCarthy, 1987). Teachers should let type three learners see how things work by *letting them try things* (McCarthy, 1985).

McCarthy defines Type Four learners as dynamic learners. These learners perceive information concretely and process it actively. Type Four learners are primarily interested in self-discovery and often ask the question *If?* (McCarthy, 1987). Teachers need to let these learners *teach themselves and others* (McCarthy, 1985).

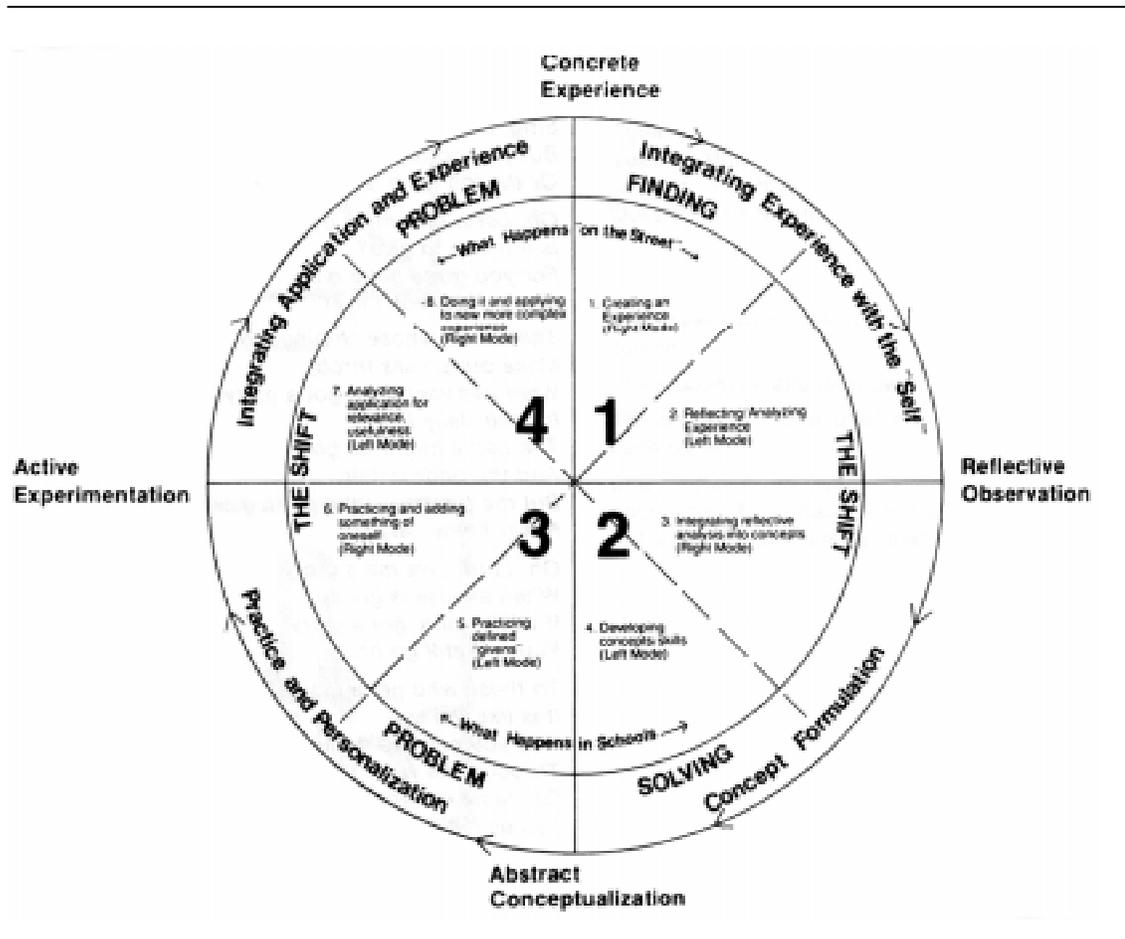
McCarthy claimed that Type Two learners are the most comfortable in traditional school settings. Unfortunately, her research showed that seventy percent of students are not Type Two learners (McCarthy, 1987). This is one of the main reasons the 4MAT System was developed by McCarthy: to create an instructional model that reaches all learners. The circular model contains four quadrants, one for each learner. This approach gives each student a comfortable period during the lesson but also introduces the student to new learning methods.

The 4Mat System is not limited to learning style quadrants. McCarthy also incorporated the brain hemisphere research of Roger Sperry (1973). Sperry conducted experiments on monkeys and cats during the 1950's. When Sperry completely severed the two halves of the animal's brains, he did not notice any differences in behavior but did notice a difference in trained tasks. McCarthy (1987) reports that similar operations on humans with epilepsy during the 1960's had similar results. Sperry and other researchers soon developed experiments that involved the two halves of the human brain.

Brain hemisphere researchers found two important discoveries through experimentation. First, they determined that the right side of the brain processes information globally while the left side of the brain processes information linearly. Second, each individual has a preferred method of processing information. McCarthy noted, however, that everyone uses both hemispheres to differing degrees, just as everyone uses all four learning styles to differing degrees (McCarthy, 1980).

The complete 4MAT System model incorporates all four learning styles and left and right mode processing. Therefore, activities that are created under the 4MAT System

model have eight steps because each learning style incorporates left and right mode processing techniques. Figure 3 shows the complete 4MAT System model.



**Figure 3**

The Complete 4MAT System Model (McCarthy, 1980, p. 122).

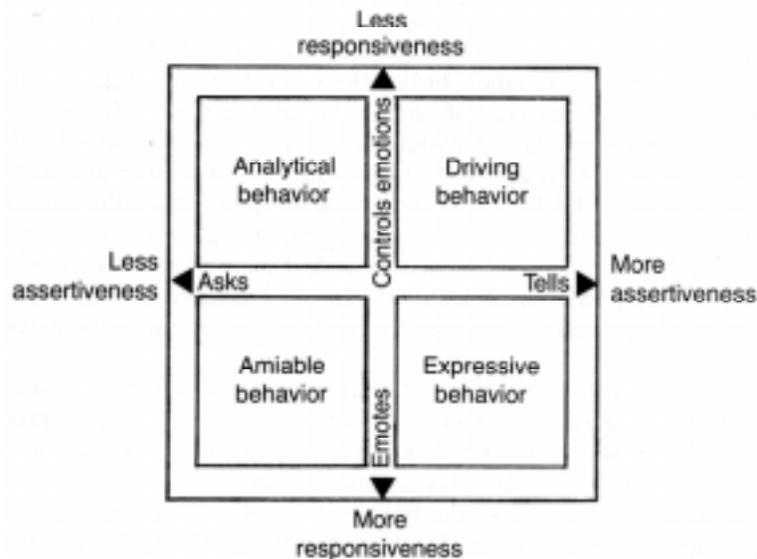
The 4MAT System has been widely used by learning style researchers from several disciplines. Blair and Judah (1990) used the 4MAT model to implement a Tech Prep program. Kelley, C. (1990) developed a model for implementing 4MAT lessons in law school. Kearney and Thacker (1994) use 4MAT lessons to teach photography in a youth correction facility. In addition, a wide range of students and teachers have

used McCarthy's work with positive results. The 4MAT System has been taught to elementary students as a method to improve student presentations (Weber and Weber, 1990). Other groups having positive results with the 4MAT System include community college personnel (Allyn, 1989), and staff developers (McCarthy, 1982 and 1985; Kelley, L. S., 1990).

There is very little negative research or literature concerning the 4MAT System or the work of McCarthy. Scott (1994) highlighted the lack of classroom research on the 4MAT System but praised designs such as Wilkerson and White's (1988) experimental pre-test, post-test dissertation. Scott (1994), however, faulted a second classroom study for poor sampling techniques and lack of validity (see Mills, 1983). The synthesis used by McCarthy to develop the 4MAT System Model and the overwhelming support it has received make it one of the dominant learning style theories in education.

In the field of management training, the work of Merrill and Reid (1981) demonstrate striking similarities to other learning style theories. Through years of observation and analysis, Merrill and Reid constructed a "social style profile" consisting of four quadrants/behaviors. Figure 4 illustrates Merrill and Reid's social style profile (1981, p. 53). The social style profile is based on research of how people describe a person. The horizontal axis describes an individual's assertiveness while the vertical axis represents responsiveness.

Merrill and Reid's model can be used to classify four observable behaviors: driving, analytical, amiable, and expressive. Driving individuals are serious, assertive people who do not display feelings or emotions readily. Expressive people are also assertive but are more willing to show their feelings than drivers. Analytical people are low in assertiveness but have good control of their emotions. Analytical individuals also tend to ask questions, gather facts, and study data. Individuals who openly display feelings, are less assertive, but are interested in being agreeable and cooperative characterize amiable behavior (Merrill and Reid, 1981).



**Figure 4**

The Social Style Profile of Merrill and Reid (1981, p. 53)

Merrill and Reid added a third dimension, versatility, to responsiveness and assertiveness. According to Merrill and Reid, "versatility is the dimension of behavior that indicates the extent to which others see us as adaptable, resourceful, and competent" (Merrill and Reid, 1981, p. 44). The versatility dimension allowed Merrill and Reid to create adjectives that could be used to observe the four behaviors. Merrill and Reid show how to use social style observation techniques in the workplace, community, and at home. In education, McCarthy has applied this research for students and teachers.

Butler (1984) used Anthony Gregorc's (1982) four classifications to assess learning style. Gregorc's four styles, concrete sequential, abstract sequential, abstract random, and concrete random, are defined and discussed in detail in the next section since he used them for diagnostic and prescriptive purposes. Butler's (1984) work used Gregorc's Energetic Model of style but went further than Gregorc and

recommended using "style differentiated instruction." Also, Butler, like Gregorc and many other learning style researchers, believed that individuals use one dominant style but the other nondominant styles are all utilized to some degree.

In addition to working with nondominant channels, Butler outlined a five-stage model that can be used for people to accept their style. Butler also outlined positive and negative ways in which learning style research could be used. All of her work paralleled Gregorc's theory and establishes the foundation of Style Differentiated Instruction (SDI). Butler (1984, p. 185) stated that SDI "is the process that promotes the intentional match or mismatch of learner style to instructional methods-- strategies, technologies, techniques, and activities."

Butler's work is recognized because of its relationship to Gregorc and consistencies with other learning style theories. Butler's model is similar to McCarthy's because it highlights learners' preferred learning styles and stretches their weaker styles. And, although a direct link to Simon and Byrum was not found, the concept of "style flexing" links Butler's work to a third learning style theory.

The research reviewed in this section has focused on curriculum development as the primary focus of learning style research. In the third section on learning styles, researchers emphasize a diagnostic or prescriptive focus for learning style theory.

### **The Diagnostic/Prescriptive Focus of Learning Style Theory**

The third classification of learning styles, according to Guild, involves identifying key elements of the individual's learning style and matching instruction and materials to the individual differences (Brandt, 1990). This classification differs from the second in two ways. First, learning style theories with a diagnostic/prescriptive focus usually assess the learner before instruction begins. Second, general guidelines instead of structured models are usually used to aid instruction.

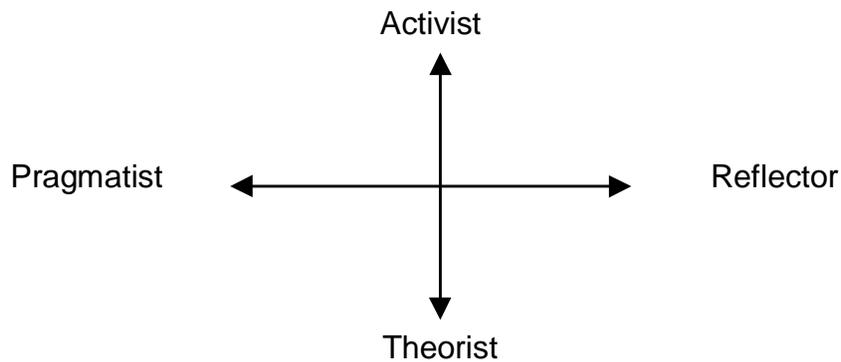
Rita and Kenneth Dunn's work on assessing and providing instructional guidelines is predominant in the learning style literature. Dunn and Dunn (1987) claimed that

learners are affected by their environmental, emotional, sociological, and physical preferences. Dunn, Dunn, and Price (1984) created the *Learning Style Inventory (LSI)* to assess these preferences for children in grades 3-12 and the *Productivity Environmental Preference Survey* as an adult version of the LSI. Both instruments are accompanied with suggestions to help facilitate academic achievement (Dunn, DeBello, Brennan, Krinsky, and Murrain, 1981).

In addition to creating assessment tools, Dunn and Dunn have concentrated on synthesizing learning style research in order to debunk myths and influence classroom practice. Several fallacies of learning style research that the Dunn's have focused on include, among others, the time of day for instruction, homework, group activities, and motivation. Many of the issues in Dunn and Dunn's research deal with teaching style and the physical learning environment. Their work is discussed further in the section that focuses on the teaching and learning environment.

Honey and Mumford created a learning style theory for organizational management based on the work of David Kolb. Instead of using learning style theory solely for style identification, however, Honey and Mumford strive to identify and modify style (Honey and Mumford, 1982). The *Learning Styles Questionnaire* is an eighty-item, self-scoring instrument designed to identify an individual's preference among four learning styles. The four learning styles identified by Honey and Mumford are the activist, theorist, reflector, and the pragmatist. Just like the learning style theories of Jung and Kolb, these learning styles consist of two pairs of polar opposites. The activist is defined as the counterpart of the theorist and the reflector is the inverse of the pragmatist. This relationship is shown in Figure 5. Honey and Mumford use a similar illustration to graphically record preferences from the *Learning Styles Questionnaire* (Honey and Mumford, 1982).

Once an individual's learning style is identified, Honey and Mumford discuss the styles' unique strengths and weaknesses. The final phase in the model involves recommendations to instill flexibility and awareness of other styles. Activities are geared toward self-development and are used primarily for managers and advisors.



**Figure 5**

Honey and Mumford's (1982) Four Learning Style Preferences.

