The effects of learning styles on the science process work of middle school students
by Walter Harold Woolbaugh

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Education
Montana State University

Abstract:
This study examined the effects of middle school students' learning styles in working with process lab science. The results of lab partners of different and similar learning styles working together were also considered.

The lab learning styles of the students were identified and classified into three types. These three types were compared with each other as to their performance on lab process skills, creativity tests, classroom grades and standardized tests.

It was found that Type I students recorded higher achievement on classroom grades and lower achievement on creativity ratings. The Type II students recorded lower classroom grades and higher creativity ratings. Both Type I and Type II students scored comparatively high on standardized tests. Type III students performed within the average scores in all areas. There was not any relationship found between learning style and lab process achievement. The learning style of the lab partner did not matter with the Type I and Type II students, but the Type III students preferred to choose their partners, and their lab performance was higher when allowed this choice.

It is recommended that educators use learning style information to educate themselves and their students as to individual strengths, weaknesses and preferences. Learning style information is beneficial when selecting lab partners to work on science labs.

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ABSTRACT

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CHAPTER I

INTRODUCTION

BACKGROUND

Some students perform better in classes where they are allowed to explore and experiment, and other students perform better in classes where information is presented in an organized lecture approach. Sometimes students enjoy working on their own projects with the grading scale dependent on their ability to create and explore. When these students are given "cookbook" type activities, they go off to explore their own possibilities for other types of activities. They do not want to attempt what has already been done, but would rather develop something new.

Other students perform better in classes where the approach is very objective and direct. The teacher tells the student exactly what is expected, the student performs according to expectations, receives a grade and goes on to the next task. This type of student sometimes likes things direct and to the point. Students seldom fit neatly into the categories researchers design for them, and yet there are students who have tendencies and preferences towards different types of activities.

Science teachers should be concerned with students' knowledge and with students' ability to explore and make discoveries in new areas. Exploration is the heart of science and scientific inquiry (Chang, 1988). Teachers attempt to create in their students the desire to explore and inquire about their environment.

Research shows that students learn more and retain the material longer when they first have a chance to explore the material(Renner, Abraham, & Birnie, 1988). Relatively open-ended investigations are sometimes called "exploratory labs."

Teachers and students labor long hours over exploratory lab science. Teachers labor over the creation and evaluation of such activities, and students labor over completion of these labs. Some students seem intuitively able to handle these labs without any problem, and other students experience difficulties. What factors would lead some students to do well with these types of activities, and what could be done to strengthen exploratory science lab work?

Teachers working with science lab students quickly realize that some students have an easier time in science lab. Although some students can learn to function comfortably and effectively in a laboratory, others are successful when science is presented other ways. Can this "lab type" be identified, and characterized for the student and teacher?

Students learn differently and teachers teach differently. To what degree does student learning style affect students' learning exploratory labs, and to what extent should teachers adjust their instructional plans accordingly?

STATEMENT OF PROBLEM

Identify the lab learning characteristics for given types of science lab students, and using this knowledge, help students to perform better and feel more comfortable during process science labs. The knowledge would also be used to help instructors design better process labs.

The steps involved in this study were:

(1) Through preference instruments and observation, to study learning styles in science lab students.

(2) Use this information to construct a Science Lab Learning Style Inventory. This inventory will assess the science lab learning styles of the students.

(3) Analyze students' abilities and preferences relating to process science lab work. Creativity and academic achievements are two related areas which will be studied.

(4) Describe any relationship between process lab work and lab learning styles, and make recommendations to improve students' performance in process science lab work.

The development of the lab learning style types and lab process studies were performed with the researchers classroom students. The testing of the Lab Learning Style Inventory, was performed in many schools with many different populations.

My initial hypotheses that were tested in this thesis included:

Learning styles affect lab process science, and this effect can be measured.

By considering student learning styles during lab design, teachers can improve student performance in science labs.

A goal for this study is to develop a lab learning style instrument which would give science teachers a practical, inexpensive assessment of students' learning style.

DEFINITIONS

This study undertakes a large area of subject matter, and terms are important to help clarify the researcher's goals. The study takes a fairly specific area (science lab learning style) and applies this to the general area of exploratory lab science. Two areas of this study include the students' learning style and exploratory lab science. Each area will be discussed separately.

Learning styles can be defined many different ways for different purposes (Entwistle, 1981). The area of learning style research is one that has many different approaches, techniques, and instruments. One could easily become confused in the midst of different terms and names. An overview of the learning style literature is presented in Chapter 2. Of particular importance is Judith Reiff's Learning Style Profile described in Chapter 2. This profile reviews and synthesizes the major work in learning style research. The intent of this study is not to formulate a new learning style framework, but rather to take the existing learning style work and apply it to lab science students. For the purposes of this study, learning style is defined as: *Those factors, behaviors, and attitudes which facilitate learning for a science student in an exploratory lab environment.*

Science is the acquisition of knowledge attained through a process of testing hypotheses. Science is a "doing" activity as opposed to a listening activity. Unfortunately in many school classrooms, this is not the case. Students may attend science classes and never have the opportunity to design an experiment or formulate an hypothesis. Some science teachers may not recognize the "doing" nature of the word science. For this reason, words like "process" science, or "exploratory" science will be used to describe the procedure of students' performing science. Throughout this study, laboratory science is herein defined as that science and science methodology which the students perform. It does not include teacher demonstrations although these are recognized as valuable forms of instructions. This study approaches science labs from the standpoint of students "discovering" the process. This process means that a student is given a problem to solve and must use their powers of observation to discover what the correct solution will be. It is this 'discovering', that forms the basis of process lab science.

Process lab science is a catchall term that is used in different ways by different authors. In an article on process science, Lunetta and Tamir (1979) developed a comprehensive list of skills and behaviors related to student science lab performance. Their list is used here to generate four areas of process science.

The first area cited by Lunetta and Tamir is **planning and design**. How well does the student formulate a question or define the problem to be investigated? Can the student make a prediction from the experimental results? Is the student able to formulate a hypothesis? The experimental design the student chooses would be included in this area. The student's ability to identify variables and to control variables would be included in this section. From this design point, the student then prepares the necessary apparatus.

The second area is the **performance** area. This involves the student in carrying out both qualitative and quantitative observations or measurements. The student would need to manipulate the apparatus, perform numeric calculations, and record results.

The third area involves the **analysis and interpretation**. This section has the student arranging data in tables or diagrams. The student would analyze this data for relationships that may exist. The student determines the accuracy of the data and uses this data to formulate a generalization or model. The student may also formulate new questions based upon the results of the investigation.

The fourth and final section is the **application**. Can the student make predictions based upon the results of his investigation? Can the student apply the experimental technique to a new problem or variable? The student may also suggest ideas and ways to continue his investigation.

These four areas provide a fairly comprehensive description of lab process skills. Learning styles could affect a student's performance on any one or part of the above skills. This study needs to survey the entire area of exploratory lab process science.

For the purposes of this study, process lab science shall include, but not be limited to *a process that has students (1) observing and measuring; (2) manipulating the equipment; (3) planning and designing of experiments; and (4) interpreting data to formulate generalizations.*

LIMITATIONS OF THE STUDY

This study relates learning styles to process lab science. This results in some limitations for this study. Some limitations are described below:

(1) Although the study hopes to show a relationship between learning styles and process science, it does not identify specific student strengths or

weaknesses in science process skills such as observing or manipulating equipment. A student may be good at collecting data and graphing this data, but may not be good at interpreting the results which the data show. This study will not test or recognize areas such as these.

(2) Due to the complex nature of process science labs, there are many factors other than learning styles potentially influencing the students' performance in these labs and these factors will not be investigated here.