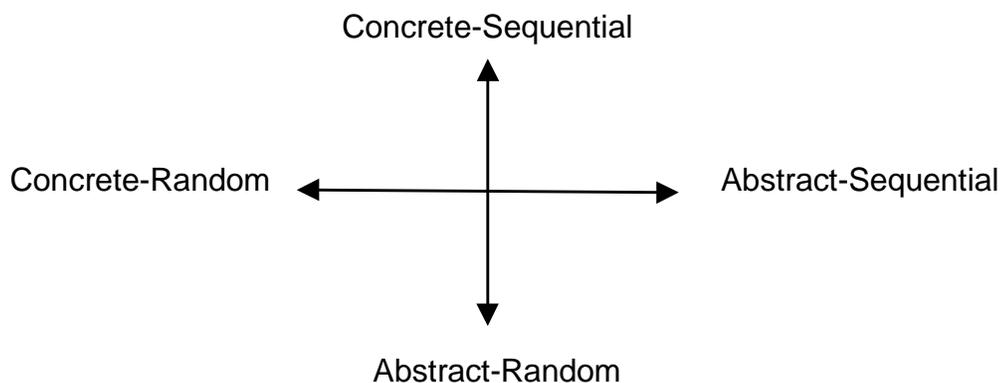
In her 1964 publication, *Movement Behavior: A Model For Action*, Hunt also identified four learning styles or "body tension" patterns. The assister, posturer, resister, and perceverator are the four learning styles Hunt identified in her research on body movement. Each style varies on how the dancer handles the reality of movement. Although Hunt's work is not directly important to this research, it is significant because of its influence on educators and learning style researchers.

Wetzig's work in the field of dance and choreography is based on Hunt's (1964) four "body tension" patterns and is also assimilated into McCarthy's 4MAT System model. McCarthy (1980) noted the similarity of Wetzig's model to learning style research. Wetzig's research showed that when dancers accepted their body patterns, they were able to develop their potential to higher degrees. Wetzig, like Butler and McCarthy, advocated exposing her students to all four patterns to increase awareness and style flexibility.

Alexis Lotas also used four learning styles to promote awareness in teachers and students (McCarthy, 1980). As a high school principal in Michigan, Lotas based his curriculum on Jung's (1971) work and identified student and teacher's learning styles

through the same learning style instrument. Lotas' work is important to this study because, similar to McCarthy, Lotas used his learning style classifications to measure teaching style.

Anthony Gregorc is another learning style researcher who has influenced the work of McCarthy, among others. The *Gregorc Style Delineator*, along with observation and interview techniques, are used to match instructional materials and methods to meet individual preferences (Dunn et al, 1981; Guild, 1985). Gregorc's theory relies on distinct, observable behaviors that show how an individual perceives and orders information. The model developed by Gregorc is very similar to Jung's two dimensions and four basic functions. According to Gregorc, we tend to perceive information abstractly or concretely and order information randomly or sequentially (Gregorc, 1979). Figure 6 displays the four learning styles used by Gregorc. This illustration is derived from the graph used to plot an individual's score on the *Gregorc Style Delineator* (formerly the *Transaction Ability Inventory*, Gregorc, 1982, pp. 12-13).



**Figure 6**

Gregorc's (1982, pp. 12-13) Four Learning Styles.

A second similarity to Jung's theory is Gregorc's belief that everyone uses either of the perception and either of the ordering abilities, but individuals tend to favor their most comfortable style. Gregorc defines his four learning styles accordingly:

*Concrete sequential learners (CS)* prefer to gain information through direct, hands-on experience. These learners prefer concrete, touchable materials that are presented in a step-by-step manner. CS learners prefer ordered presentation of material in a quiet atmosphere.

*Concrete random learners (CR)* gain information through experimentation and are able to make intuitive leaps. CR learners use trial-and-error in problem solving situations and are often ridiculed for jumping to conclusions since their method is not structured. These learners work well in small groups or independently and usually do not respond well to teacher intervention.

*Abstract sequential learners (AS)* have the ability to decode information in written, verbal, and graphic form. These learners like sequential presentations and gain a lot of information from visual images. AS learners enjoy reading and listening but do learn well from authorities.

*Abstract random learners (AR)* are keenly aware of human behavior. AR learners prefer to learn in an unstructured manner and prefer to work in multi-sensory environments. These learners do not appreciate rules and guidelines (Gregorc, 1979, pp. 20-22).

The *Gregorc Style Delineator* and the characteristics of Gregorc's four learning styles have had a tremendous impact on diagnosing individual learning styles. Gregorc's work has also influenced the construction of several learning style models, most notably the work of Kathleen Butler, Bernice McCarthy and the National Association of Secondary School Principals.

The National Association of Secondary School Principals (NASSP) model was created in 1982 through the work of a national task force. The task force sought to construct a learning style paradigm and an assessment instrument based on a comprehensive review of literature. The three main areas studied included personality theory, the information processing aspect of cognitive style research, and research on aptitude interaction (Keefe and Ferrell, 1990).

The personality theories reviewed by the NASSP task force included, among others, the work of Jung (1971) and Myers (1980, 1981). Keefe and Ferrell (1990) noted, however, that personality instruments usually do not measure deep learning style constructs. The information processing theories, such as the work of Anthony Gregorc, do measure deeper learning style constructs through experimentation and observation techniques. The NASSP model also looked at the variability of individual learners (Aptitude-Treatment-Interaction, ATI) as a measure of learning style. ATI research focuses on learning style variables such as the instructional environment and the cognitive style of the learner (Keefe and Ferrell, 1990).

Upon reviewing the literature on personality theory, information processing theory, and research on ATI, the NASSP task force defined learning style as:

The composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment. It is demonstrated in that pattern of behavior and performance by which an individual approaches educational experiences. Its basis lies in the structure of neural organization and personality which both molds and is molded by human development and the learning experiences of home, school, and society (Keefe and Ferrell, 1990, p. 59).

From this definition and the review of learning style literature, the NASSP model of student learning styles was created. The model divides learning styles into cognitive, affective, or physiological categories. As seen in Figure 7, the NASSP model simply lists the three learning style categories and their respective sub-styles.

In addition to creating the Student Learning Style Model, the NASSP started the Learning Styles Network. In 1982, the Learning Styles Network held a conference that was attended by more than thirty practitioners and researchers in the fields of learning style research and brain behavior. Among the conclusions of the Learning Styles Network conference was the recommendation to create "comprehensive, cohesive, and uncomplicated instruments to assist in identifying the ways students process information" (National Association of Secondary School Principals, 1982, p. 219). Keefe and Ferrell (1990) reported that between 1983 and 1986 the task force members used the NASSP findings on learning styles to create the *Learning Style Profile*. The *Learning Style Profile* has undergone extensive field-testing and review for readability, reliability, and validity. The four factors measured by the *Learning Style Profile* include cognitive elements, student study preferences, perceptual elements, and instructional elements.

The NASSP's *Learning Style Profile* and model are important to this study because of their comprehensiveness. Due to the overwhelming input and consensus of experts from many disciplines, the NASSP's definition of learning style was selected for this research project.

### **Summary**

Guild believed that learning style theories fall into three categories: those that focus on the individual, those that focus on curriculum development, and those that are diagnostic/prescriptive (Brandt, 1990). Regardless of a theory's particular focus, this review demonstrated the remarkable similarities between dominant theories. Many of

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## **Cognitive Styles**

### *Reception Styles*

- Perceptual modality preferences
- Field independence vs. dependence
- Scanning
- Constricted vs. flexible control
- Tolerance for incongruous or unrealistic experiences
- Strong vs. weak automatization
- Conceptual vs. perceptual-motor dominance

### *Concept Formation and Retention Styles*

- Conceptual tempo
- Conceptualizing styles
- Breadth of categorizing
- Cognitive complexity vs. simplicity
- Leveling vs. sharpening

## **Affective Styles**

### *Attention Styles*

- Conceptual level
- Curiosity
- Persistence or perseverance
- Level of anxiety
- Frustration tolerance

### *Expectancy and Incentive Styles*

- Locus of control
- Achievement motivation
- Self-actualization
- Imitation
- Risk taking vs. cautiousness
- Competition vs. cooperation
- Level of aspiration
- Reaction to reinforcement
- Social motivation
- Personal interests

## **Physiological Styles**

- Masculine-feminine behavior
- Health-related behavior
- Body rhythms
- Need for mobility
- Environmental elements

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## **Figure 7**

Student Learning Style Model (National Association of Secondary School Principals, 1982, p. 227).

the theories are based on the work of Carl Jung (1971) and utilize models that represent four distinct learning styles. The work of McCarthy (1979, 1980, 1987) highlighted these similarities and synthesized the work of twelve learning style researchers into a model for teaching and learning. The completeness of the 4MAT System model is why it was selected to identify the learning styles of technology education teachers in Virginia.

The link between teaching and learning style was established in this section. To better understand this link, the next section will review the dominant literature on teaching style theory.

## Theories of Teaching Styles

Contemporary literature on teaching and learning styles thoroughly support the notion that teachers should understand their own teaching and learning styles in order to be more flexible (see Claxton and Ralston, 1978; Dunn and Dunn, 1979; Cornett, 1983; Marshall, 1991). Although Silvernail (1986) traced teaching style research to 1896, there is little historical research connecting teaching and learning styles. Schunk (1996) offered four possible reasons why this link has been difficult to establish. First, most learning theorists (psychologists) historically researched non-human species. In contrast, educators conducted research on teaching. Second, the notion that teaching is an art, and psychology a science, led to some apprehensions of applying scientific knowledge to an art involving human subjects. Third, learning studied in psychological research was usually less context-dependent than learning in a classroom. The educational environment is very complex and involves interaction between teachers, learners, materials, and the setting. Fourth, early research methods may have been inadequate to study the complex roles of the teacher and student.

Teaching style researchers have overcome many of the problems portrayed by Schunk (1996). O'Neil (1990) showed, however, that there is still little agreement among teaching style models and approaches. Some researchers define teaching style broadly while others are very precise in their definitions. This section will only

review the theories that are based in research and are predominately cited in the teaching style literature as foundational studies.

Silvernail (1986) claimed that historically there were three dominant methods of analyzing teaching behavior. From the beginning of the nineteenth century until the 1950's, studies focused on student perceptions of their instructor. The major drawback of these early studies lay in the lack of data gathered on pupil achievement. The second phase of teaching style research, according to Silvernail, began in the 1930's and focused on observing teachers in an attempt to identify similar characteristics. Many of these instruments, however, lacked validity and reliability. The third method of analyzing teaching behavior began in the 1960's. These studies identified effective teaching behaviors and then created instruments to examine other teachers. Silvernail claimed that current research on teaching styles is heavily grounded in this third method.

Flanders' Interaction Analysis Categories system (FIAC) is the most widely used instrument to observe and record interactions between teachers and students (Silvernail, 1986). The FIAC was developed by Flanders and other researchers at the University of Minnesota between 1955 and 1960 as a "totally inclusive" instrument to measure the verbal communication of teacher talk, student talk, and silence or confusion. Figure 8 outlines the ten categories used by the FIAC. The FIAC was designed for direct observation in the classroom. The observer tallies the number of times each of the ten categories is observed. The numbers for each category are not associated with any scale and are simply used for classifying observed behaviors (Flanders, 1970).

Flanders used interaction analysis for three purposes. First, it was used to keep track of selected events that occur during classroom interaction. Flanders defined these events as the interaction that takes place between the teacher and students. Second, interaction analysis was used to help individual teachers develop and control their teaching behavior. Third, Flanders felt his research would help explain

<b>Teacher Talk</b>	<b>Response</b>	<p>1. <i>Accepts feeling.</i> Accepts and clarifies an attitude or the feeling tone of a pupil in a non-threatening manner. Feelings may be positive or negative. Predicting and recalling feelings are included.</p> <p>2. <i>Praises or encourages.</i> Praises or encourages pupil action or behavior. Jokes that release tension, but not at the expense of another individual; nodding head, or saying "Um hm?" or "go on" are included.</p> <p>3. <i>Accepts or uses ideas of pupils.</i> Clarifying, building, or developing ideas suggested by a pupil. Teacher extensions of pupil ideas are included but as the teacher brings more of his own ideas into play, shift to category five.</p>
		<p>4. <i>Asks questions.</i> Asking a question about content or procedure, based on teacher ideas, with the intent that a pupil will answer.</p>
	<b>Initiation</b>	<p>5. <i>Lecturing.</i> Giving facts or opinions about content or procedures; expressing <i>his own</i> ideas, giving <i>his own</i> explanation, or citing an authority other than a pupil.</p> <p>6. <i>Giving directions.</i> Directions, commands, or orders to which a pupil is expected to comply.</p> <p>7. <i>Criticizing or justifying authority.</i> Statements intended to change pupil behavior from non-acceptable to acceptable pattern; bawling someone out; stating why the teacher is doing what he is doing; extreme self-reference.</p>
<b>Pupil Talk</b>	<b>Response</b>	<p>8. <i>Pupil-talk-response.</i> Talk by pupils in response to teacher. Teacher initiates the contact or solicits pupil statement or structures the situation. Freedom to express own ideas is limited.</p>
	<b>Initiation</b>	<p>9. <i>Pupil-talk-initiation.</i> Talk by pupils which they initiate. Expressing own ideas; initiating a new topic; freedom to develop opinions and a line of thought, like asking thoughtful questions; going beyond the existing structure.</p>
<b>Silence</b>		<p>10. <i>Silence or confusion.</i> Pauses, short periods of silence periods of confusion in which communication cannot be understood by the observer.</p>

**Figure 8**

Flanders' Interaction Analysis Categories (FIAC) (Flanders, 1970, p. 34).

the variation that occurs in classroom events and how these differences impact educational outcomes (Flanders, 1970).

Flanders (1970) used his interactive analysis procedures to observe elementary and junior high classrooms in the United States and New Zealand over a twelve-year period. Remarkably, Flanders found striking similarities in the results of studies conducted during this period. Interaction analysis has also been used by Flanders for simulated social skill training, microteaching, and professional development. His research in these areas has proven reliable and is often cited by newer theories that are concerned with teaching styles.

The work of Bennett (1976) is also cited frequently in the teaching style literature. Bennett's research attempted to answer the following two questions: (1) do differences in teaching styles differentially affect the cognitive and emotional growth of pupils, and (2) do different types of pupils perform better under certain teaching styles (Bennett, 1976)? To answer these questions, Bennett developed a very systematic research model:

1. Break down the terms 'progressive' and 'traditional' into their constituent elements via a review of relevant literature and interviews with primary school teachers. Operationalise the elements in terms of questionnaire items so that they can be measured objectively.
2. After the questionnaire has been designed and piloted administer it to a large and representative sample of teachers.
3. Use cluster analysis to create a typology of teaching styles by grouping together teachers who responded to the questionnaire items similarly.
4. Validate the typology by independent ratings based on classroom observation and perception of pupils.