(3) There are many facets to the area of learning styles. This study attempts to isolate key aspects of learning style that relate to lab science learning. In order to make the study manageable, an attempt is made to use the existing learning style data to classify and help science lab learning style students. There are many parts of the learning style paradigm which this study omits. An example of this omission is that some areas of the physiological part of the learning style paradigm are not studied. Students were not asked their preferences or given choices of time of day, temperature or light conditions or other physiological factors that could affect exploratory lab performance.

(4) The population studied is also a limiting factor. Although the lab learning style instrument developed in this study was initially tested on over 500 students in grades sixth through ninth from a variety of communities, other portions of the study, including assessment of student abilities in process science labs, and studies in creativity and standardized test achievement were done only with seventh and eighth grade students at a single rural school. Thus some of the generalizations arrived at may not extend to other levels or school settings.

(5) The time which this study encompasses may be seen as a limitation. The data-gathering for this study was carried out by one researcher during a

three year period. A study of this nature could easily encompass many years, and involve more than one researcher.

SIGNIFICANCE OF STUDY

This study has many important factors to it.

Throughout the study, students were constantly made aware of various learning styles especially, their own personal style. Students were made aware that there is not any one right style, but rather there are many different styles. Everyone has different strengths and weaknesses. The important factor is to work on one's weaknesses and accomplish important tasks with one's strengths. It goes back thousands of years to Socrates who stated: "Know thyself." Anyone or any study that uses learning styles helps accomplish this.

Teachers involved with learning style work realize the importance of teaching too many different styles. Classes are full of students with different styles, and it is important to address as many styles as possible. When teaching, it is important to present work in all modalities whenever possible. One should strive to provide written instructions, verbal explanations and visual demonstrations for all teaching activities (Barbe & Swassing, 1988). This study helps sensitize teachers to these ideas. The study pursues the area of lab activity design. There are many factors that contribute to good lab activity design. This study adds more to the knowledge base of ways and techniques to design better labs.

The study looks at mixing and matching students with different lab learning styles. What is the effect of having two people work together with dissimilar styles? What is the effect of having two people work together with similar styles? When students are allowed to choose lab partners, what style do they choose and is there an increase in student performance based on this choice?

When performing exploratory lab science, one is re-creating a work place environment. People in labs, as in other work places, are gathered together to accomplish particular purposes. Information gathered from this study could be helpful to future employers hiring and supervising employees. The employer may want to “mix and match” learning styles during hiring or, more importantly, structure the work environment to enable individuals with different learning styles to perform successfully.

The study provides one more look at the way students learn and perform in the science lab. Despite the limitations, any ideas that are discovered as a result of the study should be beneficial to other teachers.

CHAPTER II

A REVIEW OF THE LITERATURE

LEARNING STYLES

Learning styles are not a new phenomenon. There are records that trace back to Aristotle's time indicating that each child has special talents (Osborn, 1975). Educators throughout time have recognized that individuals are unique thus must be taught in different ways (Klein, 1951). In the early 1900's personality studies were completed and learning styles started to become classified and labeled. Much of this early research in learning styles studied the relationship between memory and the type of instructional methods used (Lowenfeld, 1945). The study of learning styles developed and branched out in the 1900's. Educators attempted to use learning style models in their classrooms.

Throughout the latter part of the 1900's, instrumentation was being developed to "label" various learning styles. Researchers seemed to develop their own learning style frameworks and their own learning style instruments. Classification terms such as concrete random, kinesthetic/tactile, thinking judgment, extroverted, intuitive and many others, started appearing in the literature. The literature is full of learning style jargon. Even in 1992, understanding of various learning style profiles and their interconnections seems limited. An issue of Educational Leadership devoted to learning styles (Jan., 1979), took an article by article approach to this field. Each article presented a different learning style methodology and instrumentation. The reader was left with the idea that there are many different ways to categorize learning styles, and one should pick the favorite article and use that framework.

More recently an issue of Educational Leadership (Oct., 1990), entitled "Learning Styles and the Brain", presented research on learning styles as they are affected by personality and cognitive development. This issue contained articles on left brain/right brain research, brain processing techniques and multiple intelligences.