5. Select a representative sample of teachers from each teaching type by choosing those teachers who most closely reflect the central profile of each type.
6. Shift from a survey to a quasi-experimental research design by following through one school year the pupils of the teacher samples. Pre-test pupils on entry using a wide range of cognitive and affective instruments, and post-test prior to exit.
7. To assess the relationship between pupil personality and teaching style, create a typology of pupils based on the personality tests, using cluster analysis.
8. Validate pupil typology by observing the classroom behaviour of a 10 per cent sample of pupils (Bennett, 1976, pp. 34-36).

One of the influential findings from Bennett's research project were his classifications of teachers. Bennett classified elementary teachers as formal or informal. According to Bennett (1976), formal teachers "lay much greater stress on the promotion of a high level of academic attainment, preparation for academic work in the secondary school, and the acquisition of basic skills in reading and number work." Informal teachers were identified by Bennett (1976) as those instructors who "value social and emotional aims, preferring to stress the importance of self-expression, enjoyment of school and the development of creativity". Bennett concluded that all teachers should utilize both informal and formal teaching activities (Bennett, 1976, pp. 150-151).

Similar to Bennett, types of teachers were identified through their teaching styles by Mosston and Ashworth (1990). Mosston created the *Spectrum of Teaching Styles* in 1966 to counter the lack of consensus in teaching style theory. The goal of Mosston and Ashworth's *Spectrum* was to provide teachers with a framework so they could use as many styles as possible in the classroom. Each style was organized around three "decision sets." Pre-impact decisions involve preparing the materials and environment for instruction. Impact decisions are the decisions carried out during

instruction and post-impact decisions involve evaluation and assessment (Mosston and Ashworth, 1990).

Like the work of Flanders and Bennett, the *Spectrum* was based on years of school observations and meetings with classroom teachers. A comprehensive discussion of each of Mosston and Ashworth's eleven teaching styles is beyond the scope of this research. A significant characteristic of Mosston and Ashworth's teaching style theory, however, are the sample activities included with each teaching style.

The underlying principles and four learning styles of McCarthy are reviewed in the section titled Curriculum Development as the Focus of Learning Style Theory. McCarthy's 4MAT System of instruction, however, begins by identifying teachers' learning styles and illustrating how their style influences students (McCarthy, 1987). Through her synthesis of learning style theories, McCarthy developed four descriptions of learners, teachers and leaders. McCarthy summarized the descriptions for teachers in each of the four 4MAT learning styles as follows:

*Imaginative Learners-- as teachers...*

- are interested in facilitating individual growth.
- try to help people become more self-aware.
- believe curricula should enhance the ability to be authentic.
- see knowledge as growth in personal insight and encourage authenticity in their students.
- like discussions, group work, and realistic feedback about feelings.
- are caring people who seek to engage their students in cooperative efforts.
- are aware of social forces that affect human development.

*Analytic Learners-- as teachers...*

- are interested in transmitting knowledge.

- try to be as accurate and knowledgeable as possible.
- believe curricula should further understanding of significant information and should be presented systemically.
- see knowledge as deepening comprehension.
- encourage outstanding students.
- like facts and details and organized sequential thinking.
- are traditional teachers who seek to imbue a love of knowledge.
- believe in the rational use of authority.
- sometimes their dominating attitude tends to discourage creativity.

*Common Sense Learners-- as teachers...*

- are interested in productivity and competence.
- try to give students the skills they will need to be economically independent in life.
- believe curricula should be geared to this kind of focus.
- see knowledge as enabling students to be capable of making their own way.
- encourage practical applications.
- like technical things and hands-on activities.
- are exacting and seek quality and productivity.
- believe the best way is determined pragmatically.
- use measured rewards.
- tend to be inflexible and self-contained and lack team-work skills

*Dynamic Learners-- as teachers...*

- are interested in enabling student self-discovery.
- try to help people act on their own visions.
- believe curricula should be geared to learners' interests.
- see knowledge as a tool for improving the larger society.
- encourage experiential learning.
- like variety in instructional methods.
- are dramatic teachers who seek to energize their students.
- attempt to create new forms, to stimulate life and to draw new boundaries.
- tend to rashness and manipulation (McCarthy, 1987, pp. 37-43).

To learn more about teaching and learning styles, McCarthy conducted a study that spanned two years and included 2,367 teachers and administrators from all regions of the United States. In this group of educators, McCarthy found that common sense learners were the smallest proportion (17.4%) and analytic learners were the dominant group (31.1%). Dynamic learners accounted for 28.5% and imaginative learners made up the remaining 23% of McCarthy's sample. When these numbers were analyzed according to how teachers perceive and process information, the 4MAT System model appears to be very balanced. 51.5% of teachers and administrators perceive information concretely while 48.5% perceive abstractly. When processing information, 54.1% of McCarthy's sample preferred reflective observation and 45.9% preferred active experimentation (McCarthy, 1987). Despite these findings, the majority of research on the 4MAT System deals with implementing 4MAT lessons and observing student performance. Only a few research studies have focused on the teacher. Susabda (1992) matched student learning style with teaching style and found that matching helped students with

academic performance. Murray (1992) used the 4MAT System to train teachers to incorporate creativity in the classroom.

The lack of research verifying McCarthy's (1987) study suggests the need for other studies to investigate the 4MAT System's teaching styles. Nevertheless, McCarthy's work is significant to this study not only for her teaching and learning style research, but also for her insight into how learning style influences career choice. Like her 4MAT System model, McCarthy (1987) based her theories on career guidance on the work of David Kolb:

...undergraduate education is a major factor in the development of his/her learning style. Whether this is because individuals are shaped by the fields they enter or because of selection processes that put people into and out of disciplines is an open question at this point. Most probably both factors are operating. People choose fields which are consistent with their learning styles and are further shaped to fit the learning norms of their field once they are in it. When there is a mismatch between the field's learning norms and the individual's learning style, people will either change or leave the field (Kolb, Rubin, and McIntyre, 1979, p. 535).

McCarthy also believed people choose fields based on congruence between their learning styles and the norms of the field. McCarthy stressed, however, that all four learning styles should be equally valued and that teachers should be flexible and teach to all four types of learners. Matching teaching and learning styles is viewed negatively by McCarthy. She felt that "any 'matching' operation in a school necessitates labels, and we already have too many labels in education now" (McCarthy, 1987, p. 86).

Like McCarthy, Fisher and Fisher (1979) noted the similarities between their teaching and learning style classifications. Fisher and Fisher defined several teaching styles and distinguished them from teaching methods. According to Fisher and Fisher,

teaching styles refer "to a classroom mode, a pervasive way of approaching the learners that might be consistent with several methods of teaching" (Fisher and Fisher, 1979, p. 251). Like their learning styles, the Fishers identified teaching styles based on observations, experience, and discussions with classroom teachers. Fisher and Fisher did not see individual styles as exclusive. Like most of the researchers reviewed in this section, the Fishers believed in style variety.

The theme that teachers should utilize a variety of teaching styles is echoed throughout the literature (see Bennett, 1976; the National Association of Secondary School Principals, 1979; Guild and Garger, 1985; McCarthy, 1987; and Mosston and Ashworth, 1990). The teaching style research reviewed in this section also revealed support for the theory that teaching style can be gauged by assessing learning style. As stated in chapter one, this research project is based on the theory that learning style is an effective representation of teaching style.

## Teaching and Learning Style Research in Technology Education

Heikkinen, Pettigrew, and Zakrajsek (1985) showed that college education majors of different subject matter fields exhibit distinct learning styles. Industrial arts teachers demonstrated a high preference for working with things and preferred direct experience as opposed to the lecture approach of instruction. These findings reflect the unique history and support the theoretical base of technology education (see Anderson, 1926; Bennett, 1926, 1937; Martin, 1995; International Technology Education Association, 1985, 1988, 1991; Technology for All Americans Project, 1996, 2000). Other researchers in technology education have used a variety of instruments and methods to assess teaching and learning style. Halfin (1973), for example, advocated the observation of student mental processes over post-hoc evaluation and product evaluation.

The work of Halfin has been continued through the research of Roger Hill, Robert Wicklein, and Jay Rojewski at the University of Georgia. Hill (1997) used Halfin's seventeen mental processes to create an instrument for observing students' problem solving abilities. A BASIC computer program was written to record the length of time

students used each mental process. The Observation Procedure for Technology Education Mental Processes (OPTEMP) program was used to observe students and record their mental processes while working at several instructor created modules.

Hill and Wicklein (1999) also advocated using Halfin's mental processes to further technology education instruction. In addition to using mental processes as an observation tool, Hill and Wicklein suggested using the mental processes to construct problem-solving activities in technology education. This theory of instructional development promotes a process-based curriculum as opposed to technology education's historical product-based models.

Wicklein and Rojewski (1995) conducted research to describe the psychological preferences of technology education teachers. The *Myers-Briggs Type Indicator (MBTI)* was administered to 254 International Technology Education Association (ITEA) members in an attempt to distinguish technology teachers from the general population and from secondary educators. Wicklein and Rojewski found that 69% of their sample were practical, realistic, and preferred to solve problems conceptually through structured investigation and inquiry. When compared to the general population, Wicklein and Rojewski's (1995) sample demonstrated a greater preference for a sensing-judgement temperament type and a lower preference for a sensing-perception temperament.

Kuskie and Kuskie (1999) created a learning style instrument for use in secondary technology education classrooms. Specifically, the *Learning Channels Inventory (LCI)* was designed "(a) to enhance the learning of technology curriculum, (b) to consider how students might most effectively learn and use the technology equipment, and (c) to expand the instructional methods of the technology teacher" (Kuskie and Kuskie, 1999, p. 77). The LCI is a paper and pencil test that measures visual, auditory, and psychomotor preferences. Students read fifteen statements and prioritize three preferences for each statement. Scores are totaled to determine learning style preference. If two scores are equal, the student has not developed one

dominant style or uses whatever style is needed by a particular situation. Kuskie and Kuskie have revised the LCI and established a test-retest reliability of .80.

The LCI is designed to be used at the beginning of a class. Kuskie and Kuskie (1999) recommend assessing student preferences and then using the findings to educate students about their preferences. Like many teaching and learning style researchers, Kuskie and Kuskie noted that using a variety of visual, auditory or psychomotor activities can enhance individual and cooperative learning.

Tappenden (1983) examined the learning styles of secondary vocational education and non-vocational education students. Her research is reviewed here because her sample included trade and industrial education students in eleventh and twelfth grade. Tappenden used the *Learning Style Inventory (LSI)* created by Dunn, Dunn, and Price (1984). The LSI was designed to investigate the environmental, emotional, sociological, and physical preferences outlined by Dunn and Dunn (1987). Tappenden found that vocational and non-vocational students have significantly different learning style preferences. Vocational students demonstrated a high preference for mobility and tactile instruction. Tappenden, like many style researchers, recommended including learning style theory in teacher education programs for diagnostic and prescriptive purposes.

Similar to Tappenden, Kroon (1985) used the *Learning Style Inventory (LSI)* created by Dunn, Dunn, and Price (1984). Kroon investigated the effect of matching the perceptual strengths of technology education students with instructional materials that complemented their strongest perceptual inclinations. Kroon's sample consisted of 65 technology education students and 65 non-technology education students. Students were given the LSI to identify their preferred learning style. Six lessons that targeted auditory, visual, and tactual experiences were given to both groups with an achievement test following each lesson.

Kroon concluded that technology education students preferred tactual activities but did not prefer kinesthetic activities. A second finding showed that matching

instruction to students' perceptual preferences resulted in higher test scores for technology education students. Interestingly, Kroon also found that technology education students are not self or teacher motivated and recommended using sequential instruction based on this finding. John Banks (1973) came to a similar conclusion in his vocational-technical education study:

One conclusion was that if an individual's learning style could be determined, then it was conceivable that alternative modes of instruction could be developed to provide the student an opportunity to learn material by a method that complemented his/her learning method (in McCarthy, 1979, p. 126).

In summary, the research on teaching and learning styles in technology education demonstrates support for a variety of teaching methods. Also, the research highlights the differences between the learning styles of technology education teachers, the general population, and secondary teachers.

## Teaching and Learning Environment

The previous sections have reviewed theories of learning and teaching style. To adequately assess the nature of middle school technology education, however, an understanding of the teaching and learning environment is necessary. Technology education has a long history of experiential, laboratory-based instruction (see Anderson, 1926; Bennett, 1926, 1937; Martin, 1995). This section will review general education research on instructional strategies and the physical teaching and learning environment with a focus on programmed instruction and teaching machines.

B. F. Skinner's later research focused on the learning of young children instead of pigeons, rats, dogs and monkeys. Skinner became fascinated with the intelligence and information testing conducted by Sidney L. Pressey in the 1920's. Pressey used simple machines to record test answers and found that his machines could actually be used to teach. However, Pressey's "industrial revolution in education" was not

received in the educational community and he discontinued his research in 1932 (Skinner, 1968, pp. 30-31)

In Skinner's (1968) book titled *The Technology of Teaching*, he noted the "advancing science of learning" (pp. 14-15) that focused on the efficiency of the child rather than the aversive methods of punishment for unsatisfactory work. Skinner's theories on the technology of teaching are most recognized for his creation of teaching machines. The "Skinner box" was a device that contained paper rolls of questions and answers along with a crank to advance the material and various sliders to input answers. Immediate feedback was one of the key features of Skinner's teaching machine. A second feature was the ability of a teacher to supervise an entire class that was using the teaching machines at the same time. Students were allowed to work at their own pace and problems could be tailored to students' abilities. Because the teaching machine recorded student responses, material could be monitored to make sure it was sufficiently "reinforcing." Skinner found significant results from using his teaching machine in the fields of spelling and mathematics. He advocated the use of the teaching machine in such rote subjects because these teaching activities were "beneath the dignity of any intelligent person." Skinner believed teachers should focus their classroom time on activities that cannot be duplicated mechanically, such as reinforcing the relationships between individuals (Skinner, 1968).

Skinner's teaching machines became more elaborate as his research progressed. Some devices contained audio material to accompany written activities. Many machines were "programmed" to provide feedback for wrong answers. Students could see their wrong response and would often be given leading reinforcers but were never given the correct answer. During this point of instruction, Skinner highlighted the role of the teacher:

The real issue is whether the teacher prepares the student for the natural reinforcers which are to replace the contrived reinforcers used in teaching. The behavior which is expedited in the teaching

process would be useless if it were not to be effective in the world at large in the absence of instructional contingencies (Skinner, 1968, p. 86).