Reiff (1992) published a recent synthesis of research on learning styles (See Learning Style Profile chart). Her Learning Style Profile includes three major domains, Cognitive, Affective and Physiological. The Cognitive is based upon brain development and information-processing research. The Affective domain includes the personality and emotional factors. The Physiological domain includes factors in the student's physical environment. Each of these three domains is further broken down into sub-categories that are briefly discussed below.

COGNITIVE DOMAIN:

This domain is broken down into six sub categories.

Brain Dominance -This area deals with the left brain/right brain hemispheric dominance theories (Levy, 1983). Characteristics of the left hemisphere include verbal, sequential and analytical abilities. Dominant traits of the right hemisphere are global, holistic, and visual-spatial. Both hemispheres are equally important in our lives.

Conceptual Tempo - This area deals with the individual's consistent tendency to approach problem situations either rapidly or cautiously with accuracy or inaccuracy (Kagan, 1965). Impulsive students are quick-to-respond, risk takers who easily become bored. Reflective learners prefer to concentrate, analyze and do not like to be wrong. Both types of learners are present in schools and classroom science labs.

Mindstyles - This theory maintains that individuals think either abstractly or concretely and that their thoughts are either sequential or random (Gregorc, 1979). Students who benefit from an ordered, step-by-step approach to a science lab may have difficulty with an unstructured, holistic, creative approach to science labs.

Modalities - Modalities are pathways or channels through which people receive and learn information. The three basic modalities include: Visual, Auditory and Kinesthetic (Barbe & Swassing, 1979). Students that rely primarily on listening and hearing instructions, may experience frustration when confronted with written instructions.

Field Dependence/Independence - This category deals with how people memorize and learn information. A field dependent person is distracted by a complex background and a Field Independent person is not distracted. Field independent people may favor a math or science area, and a field dependent person may favor the humanities (Witkin, 1973). A field dependent student might enjoy the cooperative learning aspect of science labs, but may need the teacher to model how to organize the lab information.

Multiple Intelligences - This area was pioneered by Howard Gardner. He feels there is not one intelligence measured by a test, but rather at least seven intelligences. He felt that some people are stronger in some areas of intelligence than in others. His intelligences included, Bodily-Kinesthetic, Linguistic, Logical Mathematical, Musical, Spatial, Interpersonal and Intrapersonal (Gardner, 1983).

LEARNING STYLE PROFILE

Cognitive

Brain Dominance
* Analytical
* Global
* Integrated

Conceptual Tempo
*Impulsive
*Reflective

Mindstyles
* Concrete sequential
* Abstract random
* Abstract sequential
* Concrete random

Modality
* Visual
* Auditory
* Tactile
* Kinesthetic
* Integrated

Multiple Intelligences
* Bodily Kinesthetic
* Linguistic
* Musical
* Spatial
* Intrapersonal
* Interpersonal

Psychological
Differentiation
*Field dependence
*Field independence

Affective

Conceptual Level
* High
* Low

Psychological Types
* Thinker
* Sensor
* Feeler
* Intuitor

Physiological

Elements
* Environmental
  sound, light, temp., design
* *Emotional*
  motivation, persistence
  responsibility, structure
* Sociological
  self, pair, peers, team, adult
  varied
* Physical
  perceptual, intake, time, mobility

***1991, Judith Reiff, Un. of Geo., Athens, Ga.

AFFECTIVE:

Conceptual Systems - This concerns how individuals impose structure on their environment. Conceptual systems range from those of people who view things from a narrow perspective to those of complex individuals who are flexible, independent, and tolerant (Hunt, 1988). Students at a high conceptual level are more independent, needing less structure.

Psychological Types - This area was based upon the work of Carl Jung. He identified four different psychological types, Sensors, Intuitors, Thinkers and Feelers.. Each of these types were based upon how individuals viewed their environment, and interacted with their world (Jung, 1921). The Sensors are realistic, present-oriented people who like to memorize facts. They are patient with details and prefer a sequential approach to problems. The Intuitors are imaginative, inventor type people who like problem solving. They are often Global and impatient with routines. The Thinkers are logical, objective people. These analytical people are concerned with principles of justice and fairness. The Feelers are subjective people influenced by emotions. They value harmony.