Skinner anticipated criticisms for his teaching machines. He felt that educators would reject the teaching machine and programmed instruction for being too rigid, but argued "nothing could be more regimented than education as it now stands." Skinner also noted the difficulties of cognitive theory and research on student thinking so he presented the teaching machine as one tool for educators to use in the complex task of education. Skinner argued the benefits of his research on teaching machines and programmed instruction but made the dominant role of the teacher very apparent. The teacher, according to Skinner, is the central figure in education and could never be replaced by a machine (Skinner, 1968).

Like Skinner, Hunter (1967a, b) expanded on learning concepts from classical psychology. She is recognized for her educational theories on motivation, reinforcement, and retention. Her theories of motivation and reinforcement focused on the learning environment and have been assimilated into everyday classroom practices. Hunter argued that no one could *make* a student learn.

In her theory of motivation, Hunter (1967a) offered six environmental variables that teachers could alter to influence student motivation: (1) tension or concern, (2) feeling tone, (3) interest, (4) success, (5) knowledge of results, and (6) relation of activity to reward. Hunter felt that teachers could manipulate these environmental variables to motivate students and get them out of the state she called "passive equilibrium."

Hunter's (1967b) reinforcement theory could be used by anyone interested in the process of changing behavior (learning). Hunter used terms from classical psychology to outline four types of reinforcement that could be used by teachers to aid student learning. A positive reinforcer will strengthen the response it follows and make that response more likely to reoccur" (1967b, p. 1). A negative reinforcer,

according to Hunter, "...can be anything unpleasant or not desired by the student. A negative reinforcer weakens the response it immediately follows" (1967b, p. 8). The third factor of Hunter's reinforcement theory was called extinction. When a response is ignored, it becomes extinguished since positive and negative reinforcers are withheld. Hunter's fourth factor of reinforcement was closely related to extinction. If the negative behavior re-surfaced after an extended period of time, Hunter classified the reoccurrence as a spontaneous recovery. To counter the spontaneous recovery of undesired behaviors, Hunter recommended using a schedule of reinforcement. A schedule of reinforcement was created when teachers consistently use extinction and positive and negative reinforcement. Hunter acknowledged the "common sense" of her reinforcement theory but argued that it was often not used correctly. Many teachers used extinction and positive and negative reinforcement but often ignored a schedule of reinforcement (Hunter, 1967b).

Hunter's development of retention, motivation, and reinforcement theory are often overlooked by classroom teachers because they have become so ingrained into classroom pedagogy that they are often considered common sense. Some researchers, on the other hand, prefer alternatives to Hunter because they do not feel her work can address issues such as teacher evaluation (see VanCleaf, 1988).

Dunn and Dunn claimed that learners are affected by their environmental, emotional, sociological, and physical preferences (Dunn, DeBello, Brennan, Krimsky, and Murrain, 1981). The emotional and sociological preferences researched by Dunn and Dunn have been reviewed in the section titled, *The Diagnostic/Prescriptive Focus of Learning Style Theory*. Dunn and Dunn also identified and researched environmental and physical preferences such as seating, lighting, temperature, eating in class, noise, and work time (Dunn and Dunn, 1987). To help teachers deal with each of these learning style issues, Dunn and Dunn recommended assessing students' learning preferences before beginning instruction. By understanding students' styles, the Dunns believed a flexible environment could be created to fulfill all student needs.

This section has focused on general education research dealing with the physical teaching and learning environment. These underlying theories and research are important to this study because of the general education focus of technology education. The next section will outline the recent evolution of conventional and modular technology education laboratories.

### **Recent Evolution of Conventional Technology Education Laboratories**

William E. Warner believed that the scope of industrial arts after World War II had changed. Warner felt that society had changed from an industrial complex to an elaborate social environment that consisted of producers, consumers and managers of technology. This view led Warner to write *A Curriculum to Reflect Technology* (1947). One of the notable suggestions by Warner was the use of a general area shop as opposed to the traditional unit shop. Warner's vision of the general area shop included tools and machines that could be used for a variety of materials and processes as opposed to the unit shops' focus on one material or process. Proctor (1959) also highlighted the limitations of the unit shop in the 8<sup>th</sup> Yearbook of the American Council on Industrial Arts Teacher Education.

The philosophy of Warner was furthered by one of his graduate students, Delmar W. Olson. Olson's dissertation and subsequent publication, *Industrial Arts and Technology* (1963), expanded the notion of using technology as the content base of industrial arts. Olson's work recommended the following six functions for technology education curriculum development: technical, occupational, consumer, recreational, cultural, and social. Although an elaboration of each function is not necessary for this review, it is important to realize how these functions affected laboratory design. *Industrial Arts and Technology* contained many sample laboratory designs. When reviewing these designs, it is clear to see how Olson took the general area shop to a new level. Many of the designs are arranged in a modular format. It is important to note, however, that Olson did not intend these lab areas to be autonomous units. On the contrary, Olson envisioned flexibility in his labs with student's moving between stations and utilizing the tools and materials in an integrated manner. The influence of Olson's work upon industrial arts philosophy, curriculum, and laboratory

development in the 1960's is apparent in such projects as The Maine Plan (Maine State Department of Education, 1965).

The American Council on Industrial Arts Teacher Education (ACIATE) has published several yearbooks that focus on technology education facilities. The eighth ACIATE yearbook published in 1959 detailed existing laboratories, equipment selection, planning, architecture, and planning and evaluation procedures. The 1959 yearbook contains numerous photographs, reference lists and sample laboratory layouts (Nair, 1959).

During the 1960's, industrial arts went through an unparalleled period of curriculum development projects (see Cochran, 1970; Householder, 1972). Even the current paradigm of vendor-driven modular programs pales in comparison to the number of projects that took place in the sixties. Herschbach (1997) attributed the expansion of curriculum projects during the 1960's to Federal and private grants, legislation, and as a response to the academic rationalist movement in education. To reflect the curriculum changes in industrial arts and as a reaction to the popularity of the eighth Yearbook, the ACIATE published a second yearbook on facilities in 1975 (Moon).

The 24<sup>th</sup> ACIATE yearbook (Moon, 1975) included many of the features of the 8<sup>th</sup> yearbook but also contained facility information for many of the curriculum projects created in the 1960's. Specifically, the 1975 yearbook presented facility information for the following curriculum projects: American Industry Project, Georgia Plan, Industrial Arts Curriculum Project, Maryland Plan, Occupational Versatility, and the Orchestrated Systems Approach. In addition, information was provided on transportable industrial arts laboratories and the emerging field of visual communications.

In 1985 the American Industrial Arts Association (AIAA) changed its name to the International Technology Education Association (ITEA). To reflect the paradigm shift of curriculum based on industry to curriculum based on technology, the ACIATE (renamed the Council on Technology Teacher Education (CTTE) in 1986) created a

series of six yearbooks related to content, facilities, and instruction. The ACIATE's 1986 yearbook, titled *Implementing Technology Education*, was designed to explain the changes taking place within the profession. Although this yearbook did not highlight laboratory environments, it was the first of two yearbooks designed to establish the conceptual foundations for the four yearbooks that do highlight facilities. The second conceptual yearbook in the series was published in 1988 and was titled *Instructional Strategies for Technology Education* (Israel, 1994).

The remaining four CTTE yearbooks created to establish a conceptual framework for technology education were published between 1990-1994. Each yearbook was based on one of the content organizers outlined in the *Jackson's Mill Industrial Arts Curriculum Theory* (Snyder and Hales, 1981). The four organizers outlined in *Jackson's Mill* are communication, transportation, manufacturing, and construction. The four CTTE yearbooks dealing with these topics each contain a chapter on facilities. Although these chapters focus more on content than on physical characteristics, their differences from earlier facilities yearbooks can be seen in several ways. First, there was considerable emphasis on studying the impacts of technology. Second, areas for research and experimentation are emphasized. However, both of these concepts are not new to technology education (see Olson, 1963; Maley, 1970; Earl, 1960).

Many of the conventional facility plans mentioned in this section are strikingly similar, regardless of their age. Change in education is slow. New names for the field and new curriculum paradigms have done little to change facility design in technology education. Until the creation of the modular lab, the only change in many technology education facilities occurred in the area of curriculum.

### **Recent Evolution of Modular Technology Education Laboratories**

Modular labs have been widely implemented in secondary technology education programs during the last two decades. The Gestalt principle of summation, which states that the whole is more than the sum of its parts (Rothstein, 1990), along with programmed instruction and the teaching machines of Skinner, appear to have

influenced the creation of modular technology education (MTE). This section will look at the historical foundations and development of MTE laboratories.

The "teaching machine" research of B. F. Skinner in the 1950's created a wealth of classroom investigation and curriculum development. During the 1960's this line of research became known as programmed instruction. Programmed instruction was characterized by small instructional steps, active student involvement, immediate confirmation or reinforcement, and self-pacing. Russell (1974) credited S. N. Postlethwait for using programmed instruction to create "a small unit of subject matter which could be treated coherently as an individual topic and could be conveniently integrated into a study program." Postlethwait used audio and self-instructional carrels to create "micro-courses" that were centered around content objectives. Similar instructional methods were soon developed under titles such as "concept-o-pac," "instruc-o-pac," "unipak," "learning activity package" (LAP) and "individualized learning package" (ILP) (Russell, 1974, p. 3).

In the early 1970's the term "module" emerged as a generic description for individualized learning packages (Bolvin, 1972). Russell's definition of a module could easily describe the packages currently being used by technology education:

A module is an instructional package dealing with a single conceptual unit of subject matter. It is an attempt to individualize learning by enabling the student to master one unit of content before moving to another. The multi-media learning experiences are often presented in a self-instructional format (Russell, 1974, p. 3).

In technology education, Johnston (1986) used the work of Russell (1974) to compare the effectiveness of conventional and modular instruction in a high school manufacturing class. Four written modules were created and presented to one class while a second class was taught with conventional instruction. Johnston's (1986) findings are significant to technology education but have been overlooked in the

literature. Johnston (1986) found that students who received conventional instruction achieved higher scores on a post-test than students who received modular instruction.

Directly important to this study was Johnston's (1986) research on learning styles. The *Learning Styles Inventory* (Dunn, Dunn, and Price, 1984) was used to assess student learning styles. Johnston (1986) found that students whose learning styles were matched by persistence, work with adults, and work with peers had higher achievement than students whose styles were not matched. Although Johnston's research appears to be the earliest work dealing with modular instruction in technology education, it is difficult to draw conclusions since the research only involved two classes at one high school.

Flexibility is the main differences between Bolvin's (1972) and Russell's (1974) concept of modules and the current modules used in technology education. Russell (1974) described modules as portable units that could be completed in different periods of time. Bolvin (1972) highlighted the importance of the student's rate of learning and the need to sequence instruction according to individual needs. Volk (1996) and Petrina (1993), however, noted that many of the commercial modules being used in technology education today are organized and constrained by the equipment and devices contained in such programs.

The change from the flexible modules of the 1970's to the rigid modules described by Volk (1996) and Petrina (1993) are highlighted by Dean (1997). During the early 1970's, technology teachers Harvey Dean and Max Lundquest created a process cart that "contained all a project's required equipment, instructions, and supplies" (Dean, 1997, p. 72). The process carts were distributed by Dean's company, the Pittsburg Industrial Teacher Service Company (PITSCO). According to Dean, the creation of technology education modules as they are presently known, however, did not occur until 1985. When the American Industrial Arts Association (AIAA) changed to the International Technology Education Association (ITEA) at the 1985 conference in San Diego, confusion and controversy resulted (see LaPorte, 1986). Dean (1997)

noted that Max Lundquest and Mike Neden left the conference and returned to Pittsburg, Kansas with the notion of creating a laboratory that would represent technology education. Through their discussions, the concept of the process cart resurfaced but this time "as a stationary work station, and the strategy of dividing students into groups was further refined; now the 'groups' became teams of two" (Dean, 1997, pp. 76-77).

Although Dean credited Max Lundquest and Mike Neden for creating MTE, this section showed that modular instruction, like many historical developments, was an evolutionary process. Nevertheless, the laboratory at Pittsburg middle school and Dean's marketing have significantly influenced MTE (see Evans, 1999).

### **Research on Conventional and Modular Technology Education Laboratories**

The need for research on laboratory instruction in technology education is well documented. McCrory (1987) noted that there were no studies on laboratories (excluding machine safety) or new technology education equipment in the period 1980-1986. Laboratory studies during the period 1987-1993 concentrated on curriculum and did not focus on new instructional methods and strategies (Zuga, 1994). Despite these findings, several surveys and status studies concerning conventional laboratory instruction have been completed in technology education.

Although industrial arts changed to technology education in 1985, Dugger, French, Peckham, and Starkweather (1992) noted that industrial arts courses such as woodworking still dominated secondary instruction in 1991. Even as late as 1995, Jewell found that secondary principals in North Carolina still believed woodworking and metalworking should be a part of technology education. These studies provide some insight into the status of conventional laboratories but also demonstrate the need for further research in this area.

Until recently, there was little research to support or refute the instructional merit of modular laboratories. Many polemic papers have been written which discuss the

advantages and disadvantages of modular laboratories. For example, Petrina (1993) claimed that modular technology education is a continuation of industrial arts practices, uses problematic systems metaphors, concedes authority to product companies, and circumvents curriculum theory. Gloeckner and Adamson (1996), however, stressed teacher motivation and highlighted the use of modules as one tool that could be incorporated into technology education programs. Although such editorials are important for professional dialogue, this review will focus on research covering modular technology education.

Begley (1997) conducted a survey of major school systems in Virginia to determine the status of modular technology education. The questionnaire was sent to technology education supervisors in school systems with populations of 10,000 or more residents. Of the nineteen districts surveyed, Begley had a 100% return and found that 51% of the secondary technology education laboratories were modular. This survey contained some interesting findings but Begley's review of literature and recommendations were not very informative.

Brusic and LaPorte (1999) conducted a survey similar to Begley's on the status of modular technology education in Virginia. Their design, however, surveyed the entire population (N=963) of technology teachers as identified by the Virginia Department of Education. The strength of their research is in the sampling procedures and the development of their survey. Brusic and LaPorte utilized input from classroom teachers and the research on innovations conducted by E. M Rogers. Specifically, LaPorte and Brusic (1999, p. 2) conducted their study "to determine how many Virginia Technology Education (VTE) teachers are teaching in modular labs as compared to conventional labs, and to describe Virginia Modular Technology Education (MTE) teachers' (i.e., technology teachers who teach in modular labs) experience with, and feelings about their MTE laboratories."

Brusic and LaPorte discovered several very interesting findings. First, almost half of the technology education teachers who returned instruments (n=492, 92% of which were usable) taught in some type of modular lab. A second finding showed that most

MTE teachers who felt that less preparation time was the greatest advantage of MTE labs would return to a conventional lab if the preparation time was similar. The theoretical basis and preliminary findings of Brusica and LaPorte (1999) have a direct influence on the conceptual basis of the research project being outlined in this work.

Technology education professionals have not conducted a significant amount of experimental research. Rogers (1998b), however, used a pretest-posttest non-equivalent group design to study seventh grade technology students in Nebraska. Students were tested before a nine-week technology class and again at the conclusion of the course. Each group was in a different lab environment: one traditional, one contemporary, and one modular. After the test data were collected, Rogers used analysis of covariance (ANCOVA) to compare the three different instructional settings. The findings suggested that the achievement gain of students in the contemporary lab was significantly greater than those in the traditional and modular labs ( $F=11.09$ ,  $P=.0001$ ). This finding supports many of the polemic claims that modular programs do not significantly affect achievement. Apparently, Rogers' research was not published and therefore is not widely recognized.

A recent dissertation completed by Weymer (1999) used a similar experimental format. Weymer utilized a pretest-posttest design and the Group Embedded Figures Test (GEFT) to analyze student achievement and cognitive styles in a modular lab. Each independent variable (i.e., cognitive style, sex, and quantitative ability) was analyzed separately with a *t*-test in regard to the dependent variable (i.e., posttest scores). Weymer also used multiple regression analysis to determine the existence of combinations of relationships between the independent variables with regard to posttest scores.

Weymer's (1999) dissertation provided some insightful conclusions for teachers and curriculum developers. His findings showed that many of the field dependent and field intermediate students were lost in the modular lab. Weymer also concluded that many of the students did not have the verbal skills necessary to follow the self-paced format of modular instruction.

Hill (1997) developed a unique method for studying modular technology education programs by observing the interactions of the students. This is an area of research that is extremely scarce in technology education. Many researchers focus on teachers, supervisors, and teacher educators while overlooking the student. Hill's method measured technological processes and problem solving skills through the direct observation of students working at three different modules. Hill cited Halfin's (1973) research as the basis for using the mental processes of students to measure their problem solving ability. Hill first listed and explained the seventeen mental processes that Halfin developed after reviewing the writings of ten key historical technologists. After these mental processes were identified, Hill explained how to videotape students and mark the time length each student spent on a particular mental process. Hill's (1997) conclusions are interesting and leave room for further research. On each of the three pairs of students studied, Hill found that they spent a significant amount of time communicating with each other. From this and other study findings, he recommended using the mental process method to look at various commercial packages and laboratory activities.

This analysis of literature on modular technology education shows the applications of a variety of research methods. Each method has its own classical benefits and problems. Surveys often contain limitations associated with sampling. Experimental designs can have problems with the control of extraneous variables, validity, and reliability. Mixed and qualitative methods rely on the credibility of the researcher as the instrument of data collection. The research on modular technology education both supports and refutes many of the opinions that have inundated the literature. More research must be conducted to establish a better understanding of the increasingly pervasive modular instructional method. This review has highlighted the need for research on the teaching and learning style aspects of modular laboratory teachers.

## Summary

The theories and research that influence technology education were presented in this chapter. First, the underlying theories of learning and instruction were reviewed. Second, the theories and research concerned with teaching and learning styles were reviewed. Third, the recent evolution of technology education laboratories, both conventional and modular, was reviewed. Finally, research concerning laboratory instruction in technology education was highlighted. This review has highlighted the lack of research within technology education concerning laboratory instruction and the learning styles of technology teachers.

In the next chapter, the research methods and procedures for this study are established. Research hypotheses are presented along with information on the population, sample, instrumentation, and data collection procedures. Statistical analysis procedures along with the reliability and validity of this study conclude the third chapter.

## Chapter 3. Methods and Procedures

### Overview

This study investigated the relationship between the laboratory environments and the teaching and learning styles of middle school technology education teachers in the Commonwealth of Virginia. In chapter one, researchable questions and a list of terms that were incorporated into this research were reported. Delimitations and assumptions were outlined to establish the parameters of this research project. Chapter two consisted of a comprehensive review of related literature and research. Emphasis was placed on the underlying principles of teaching and learning style theory, as well as recent research on middle school laboratory instruction within technology education. The four learning styles defined by McCarthy (1987) and the *Learning Type Measure* instrument (Excel, 1998) were selected for this study due to their comprehensiveness and record of validity and reliability. In this chapter, the research methods and procedures are established. Research hypotheses are presented along with information on the population, sample, instrumentation, and data collection procedures. Statistical analysis procedures along with the reliability and validity of the instrument used in this study are also presented in this chapter.

### Design of the Study

This research is a descriptive study. According to Isaac and Michael (1981, p. 46), descriptive research is used "to describe systematically the facts and characteristics of a given population or area of interest, factually and accurately." The design of this study portrayed the state of middle school technology education in two distinct ways. First, the context for this study was established through a comprehensive review of literature on theories of learning and instruction, learning and teaching styles, and technology education laboratories. Second, to describe the teaching and learning styles of middle school technology educators in the Commonwealth of Virginia, this study utilized random sampling, a demographic questionnaire, the *Learning Type Measure* instrument, Pearson's Chi-square and crosstab analysis. The learning

styles of respondents were described in relation to the type of laboratory in which they taught. Both groups of technology educators were also compared to McCarthy's (1987) national findings for secondary teachers and administrators.

## Hypotheses

The hypotheses were developed from the review of related literature and resulting problem statement. The research hypotheses were presented in the first chapter. The null form of the hypotheses are presented below.

- H<sub>10</sub>: Middle school technology education teachers who teach in modular laboratories do not have different teaching and learning styles from those who teach in conventional laboratories.
- H<sub>20</sub>: Middle school technology education teachers generally do not have different teaching and learning styles from secondary teachers in general.

## Population and Sample

Participants for this research were randomly selected from Brusich and LaPorte's (1999) database. This database contained the entire population (N=392) of the middle school technology education teachers that were listed with the Commonwealth of Virginia's Technology Education Service. The formula developed by Krejcie and Morgan (1970) was used to determine that a sample of 195 teachers would be needed to accurately represent the population in question. Figure 9 displays these calculations. Next, a list of random numbers was created using the random number generation capabilities of Microsoft Excel. Finally, mailing labels were generated and the materials were assembled for the initial mailing to the 195 randomly selected participants.

---

$$s = X^2NP(1-P) \div d^2(N-1) + X^2P(1-P)$$

$$s = 3.841(392)(.5)(1-.5) \div (.05)^2(392-1) + 3.841(.5)(1-.5)$$

$$s = 376.418 \div 1.93775$$

$$s = 194.25519$$

s = required sample size.

$X^2$  = the table value of chi-square for 1 degree of freedom at the desired confidence level ( $\alpha = .05$ ).

N = the population size.

P = the population proportion (assumed by Krejcie and Morgan (1970) to be .5 since this provides the maximum sample size).

d = the degree of accuracy expressed as a proportion (.05).

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## Figure 9

Calculations to Determine Sample Size

### Instrumentation

A demographic questionnaire and the *Learning Type Measure* instrument were used to collect data in this study. The demographic questionnaire (Appendix C) collected information concerning gender, teaching experience, the type of lab predominantly used by the responding teachers and their preferred type of laboratory for implementing middle school technology education.

The *Learning Type Measure* instrument (LTM) is published by About Learning, Incorporated of Wauconda, Illinois (formerly named Excel, Inc.). Specifically, the LTM

reflects individual preferences for attending to, acting upon, and creating representations of knowledge and experience. When considered situationally, these preferences help individuals examine their behaviors related to motivation, thinking, problem-solving, and performance. This enhanced awareness can have a positive impact on personal development (Excel, 1998, p. 2).

Initially, McCarthy utilized Kolb's *Learning Style Inventory* to encourage and validate diversity in problem solving and thinking. However, through McCarthy's action research in schools and organizations and graduate dissertations, the critical question "shifted from 'What is your learning style?' to 'What is the interactive relationship of your style with other modes of learning and how does this create the dynamic for personal development?'" (Excel, 1998, p. 2). From this question, McCarthy soon realized the need for an instrument that reflected the whole cycle of learning that was outlined by her 4MAT System model (Excel, 1998).

The LTM instrument is well grounded within learning style research. Based on the work of Carl Jung, David Kolb, Kurt Lewin, Isabel Myers, Joseph Bogen, and Bernice McCarthy, the LTM is a reflection of:

1. situational adaptations of Jung's constructs of feeling, thinking, sensing, intuition, extroversion, and introversion,
2. behaviors modeled after Kolb's constructs of concrete experiential, reflective, abstract, and active learners,
3. representations of hemispherity drawn from Bogen, and
4. McCarthy's field work (Excel, 1998, p. 3).

The LTM instrument is a paper and pencil instrument that contains three sections. The first section measures the learning style preferences of feeling, thinking, sensing, or intuiting. The second section of the LTM assesses whether individuals process newly learned information reflectively (by watching) or actively (by doing). In the third section, scores from the first section are plotted on a grid that is divided into

the four learning style quadrants. Once the preferred learning style is identified, participants plot their scores for processing information in the quadrant of their preferred learning style. According to Excel (1998) everyone processes new learning by doing and watching. What makes individuals unique, however, is the intensity of their predisposition.

## Instrumentation Validity

Isaac and Michael (1981) identified three types of validity that indicate the degree to which a test is capable of achieving certain aims. Content validity is demonstrated by showing how well the content of the test samples the subject matter about which conclusions are to be drawn. Criterion-referenced validity, according to Isaac and Michael, is demonstrated by comparing the test scores with one or more external variables considered to provide a direct measure of the characteristic or behavior in question. Construct validity is evaluated by investigating what qualities a test measures, that is, by determining the degree to which certain explanatory concepts or constructs account for performance on the test.

The content validity of the *Learning Type Measure* instrument has been established through the research of McCarthy (1979, 1980, and 1987). In this research, McCarthy found amazing similarities in the teaching and learning style studies of twelve noted researchers from various disciplines. McCarthy synthesized the four types of learners described in Part A of the LTM and the two types of activities described in Part B of the LTM from her extensive review of learning style research (Excel, 1998).

Criterion-referenced validity, also referred to as concurrent validity, of the LTM has been established by comparing the instrument to the Kolb *Learning Style Inventory* (LSI) and the *Myers Briggs Type Indicator* (MBTI). To compare the LTM and the LSI, a contingency table (n=175) was constructed and determined a 61.1% agreement between the two instruments. In addition to the Contingency Coefficient, Pearson's Chi-square and Cramer's V show a significant relationship between the LSI and the LTM (Excel, 1998).

When compared to the MBTI, the following significant relationships with the LTM were determined through correlation:

The F, or Feeling score is most associated with the Learning Type 1 score (Imaginative Learners).

The I, Introvert, T, Thinking, and J, Judging scores are most associated with the Learning Type 2 score (Analytic Learners).

The S, Sensing score, is most associated with the Learning Type 3 score (Common Sense Learners).

The E, Extrovert, N, Intuitive, and P, Perceiving scores are most associated with the Learning Type 4 score (Dynamic Learners) (Excel, 1998, pp. 11-12).

Each of the MBTI dimensions and 4MAT System learning styles are reviewed in the section of chapter two on learning styles.

Construct validity of the LTM has been established three ways. First, to determine if people have one, distinguishable learning type, 390 subjects were administered the LTM. Only ten participants had a tie between two learning types. Second, to determine if people have sharply peaked profiles, the maximum rating for each learning style preference ( $15 \times 4 = 60$ ) was compared to the minimum rating for each learning style ( $15 \times 1 = 15$ ). Of the 390 subjects, 70% had a difference of 5 or more between their maximum sum and their next highest sum. Differences ranged from 0 for the ten subjects with two identical sums (two learning style preferences) to 25 (a very peaked profile). The third method used to measure construct validity was to determine if the "correct" respondents rated a particular stem strongly (marked the stem with a 3 or 4). Of the sixty stems in the LTM, fifty-one (85%) were marked strongly (with a 3 or 4) over 70% of the time by the 390 subjects (Excel, 1998).

The content, criterion-referenced, and construct validity research offered by Excel (1998) suggest that the LTM can effectively indicate learning and teaching style

preference of middle school technology education teachers in the Commonwealth of Virginia.

## Instrumentation Reliability

Reliability, according to Isaac and Michael (1981, p. 125), "refers to the accuracy (consistency and stability) of measurement by a test." The reliability of the *Learning Type Measure* instrument has been established in two ways. The internal consistency of the LTM was measured using Cronbach's alpha and the test-retest reliability was established through correlation.

Cronbach's alpha is used when measures have items that are not scored simply as right or wrong (Ary, Jacobs, and Razavieh, 1996). According to the LTM Presenter's Manual (Excel, 1998), attitude or affective inventories have alphas between .80 and .90. The Cronbach alpha values of Part A and Part B of the LTM have been established as follows (Excel, 1998, p. 11):

Scale	Cronbach's Alpha
Part A: Learning Type One	.85
Learning Type Two	.83
Learning Type Three	.76
Learning Type Four	.88
Part B: Do vs. Watch	.86

Ary, Jacobs, and Razavieh (1996, p. 279) claim "an obvious way to estimate the reliability of a test is to administer it to the same group of individuals on two occasions and correlate the paired scores." The test-retest reliability coefficient of the LTM was determined to be .71 (n=390). Because the test-retest coefficient is indicative of the consistency of scores over time, it is often referred to as the coefficient of stability (Ary, Jacobs, and Razavieh, 1996). Self-report measures of human qualities contain some degree of error. When this error is considered, Excel, Inc. (1998) claims that a .71 test-retest coefficient is an indicator of a high level of stability.

## Data Collection

A random sample ( $n=195$ ) was drawn from the entire population ( $N=392$ ) of middle school technology education teachers identified in 1998 by the Virginia Department of Education's Technology Education Service. The initial mailing, conducted on Friday, January 21, 2000, included a cover letter, postage-paid return envelope, the *Learning Type Measure* instrument, and one dollar as an incentive to complete and return the instrument.

Dillman (1978) recommended conducting follow-up mailings during the first, third, and seventh week prior to the initial mailing. Due to the cost of the *Learning Type Measure* instrument, replacement instruments could not be provided in the follow-up mailings. Because replacement instruments were not financially feasible, a postcard (Appendix E) was sent to the entire sample during the first week following the initial mailing (Saturday, January 29, 2000). A second postcard was mailed three weeks after the initial mailing (Saturday, February 12, 2000). The follow-up mailings served as both a courteous reminder to complete the instrument and as a thank you for the individuals who already returned the instrument.

Eleven non-respondents (10%) were randomly drawn from the sample and contacted by telephone. The demographic questionnaire (Appendix C) was modified and used to obtain data from each non-respondent. The modified questionnaire (Appendix F) contains questions concerning non-participation, gender, laboratory environment, preferred laboratory environment, and years of teaching experience. Comparisons between respondents and non-respondents were completed using analysis of variance.

In addition to the analysis of demographic variables, item six of Appendix F was added to assess the learning styles of non-respondents. While a single question cannot validly establish the learning styles of non-respondents, it can be helpful to gauge whether the non-respondents' learning styles are representative of the respondents'. Question three from Part A of the LTM was selected for the non-

response questionnaire for two reasons. First, after reading the four learning style descriptions for teachers (McCarthy, 1987), the question seemed to be representative of each style. Second, the question appeared to be concise enough for telephone interviews. Analysis of variance was used to compare the non-respondent findings for question three of the LTM to the learning style findings of respondents. Table 1 illustrates that no significant difference was found between the two groups with regard to gender, laboratory environment, laboratory preference, teaching experience, or preferred learning style.

## Analysis of Data

Data collected from the LTM were analyzed using contingency tables and Pearson's Chi-square. A contingency table evaluates whether a relationship exists between two variables. In this study, the relationships in the population between the row and column variables (defined in the two hypotheses) were being evaluated. Pearson's Chi-square, according to Isaac and Michael (1981, p. 158), is "a measure of squared deviations between observed and theoretical numbers in terms of frequencies in categories or cells of a table, determining whether such deviations are due to sampling error or some interdependence or correlation among the frequencies." Pearson's Chi-square was used in this study to determine if there was a relationship between the categorical data in each contingency table cell.

To address the first hypothesis, the learning styles of the modular laboratory teachers were compared to the learning styles of conventional laboratory teachers using a contingency table and Pearson's Chi-square. Because there were two laboratory environments and four learning styles defined in this study, a 2 X 4 contingency table was desirable. However, due to low frequencies in several cells, some learning styles were combined and analyzed in a 2 X 2 contingency table. Since a large number of respondents were Common Sense learners, this category was not pooled. The three remaining learning styles, Imaginative, Analytic, and Dynamic, were all pooled due to low response. Pooling is assumed not to adversely affect the reliability of the *Learning Type Measure* instrument.

Table 1

*Comparison of Respondents and Non-Respondents Using Analysis of Variance*

Variable	Category	n	Mean	SD	F	df	p
Gender <sup>a</sup>	Respondents	65	1.06	0.24	0.129	1.00	0.721
	Non-Respondents	11	1.09	0.30			
Laboratory Environment <sup>b</sup>	Respondents	65	1.40	0.49	0.113	1.00	0.738
	Non-Respondents	11	1.45	0.52			
Preferred Lab Environment <sup>c</sup>	Respondents	65	1.22	0.41	0.062	1.00	0.804
	Non-Respondents	11	1.18	0.40			
Years of Experience	Respondents	65	17.38	9.51	0.595	1.00	0.443
	Non-Respondents	11	15.00	9.06			
Learning Style <sup>d</sup>	Respondents	65	1.69	0.47	0.712	1.00	0.401
	Non-Respondents	11	1.82	0.40			

<sup>a</sup> Male=1, Female=2

<sup>b</sup> Modular laboratory=1, Conventional laboratory=2

<sup>c</sup> The preferred middle school laboratory was the respondents/non-respondents current laboratory=1, Not preferred=2

<sup>d</sup> Imaginative, Analytic, Dynamic learning styles=1. Common Sense learning style=2.

The second hypothesis was addressed by comparing the learning styles of technology education respondents as a group to the national learning style findings for secondary teachers and administrators (McCarthy, 1987). Again, due to low frequencies in several contingency table cells, some learning styles had to be combined and analyzed in a 2 X 2 contingency table.

In summary, research participants were randomly selected and categorized according to the two response variables identified in each hypothesis. The variables were analyzed using contingency tables, Pearson's Chi-square, and Statistical Package for the Social Sciences (SPSS) computer software.

## Summary

The research methods and procedures of this study were established in this chapter. Research hypotheses were presented along with information on the population, sample, and instrumentation reliability and validity. Data collection procedures and statistical analysis procedures were also presented in this chapter.

The findings, conclusions, and recommendations of this study are presented in chapters four and five. Statistical tests on the collected data are performed and discussed in relation to the research questions and hypotheses. Finally, conclusions are drawn and recommendations for further research are presented.

## Chapter 4. Findings

### Overview

This study was designed to investigate two problems. The first problem was to determine whether middle school technology education teachers who teach in modular laboratories have a different learning style than technology teachers who teach in conventional laboratories. Based on the assumption that a strong relationship between teaching and learning styles exists, it was hypothesized that teacher preference for one type of laboratory over another (conventional or modular) may be an issue of teaching and learning style. The second problem was to determine whether middle school technology education teachers have different learning styles from secondary teachers and administrators in the United States. The methods of investigating these problems using Pearson's Chi-square and contingency table analysis were outlined in Chapter Three. The study findings are presented in this chapter and the conclusions and recommendations are presented in Chapter Five.

### Demographic Analysis

Eighty-three (42.5%) of the middle school teachers surveyed responded and sixty-five of the instruments (78%) were usable. Eleven of the eighteen unusable instruments were not complete. The seven remaining returns were not analyzed, because the respondents indicated that their time was split equally between a modular and conventional laboratory (n=5) or their preferred laboratory was a hybrid laboratory that was both modular and conventional (n=2).

Table 2 illustrates the breakdown of respondents by laboratory environment and years of teaching experience. Sixty-percent of respondents (n=39) teach the majority of their classes in a modular lab while only forty-percent (n=26) teach in a conventional laboratory. Conventional laboratory teachers had slightly more teaching experience ( $\bar{x} = 18.4$ ) than modular laboratory teachers ( $\bar{x} = 16.7$ ). The negative skewness for each group (modular, conventional, and total) suggests that the

majority of respondents had considerable teaching experience. Sixty-one (94%) of the respondents were male and four (6%) were female.

Table 2

*Type of Laboratory and Years of Teaching Experience*

Laboratory	Mean	SD	Median	Mode
Modular (n=39)	16.7	9.7	19	2 and 21
Conventional (n=26)	18.4	9.4	20	20
Total (n=65)	17.4	9.5	20	21

Chapter 2 outlined the four learning styles identified by the *Learning Type Measure* instrument. A second important section of the LTM measures how individuals process new learning. When new information is obtained, individuals have a predisposition to handle it in two ways. *Watchers* prefer to engage in subjective introspection before acting on information or experience. People who prefer *Doing* act first and then reflect on their actions. Like learning styles, most people have a dominant way to process information, although they may use both methods (Excel, 1998). Of the sixty-five respondents, only two (3%) were balanced between *watching* and *doing*. Fifty-one percent of respondents (n=33) preferred to *Watch* and make sense of new learning before acting. The remaining 46% (n=30) of respondents *Do* when they process new information.

Respondents were asked if the laboratory in which they currently taught technology education was their preferred laboratory for implementing Virginia's middle school curriculum. Thirty-three of the modular laboratory teachers (84.6%) claimed the modular laboratory was their preferred lab while only six (15.4%) answered "no." Eighteen of the conventional laboratory teachers (69.2%) claimed the conventional

laboratory was their preferred lab while only eight (30.8%) said it was not. Table 3 illustrates the crosstabulation of laboratory environment and laboratory preference.

Table 3

*Comparison of Respondents Preferred Laboratory to Current Laboratory*

Current Laboratory Environment	Preferred Laboratory			
	Modular		Conventional	
	n	%	n	%
Modular	33	84.6	6	15.4
Conventional	8	30.8	18	69.2

## Hypothesis Testing

This section presents the testing of the two hypotheses that were established in Chapter One. Due to low frequency counts in some of the learning style cells, several learning style categories were combined to maintain the validity of the Chi-square and contingency table analysis. Pooling of categories was based on the respondents of this study and the findings of a national study conducted by McCarthy (1987). Since a large number of respondents were Common Sense learners, this category did not need to be pooled. The three remaining learning styles, Imaginative, Analytic, and Dynamic, were all pooled due to low response. Table 4 illustrates the inverse relationship between the respondents of this study and McCarthy's (1987) national study of secondary teachers and administrators (n = 2,367).

The Chi-square goodness-of-fit test is designed to test the significance between data (observed frequencies) and theory (expected frequencies) (Howell, 1997). With regard to the first hypothesis, the observed frequencies did not differ from hypothesized proportions. The learning styles of conventional laboratory and

modular laboratory respondents did not differ significantly from the learning style proportions of all respondents,  $\chi^2(3, N=65) = .301, p < .960$ .

Table 4

*Comparison of Learning Style Between Respondents and National Sample*

Learning Style	Middle School Technology Teachers in Virginia	Rank	National Study of Secondary Teachers and Administrators (McCarthy, 1987)	Rank
Imaginative (Type I)	13.9%	2	23.0%	3
Analytic (Type II)	4.6%	4	31.1%	1
Common Sense (Type III)	69.2%	1	17.4%	4
Dynamic (Type IV)	12.3%	3	28.5%	2

A two-way contingency table (crosstabulation) evaluates whether a statistical relationship exists between two variables (Howell, 1997). Crosstabulation of laboratory environment by learning styles was performed to test the first hypothesis:

H<sub>10</sub>: Middle school technology education teachers who teach in modular laboratories do not have different teaching and learning styles from those who teach in conventional laboratories.

Table 5 illustrates that the observed frequencies of the laboratory environments and learning styles did not differ from expected values more than would be predicted by chance, Pearson  $\chi^2(1, N=65) = .301, p < .583$ . The null hypothesis is not rejected at the .05 level since  $\chi^2_{.05} = 3.84$  (Howell, 1997, p. 672).

Table 5

*Distribution of Learning Style by Laboratory Environment*

Laboratory Environment	1,2,4 <sup>a</sup>		Learning Styles		3 <sup>b</sup>	
	n	%	n	%	n	%
Modular	13	33.3	26	66.7		
Conventional	7	26.9	19	73.1		

<sup>a</sup> Imaginative, Analytic, and Dynamic Learning Styles

<sup>b</sup> Common Sense Learning Style

To further investigate the first hypothesis, respondents' learning styles were crosstabulated with their laboratory preference (Table 6). Chi-square analysis revealed that the frequencies for laboratory preference and learning style did not differ significantly from expected values, Pearson  $\chi^2(1, N=65) = .046, p < .830$ .

Table 6

*Distribution of Learning Style by Laboratory Preference*

Laboratory Preference	1,2,4 <sup>a</sup>		Learning Styles		3 <sup>b</sup>	
	n	%	n	%	n	%
Modular	13	31.7	28	68.3		
Conventional	7	29.2	17	70.8		

<sup>a</sup> Imaginative, Analytic, and Dynamic Learning Styles

<sup>b</sup> Common Sense Learning Style

Crosstabulation of the learning styles of middle school technology teachers in Virginia by the national findings of McCarthy (1987) was performed to test the second hypothesis:

H<sub>20</sub>: Middle school technology education teachers generally do not have different teaching and learning styles from secondary teachers.

The Chi-square goodness-of-fit test for the second hypothesis showed a significant difference when the learning styles of respondents were compared to national proportions of secondary teachers and administrators,  $\chi^2(1, N=65) = 126.5, p < .001$ . Table 7 illustrates that the observed frequencies of the technology teachers and the learning styles from the national sample do differ from expected values more than would be expected by chance, Pearson  $\chi^2(1, N=65) = 5.885, p < .015$ . The null hypothesis is rejected at the .05 level since  $\chi^2_{.05} = 3.84$  (Howell, 1997, p. 672).

Table 7

*Comparison of Learning Styles of Respondents to National Sample*

Learning Styles of Technology Teachers in VA	National Learning Styles Study <sup>c</sup>			
	1,2,4 <sup>a</sup>		3 <sup>b</sup>	
	n	%	n	%
1,2,4 <sup>a</sup>	20	100.0	0	0.0
3 <sup>b</sup>	34	75.6	11	24.4

<sup>a</sup> Imaginative, Analytic, and Dynamic Learning Styles

<sup>b</sup> Common Sense Learning Style

<sup>c</sup> McCarthy (1987)

**Summary**

The findings presented in this chapter indicate that respondents were overwhelmingly male and possessed considerable teaching experience. Sixty-

percent of respondents reported they teach in a modular laboratory compared with forty-percent who reported they teach in a conventional laboratory. Respondents indicated that they process new learning by *watching* slightly more than *doing*, fifty-one percent and forty-six percent, respectively.

The first null hypothesis stated that middle school technology education teachers who teach in modular laboratories do not have different teaching and learning styles from those who teach in conventional laboratories. A Chi-square goodness-of-fit test for the first hypothesis showed that the learning styles of conventional and modular laboratory teachers did not differ significantly from the frequencies of the entire sample of technology teachers. The second null hypothesis stated that middle school technology education teachers generally do not have different teaching and learning styles from secondary teachers. Learning style rankings indicated a direct inverse relationship between technology teachers in Virginia and national findings. The second Chi-square test indicated the learning styles of technology teachers were significantly different when compared to national proportions.

## Chapter 5. Summary, Conclusions and Recommendations

### *Summary*

The primary purpose of this study was to investigate the relationship between the learning styles of middle school technology education teachers and their laboratory environments. In addition, the learning styles of technology education teachers were compared to secondary teachers in general.

The three areas within technology education that can benefit from research on laboratory instruction were highlighted in Chapter One. First, there is a considerable amount of conflict within the literature concerning laboratory methods at the middle school level, particularly methods concerning commercially created curriculum packages and materials. Second, teaching and learning style research can help in-service teachers use a variety of instructional methods to reach their students. Third, teacher educators can utilize learning style research to help pre-service teachers understand the need for flexible teaching methods in the laboratory.

Chapter two consisted of a comprehensive review of related literature and research. Emphasis was placed on the underlying principles of teaching and learning style theory, as well as recent research on middle school laboratory instruction within technology education. Many learning style theories are based on the work of Carl Jung, utilize models, and contain four distinct learning styles. Literature supporting learning style as a measurement of teaching style was also presented. The four learning styles defined by McCarthy (1987) and the *Learning Type Measure* instrument (Excel, 1998) were selected for this study because of their comprehensiveness, reliability, and validity.

The research methods and procedures were established in Chapter Three. The following two research hypotheses were presented:

- H<sub>10</sub>: Middle school technology education teachers who teach in modular laboratories do not have different teaching and learning styles from those who teach in conventional laboratories.
- H<sub>20</sub>: Middle school technology education teachers generally do not have different teaching and learning styles from secondary teachers.

Next, a random sample was selected from the entire population of middle school teachers as identified by the Virginia Department of Education's Technology Education Service in 1998. Selected teachers were mailed the *Learning Type Measure* instrument, demographic questionnaire, postage paid return envelope, and one dollar for taking the time to complete and return the materials. To investigate the research hypotheses, Pearson's Chi-square and contingency table analysis was selected.

The findings and statistical tests on the collected data were presented in Chapter Four. The Chi-square goodness-of-fit test for the first hypothesis showed that the distribution of learning styles of conventional and modular laboratory teachers did not differ significantly from the frequencies of the overall group. Learning style rankings indicated an inverse relationship between technology teachers in Virginia and a national sample of secondary teachers and administrators. The second Chi-square test indicated the learning styles of technology teachers were significantly different when compared to national proportions.

Hypothesis testing showed that the learning styles of modular laboratory teachers did not differ significantly from conventional laboratory teachers. However, the learning styles of middle school technology teachers in Virginia were significantly different than the learning styles of secondary teachers and administrators.

The portion of this chapter which follows presents the conclusions that were drawn from the findings. Recommendations for practitioners and researchers are also presented.

## Conclusions

The following conclusions were drawn from the findings of this study and relate to the problem statement and two hypotheses. Caution should be taken concerning the generalizability of these conclusions beyond the middle school technology teachers in Virginia who responded to the study.

1. The learning styles of respondents in conventional laboratories were not significantly different from the learning styles of respondents in modular laboratories. Though it seems logical that learning style might explain laboratory preference, this notion was not supported by this study. Clearly, however, the respondents of this study had a strong preference for either a conventional or modular laboratory. This preference might be explained by several factors not investigated in this study. First, preference might not be a matter of learning style as measured by the LTM. Perhaps a different learning style instrument or a teaching style instrument could help explain the preference for one type of laboratory over another. Second, the Common Sense learning style might be multi-dimensional and the LTM is not sensitive enough to distinguish between the dimensions. Third, it is possible that learning style is not related to teaching style as the literature suggests, at least not with this sample of teachers and the instrument used. Fourth, the laboratory preference of a technology education teacher could be influenced by the opinions of administrators, supervisors or teacher educators. Gloeckner and Adamson (1996) highlighted the importance of teacher autonomy when they stated "it is important to encourage teacher individuality, enabling all teachers to use their professional judgement and philosophy to design effective programs from the variety of choices" (p. 21). However, not all editorials concerning laboratory instruction in technology education are

consistent with the conclusions of this study. For example, Petrina (1993) stated that modular technology education is no match for the "practices of an imaginative and resourceful teacher..." (p. 78). Petrina's comment assumes that imaginative and resourceful teachers are not attracted to modular laboratories. If the notion of an imaginative and resourceful teacher is related to learning style, this study did not confirm that relationship.

2. The self-perceived learning styles of technology teachers in Virginia were significantly different when compared to McCarthy's (1987) findings for secondary teachers and administrators. These learning style findings clearly demonstrate the uniqueness of the technology teachers in this sample and also support past research concerning the uniqueness of technology teachers. Namely, in a national study of International Technology Education Association (ITEA) members, Wicklein and Rojewski (1995) used the Keirsey-Bates Temperament Sorter to assess the temperament types of technology teachers. When compared to the general population, technology teachers demonstrated a higher preference for a Sensing-Judgement (SJ) temperament. Individuals with an SJ temperament tend to gather information directly through the five senses and prefer to live in a structured, orderly, and planned fashion.

The following conclusions are not drawn from the hypotheses of this study but are consistent with previous research.

3. Of the four learning styles defined by the *Learning Type Measure* instrument (Imaginative, Analytic, Common Sense, and Dynamic), over sixty-nine percent of respondents were identified as Common Sense learners. Therefore, these teachers...
  - are interested in productivity and competence.
  - try to give students the skills they will need to be economically independent in life.

- believe curricula should be geared to this kind of focus.
- see knowledge as enabling students to be capable of making their own way.
- encourage practical applications.
- like technical things and hands-on activities.
- are exacting and seek quality and productivity.
- believe the best way is determined pragmatically.
- use measured rewards.
- tend to be inflexible and self-contained and lack team-work skills (Excel, 1998).

This conclusion suggests homogeneity among middle school technology education teachers and supports past research concerning learning style theory and industrial arts/technology education such as that reported by Heikkinen, Pettigrew, and Zakrajsek (1985). They showed that college education majors of different subject matter fields exhibited distinct learning styles. Students majoring in industrial arts demonstrated high preferences for working with things, direct experience, and detail.

4. Modular laboratory teachers in this study overwhelmingly (84.6%) indicated that their current laboratory environment was their preferred method for implementing Virginia's middle school technology education curriculum. In a similar finding, Brusica and LaPorte (1999) reported that their sample of modular laboratory teachers thought modular labs allowed them to implement most (60% or more) of the Virginia curriculum, but not nearly all (80% or more) of it. There is clear support among modular laboratory teachers that modular laboratories are an effective way to implement Virginia's middle school technology education curriculum.

## Recommendations for Practitioners

The following recommendations are based on the findings and conclusions of this study. This section highlights recommendations for technology education classroom teachers, supervisors, and teacher educators.

1. Since the self-perceived learning style findings in this study highlight the homogeneity of technology teachers, it is recommended that teachers assess their own learning style and attempt to reach all learners through a variety of teaching methods. Teaching and learning style research suggests that teachers who are aware of their preferred learning style tend to use a variety of teaching methods to reach students (see Bennett, 1976; the National Association of Secondary School Principals, 1979; Guild and Garger, 1985; McCarthy, 1987; Mosston and Ashworth, 1990). Supervisors should help promote teaching and learning style awareness through in-service training.
2. The analysis of learning styles used in this study between conventional and modular laboratory teachers was not significantly different. Therefore, learning style, as measured by the *Learning Type Measure* instrument, is simply one factor that can be used by a teacher for choosing a laboratory environment.
3. The differences found between the learning style rankings of middle school technology teachers and the rankings of other secondary teachers and administrators (Table 4) should be used to the advantage of technology teachers. McCarthy (1987) claimed that Common Sense learners as teachers offer unique opportunities for students that are not often found in secondary education. It is recommended that technology teachers who are Common Sense learners use these qualities as a marketing tool for their program. The practical, hands-on activities

advocated by Common Sense learners can be attractive for students with similar learning styles.

4. Rogers (1998a) suggested that many teacher education programs are not preparing technology teachers for the type of laboratory environment they will typically encounter upon graduation. Hopefully, this research will enlighten teacher educators to the benefits of learning style research. It is recommended that teacher educators assess the learning styles of pre-service teachers and help them understand the relationship between learning style and instructional variety. By understanding the concept of instructional variety, pre-service teachers will be prepared for a variety of teaching environments.
  
5. Both conventional and modular laboratory teachers overwhelmingly indicated they prefer the laboratory environment in which they currently teach. Six respondents, however, indicated a mixed laboratory as their preferred environment for middle school instruction. Based on the diversity of these findings, it is recommended that supervisors approach teachers, in addition to product vendors and instructional designers, for comments concerning new laboratories and laboratory renovations. Furthermore, supervisors and administrators should allow teachers to run their laboratory in a manner that best meets their student's needs and the teacher's administrative style. This recommendation is reiterated by Starkweather (1997):

"The danger here is the potential of creating a generation of lower-level thinkers who have been *trained, not necessarily educated* [italics original], to follow directions on "high-tech" equipment with closed/limited options in learning rather than open-minded (the sky being the limit) learning" (p. 6).

## Recommendations for Researchers

The following recommendations for further research are based on the findings and conclusions of this study. This section highlights recommendations for studies concerning laboratory instruction and learning styles.

1. Since the learning style rankings of middle school technology education teachers in Virginia were completely opposite of McCarthy's (1987) national findings for secondary teachers and administrators, replication of this study is highly recommended. Replication in other states can be helpful for comparison purposes. Replication at the high school level or the collegiate level can also add validity to these findings. A larger sample is suggested so learning styles do not need to be pooled in the contingency table analysis.
2. Future studies should focus on teachers' perceptions of laboratory environments in several ways. First, since it does not appear to be a matter of learning style, research should help to determine what factors influence teachers' preferences for one laboratory environment over another. Second, studies should help to determine how much input technology teachers have in the type of laboratory (modular or conventional) in which they teach. Are modular laboratory teachers agreeing that it is their preferred environment simply because they do not want to go against administrative wishes? Or, do conventional teachers claim they are in their preferred laboratory simply because they are resistant to change?
3. The method that middle school technology teachers process new knowledge (*Watching* or *Doing*) should be investigated further. For example, do teachers who process new information by *watching* teach the problem solving approach? Do teachers who prefer to *do* first and

reflect later demonstrate a greater amount of creativity than those who *watch*?

4. Studies should be conducted to see if secondary technology students have similar learning style preferences as their teachers. Such research can help to determine whether the content of a technology program or the teachers' preferred learning style attracts students. Teacher education programs can also benefit from research on the learning style preferences of secondary students. Similar research has shown organizational psychologists that "people choose fields which are consistent with their learning styles and are further shaped to fit the learning norms of their field once they are in it" (Kolb, Rubin, and McIntyre, 1979, 535).

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**Appendix A: Permission Letter for the Learning Type Measure  
Instrument**



December 8, 1999

Mr. Philip A. Reed  
655 Kamran Drive  
Christiansburg, VA 24073

Dear Mr. Reed:

Thank you for your November 11, 1999 letter requesting permission from Dr. Bernice McCarthy to administer the Learning Type Measure (LTM) for your dissertation study at Virginia Polytechnic Institute and State University. After reviewing your proposal, **The Identification of Teaching and Learning Style Preference of Middle School Technology Education Teachers in the Commonwealth of Virginia**, we authorize and support your use of the LTM for this research study.

We understand that the data will be collected in the spring semester, 2000, as part of a survey of middle school technology education teachers. At the conclusion of your study, we would appreciate being kept informed of the findings and recommendations so that we may consider your work for inclusion in our Research and Dissertation Guide.

Best wishes as you complete your research.

Sincerely,

Bernice McCarthy  
CEO and President

Linda Lippitt, Ph.D.  
Director, Research Division

## **Appendix B: Letter to Technology Teachers**



VIRGINIA POLYTECHNIC INSTITUTE  
AND STATE UNIVERSITY

Technology Education

144 Smyth Hall  
Blacksburg, Virginia 24061-0432  
(540) 231-6480 Fax: (540) 231-4188  
<http://TechEd.vt.edu/TE.html>

January 21, 2000

Dear Technology Educator,

Modular laboratories have created considerable debate within technology education. To help understand this issue, we are conducting a study of middle school teachers in Virginia and need your assistance. We are interested to see if teachers' preference for a particular type of laboratory is related to their learning style.

Enclosed you will find a brief questionnaire, the Learning Type Measure (LTM) instrument, and a postage-paid return envelope. Please accept the enclosed dollar, personally provided by Philip Reed, for taking the time to answer and return the questionnaire and the LTM. Because the LTM is a self-reporting instrument, you will gain immediate insight into your preferred learning style. Also, your assistance with this project will add to the research knowledge of technology education. Your time and efforts are appreciated. It should only take about 15 minutes of your time to complete the questionnaire and the LTM.

All information will be kept strictly confidential. Please return the questionnaire and the LTM instrument in the postage paid envelope **by Friday, February 3**. Thank you for your support of this study and for your contribution to technology education in Virginia.

Sincerely,

George R. Willcox  
Principal Specialist  
Virginia Department of Education

Philip A. Reed  
Graduate Teaching Assistant  
Virginia Tech

## **Appendix C: Demographic Questionnaire**

Before completing the Learning Type Measure (LTM) instrument, please answer the following questions. Please be assured that all information will be kept strictly confidential.

1. Is your name and school address correct?  Yes  No. If you answered no, please write the correct contact information below.
2. Please indicate your gender:  male  female.
3. A **modular laboratory** is completely (or nearly completely) organized such that students rotate among content modules in which all of the instructional materials and equipment are provided, requiring minimal assistance or instruction from the teacher. Modular laboratories may be purchased from vendors, such as Lab 2000 or Synergistics, or they may be developed by the teacher.

A **conventional laboratory**, for the purpose of this study, is any laboratory not identified as modular.

Given the above definitions, please indicate the type of laboratory that you teach the *majority* of your technology education classes:

Modular Laboratory  
 Conventional Laboratory

4. Overall, do you feel the laboratory teaching environment you marked in question three is your *preferred* type of laboratory for implementing middle school technology education?

Yes  
 No

5. Not counting this year, how many years of teaching experience do you have? \_\_\_\_

Next, please complete the LTM and return both instruments in the postage paid envelope. Thank you very much for your participation in this study.

## **Appendix D: The Learning Type Measure Instrument (LTM)**

## PART A INSTRUCTIONS

The following questions are designed to indicate your preferences in attending to and acting on what you learn. **When learning, which descriptor is most like you?** Using 4, 3, 2, and 1, place a "4" in the blank corresponding to the descriptor MOST LIKE YOU and a "1" in the blank for the descriptor which is LEAST LIKE YOU. Then fill in your "2" and "3" responses. You must use all four numbers. Do not make ties.

# for research use only

- I EXCEL AT:**  
 making realistic decisions     reaching accurate conclusions     uncovering hidden connections     respecting people's feelings
- FOR ME, IT IS PARTICULARLY IMPORTANT FOR LEARNING ENVIRONMENTS TO EMPHASIZE**  
 original thinking and creativity     logical reasoning and order     discussion and collaboration     problem-solving and experiments
- I LEARN BEST BY:**  
 testing how things work     working in groups     self-discovery     reflecting and thinking
- PEOPLE WOULD IDENTIFY ME AS:**  
 productive     creative     responsive     logical
- ONE OF MY STRENGTHS IS:**  
 reflective thinking     enthusiasm     practicality     listening skills
- WHEN LEARNING I ENJOY:**  
 exploring hidden possibilities     organizing ideas     making personal connections     producing results
- I STRIVE FOR:**  
 consensus     objectivity     efficiency     originality
- GENERALLY I AM:**  
 nurturing     dependable     decisive     intuitive
- I TEND TO BE:**  
 too impulsive     too impressionable     too eager for closure     too critical
- GENERALLY I AM:**  
 cooperative     methodical     straightforward     free-spirited
- LEARNING ENVIRONMENTS SHOULD EMPHASIZE:**  
 real problem-solving     clarity of reasoning     connections to personal meaning     adaptability to change
- I AM MOST COMFORTABLE WITH PEOPLE WHO ARE:**  
 supportive     unique     productive     informed
- I HAVE PARTICULAR DIFFICULTY WITH TEACHERS WHO ARE:**  
 rule-bound     disorganized     emotional     impersonal
- GENERALLY, I AM:**  
 studious     caring     down-to-earth     innovative
- I WOULD PREFER TO:**  
 make the world a happier place     acquire knowledge     solve practical problems     create new ways of doing things

## PART B INSTRUCTIONS

For each numbered item, circle the one descriptor which best describes you.

- WHEN LEARNING, I PREFER:**  
 a quiet environment     an active environment
- WHEN LEARNING, I PREFER TO:**  
 reflect before I act     act and then reflect
- I TEND TO:**  
 keep a lot inside     talk out my ideas
- I AM:**  
 public     private
- I PREFER TO:**  
 initiate     evaluate
- GENERALLY, I AM:**  
 action-oriented     reflective
- WHEN SOLVING PROBLEMS, I:**  
 ponder     experiment
- GENERALLY, I AM:**  
 reserved     energetic
- GENERALLY, I AM:**  
 talkative     quiet
- I TEND TO BE MORE:**  
 extroverted     introverted
- I PREFER LEARNING TASKS THAT ARE:**  
 individual     group

The 4MAT Learning Type Measure was co-developed by Dr. Bernice McCarthy and Dr. Clif S. Gensain. Technical manual by Dr. Marcus Liebenow. 4MAT and Learning Type Measure (LTM) are registered trademarks of About Learning, Inc.

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Score	Q1 _____	Q3 _____
	Q2 _____	Q4 _____
	Part B _____	

**PART A SCORING INSTRUCTIONS:** The following page of this instrument (page 4) is perforated. ● Begin by tearing it out and laying it to the right of this page. ● For each numbered item on page 3, transfer the number inside the circle symbol to the circle column on page 4. Then transfer the square, triangle and star scores on page 3 to their respective columns on page 4. ● Add each of the columns on page 4 and write the totals at the bottom of the column. The four column totals added together should equal 150. ● Write your column totals (from page 4) into the appropriate quadrant on page 2 (the page opposite this page). ● Lastly, fill in the numbers of the quadrants (1, 2, 3, 4) in order of preference in the boxes at the bottom left of page 2 (you may refer to the instructions there).

1.	▲	■	★	●
2.	★	■	●	▲
3.	▲	●	★	■
4.	▲	★	●	■
5.	■	★	▲	●
6.	★	■	●	
7.	●	■	▲	★
8.	●	■		★
9.	★	●	▲	■
10.	●	■	▲	★
11.	▲	■	●	★
12.	●	★	▲	■
13.	★	■	▲	●
14.	■	●	▲	★
15.	●	■	▲	★

**PART B SCORING INSTRUCTIONS:** Total the "plus" numbers that are circled. This is your "Doing" Score. Total the "minus" numbers that are circled. This is your "Watching" score. Compute the difference to determine your Watching/Doing Score. Enter totals below.

1.	-1	+1
2.	-1	+1
3.	-1	+1
4.	+1	-1
5.	+1	-1
6.	+1	-1
7.	-1	+1
8.	-1	+1
9.	+1	-1
10.	+1	-1
11.	-1	+1

Doing Score (+ numbers)      + \_\_\_\_\_

Watching Score (- numbers)      - \_\_\_\_\_

Watching/Doing Score  
(Compute the difference)      =

## **Appendix E: Follow-up Post Card**

Philip A. Reed  
655 Kamran Drive  
Christiansburg, VA 24073

Mr. Devin S. Reed  
Technology Education Program  
Virginia Middle School  
Street Address  
Somewhere, VA 00000

Dear Technology Teacher,

Recently, you were mailed a questionnaire and Learning Type Measure (LTM) instrument as part of a study on modular technology education. Thank you very much if you have already completed and returned these materials. If you have not been able to participate in this study, please take a few minutes to complete and return the materials in the postage-paid envelope. Thank you for your support of this study and for your professional contribution to technology education in Virginia.

Sincerely,

Philip A. Reed, Graduate Teaching Assistant  
Virginia Tech

**Appendix F: Telephone Questionnaire for Non-Respondents**

Non Response #: \_\_\_\_\_

1. Did you receive the Learning Type Measure instrument and demographic questionnaire? \_\_\_\_\_ Yes \_\_\_\_\_ No.

If yes, why didn't you complete and return these materials?

2. Non-respondents gender: \_\_\_\_\_ male \_\_\_\_\_ female.
3. What type of laboratory do you teach the *majority* of your technology education classes:  
\_\_\_\_\_ Modular Laboratory  
\_\_\_\_\_ Conventional Laboratory

If necessary, read the following definitions to the non-respondent:

A **modular laboratory** is completely (or nearly completely) organized such that students rotate among content modules in which all of the instructional materials and equipment are provided, requiring minimal assistance or instruction from the teacher. Modular laboratories may be purchased from vendors, such as Lab 2000 or Synergistics, or they may be developed by the teacher.

A **conventional laboratory**, for the purpose of this study, is any laboratory not identified as modular.

4. Overall, do you feel the laboratory teaching environment you marked in question three is your *preferred* type of laboratory for implementing middle school technology education?

\_\_\_\_\_ Yes \_\_\_\_\_ No

5. Not counting this year, how many years of teaching experience do you have? \_\_\_\_
6. I learn best by:  
Working in groups (1-Imaginative)  
Reflecting and thinking (2-Analytic)  
Testing how things work (3-Common Sense)  
Self Discovery (4-Dynamic)

## **Appendix G: Un-Solicited Comments**

### ***Comments on Usable Instruments***

- 1 This is very interesting! I answered the questions in reverse priority (sorry) but then corrected the results.
- 2 I am getting four modules next month. I cannot say I prefer something when I've never taught in the other type.
- 3 Sorry, I didn't receive this until 2-8-2000. Hope it's not too late.
- 4 Please donate [dollar] to the fund of your dearest charity.
- 5 Sorry this is late. We have been out of school for all but two days in the last three weeks.
- 6 I'm not sure of the purpose of taking this test. If you are trying to relate a teacher's lab preference to a particular learning style used in class, I think there are many issues to consider. I think a new teacher will develop a learning style preference over time. Mine has changed over the years as did my environment. My Synergistic lab does not allow too much innovation outside of the modules unless one leaves its structured curriculum for a period of time. Also if one follows guidelines laid out by the company, (Pitsco-Synergistic) learning style is defined, but I know many experienced teachers who deviate from the module curriculum just for a break from boredom to them and to the students also. Many teachers did not choose the module lab, it was purchased by the school system, thus they had to change their style of teaching & learning to satisfy the curriculum if the curriculum was to be taught as presented by the company. Of course as I said I know many who fudge on the curriculum, doing other things just for some variation to the students and themselves. I would never go back to the old days of conventional labs, shop or technology in a shop like atmosphere. I think one can be more innovative in that environment with different learning styles but to administrators and guidance, shops and learning labs are still shops no matter how technologically literate your program is. This stills [sic] leads to dumping of those students no teacher wants to put up with. With all its advantages and disadvantages, the modular concept has given credibility to the course and for the most part problem students are not placed in the class since administration does not want to see the facility abused. Put them in art or music. Its kind of like band, no problem students there, they will tear up expensive instruments.
- 7 Dear Sirs: Knowing my learning style and preference of laboratory may be good for me, but aren't we missing the point! What do the students want? I admit I have never worked in a Modular setting, but I have tried to use some of the activities. Kids tire of them and want to go to the shop! What do they need? Give kids (any age) a pair of scissors and ask them to cut something out. Using their hands and head seems to be a lost art; unless you're turning on some kind of toy or TV. Best of luck with your study.
- 8 Yes [modular laboratories are my preferred laboratory for middle school], I have a Lab 2000, but I don't like it. I prefer a Synergistics Lab.
- 9 I believe that the ideal lab would include both modular and a traditional section (for problem solving activities i.e. Rube Goldberg, etc.)
- 10 Please (if possible) allow me to read some of your research on modulars [sic] in the middle school. See email address on the LTM. Thanks.

### ***Comments on Un-usable Instruments***

- 1 Both is [sic] needed. Have a balance between traditional-modular. High tech and dirty lab, wood, plastics, metals.
- 2 7<sup>th</sup> grade technology is a required 18 week class. Students are rotated between "modular lab" and "conventional lab" for 9 weeks each.
- 3 I took it but I don't want to score it.
- 4 I am currently teaching Office Technology (2<sup>nd</sup> year). Our program was for high school students. It was moved back to our middle schools before this year started.
- 5 Not my field.
- 6 Don't have time.

## Vita

Philip Anthony Reed  
655 Kamran Drive  
Christiansburg, VA 24073  
(540) 381-5802  
preed@vt.edu

### ***Education***

Doctor of Philosophy, May, 2000.  
Curriculum and Instruction, Technology Education  
Virginia Polytechnic Institute and State University, Blacksburg, VA.

Master of Arts, August, 1996  
Industrial Technical Education  
University of South Florida, Tampa, FL.

Bachelor of Science, May, 1992  
Secondary Education, Technology Education  
Old Dominion University, Norfolk, VA.

### ***Professional Experience***

- 1998-2000 Graduate Teaching Assistant for Materials and Processes (2425 and 2426), Sophomore and Junior Field Experiences (3754 and 4964), and Teaching Methods in Technology Education (4434) at Virginia Polytechnic Institute and State University under the supervision of Dr. James E. LaPorte and Dr. E. Allen Bame.
- 1997-1998 Instructor for two sections of Materials and Processes (2425 and 2426) at Virginia Polytechnic Institute and State University under the supervision of Dr. James E. LaPorte.
- 1995-1997 Technology Education teacher at Dan McCarty Middle School, Fort Pierce, Florida. Set up a new forty-module, three instructor science and technology laboratory in October 1995 and team-taught five classes daily.
- 1992-1995 Technology Education teacher at Southport Middle School, Port St. Lucie, Florida. Set up a new twenty-five module, two instructor laboratory and taught five classes daily.

### ***Honors and Awards***

- 1999 Donald Maley Spirit of Excellence Outstanding Graduate Student Citation sponsored by the International Technology Education Association.
- 1996 Nominated for Teacher of the year. Dan McCarty Middle School.
- 1996 Dan McCarty Middle School Teacher of the Month for February.

## **Research Activity**

- Reed, P. A. (2000). The Relationship Between Learning Style and Modular Laboratory Preference Among Technology Education Teachers in Virginia. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA.
- Reed, P. A. and LaPorte, J. E. (2000). Twenty-five years of ITEA conferences: A content analysis. Paper presented at the annual conference of the International Technology Education Association, Salt Lake City, UT.
- Reed, P. A. (1998). Focus Group Facilitator for Virginia Tech's Center for Academic Enrichment and Excellence. Attended one training session under Dr. Delores Scott, conducted one focus group meeting, and returned data to CAEE office.

## **Professional Presentations**

- Reed, P. A. (2000). *Modular labs: A matter of teaching style?* Salt Lake City, UT: Annual Conference, International Technology Education Association.
- Reed, P. A. and LaPorte, J. E. (2000). *Twenty-five years of ITEA conferences: A content analysis*. Salt Lake City, UT: Annual Conference, International Technology Education Association.
- Reed, P. A. and Sanders, M. E. (1999). *Creating web based instructional modules*. Indianapolis, IN: Annual Conference, International Technology Education Association.
- Reed, P. A. (1996). *Enhancing service to middle school technology students*. Tampa, FL: Annual Conference, Florida Technology Education Association.
- Reed, P. A. (1996). *Florida Explores weather program and sixth grade technology curriculum*. Fort Pierce, FL: North Region Meeting, Florida Technology Education Association.

## **Publications**

- Reed, P. A. (1999). Fore! Playing Through the Mystery of Golf Course Design. *Ties*, (September), 18-21.
- Reed, P. A. (1999). Book Review. [Review of the book *The Biotech Century*]. *Journal of Technology Education*, 10(2), 72-75.
- Reed, P. A., Michael, K. and Schnitz, R. (1999). Technology Education Machine Safety Site. [Online]. Available: <http://teched.vt.edu/StudentWebSites/MachineSafety/Safety.html>
- Reed, P. A. and Colvin, J. A. (1998). Interactive Holography Module. *Graphic Comm Central*. [Online]. Available: <http://teched.vt.edu/gcc/HoloProject/HTML/index.html>
- Reed, P. A. (1996). Exploring Technology at Southport Middle School. *Florida Technology Teacher*, 40(2), 30-31.
- Reed, P. A. (1996). *St. Lucie County's Sixth Grade Technology Studies Curriculum Guide*. Fort Pierce, FL: St. Lucie County School Board.

### ***Professional Development***

- 1996 Florida Technology Student Association (TSA) Advisor Training Workshop.
- 1994 NASA Educational Workshop at the Kennedy Space Center.
- 1993 Florida's Professional Orientation Program.
- 1993 Eighteen-hour survey course for English Speakers of Other Languages (ESOL).

### ***Professional Membership***

- 1998-Present Epsilon Pi Tau International Honorary for Professions in Technology.
- 1998-Present National Association of Industrial and Technical Teacher Education (NAITTE).
- 1997-Present Council on Technology Teacher Education (CTTE).
- 1997-Present Virginia Technology Education Association (VTEA).
- 1991-Present Iota Lambda Sigma Professional Honorary.
- 1991-Present International Technology Education Association (ITEA).

### ***Volunteer Experience***

- 1997 Florida Youth Golf Association, Dennis Burnham, Director. Work with 5-17 year old golf students, three hours a day, five days a week. Program runs for eight weeks from June to August.