Combine attitudes of Extroversion and Introversion with orientations to the world of either Judgment or Perception, and one has all sixteen types used in the Myers-Briggs Inventory (Myers & McCaulley,1990). This is the most popular instrument used to measure psychological types, and is probably the most commonly used Learning Style Inventory in existence. Many employers use the Myers-Briggs to "inventory" their employees. A person classified as INFJ (Introverted Intuition with Feeling) might be someone that is independent and individualistic and governed by inspirations that come through intuition. Because of the relatively high reading level of the Myers-Briggs Inventory, it is not a commonly used instrument in schools.

PHYSIOLOGICAL:

This domain looks at students' preference towards their physical environment. The physical environment is divided into four major areas. The areas are environmental, emotional, sociological and physical. The environm ental area is concerned with sound, light, and temperature. The emotional area considers motivation, persistence, responsibility and structure. A person's preferred method of learning would be included in the sociological area (peer, self, team or adult). The physical stimuli include what time of day the student prefers to learn, and whether the student prefers mobility during learning.

This area was popularized by Ken and Rita Dunn. Their self-reporting inventory looked at learners' preferences towards the above four areas Their inventory developed in 1975 has been tested on thousands of people and used in hundreds of research projects (Dunn & Dunn, 1978). A complete discussion of the Dunn and Dunn Learning Style Instrument (LSI) is found in chapter three. The reading level of the LSI makes it suitable for middle school students.

RESEARCH REVIEW

The learning style framework used in this thesis primarily relies on the work of Carl Jung, using instrumentation adapted from the Myers-Briggs survey and the work of Barbe and Swassing (1979). An instrument developed by Dunn and Dunn was also used in this study for data gathering. This research review looks at earlier studies that made use of the instruments developed by these three research teams. Research that studies learning styles in relationship to science labs will be discussed in the last section of this chapter.

Research based upon the Myers - Briggs Instrument.

Due to the reading level of the Myers-Briggs instrument, it is mainly used with adults. One school study used the Myers-Briggs Indicator to identify student learning styles. Students then preferred a curriculum program. It was found that Intuitive students selected curriculum that had new possibilities such as being able to select their own courses, and avoided a curriculum perceived as static. Sensing students sought experiential approaches to learning (Steele, 1986). This study supports findings that students seem to select the curriculums that fit their learning styles.

Research based upon the Dunn and Dunn Instrument.

The Dunn and Dunn Learning Style Inventory was developed and tested for use with fifth through twelfth graders. Because of its' reading level and the research support given by the Center for Learning Style Research located at St. Johns University, N.Y., The Learning Style Inventory (LSI) seems to be the most commonly used learning style instrument in school classroom research.

Research using the LSI seems to indicate that there is a relationship between learning styles and academic achievement. This research seems to be consistent in demonstrating: (1) Students do learn differently. (2) When students are taught using approaches that utilize their individual learning styles, their academic work improves. The above statements are supported by research from: DeBello, 1985; Dunn, DellsValle, Dunn, Geisert, Sinatra, and Zenhausern, 1982; Giannitti, 1988; Hill, 1987; White, 1980; Hodges, 1985; Jarsonbeck, 1984; Kroon, 1985; Lemmon, 1985; Lynch, 1981;, MacMurren, 1985; Martini, 1986;

Miles, 1987; Murrain, 1983; Pizzo, 1981; Shea, 1983; Spires, 1983.

Cited below is research which supports the hypothesis that students perform better in classes where learning style is taken into account by the teacher. The implication of these studies is that students may perform better in science labs where learning style preferences are considered.

Spires (1983) studied the results of using learning style preference to teach reading and math to K-6 graders. He found significant gains were made when individual students learning styles were addressed.

Price (1980) administered the LSI to 3,972 subjects. These students were in grades 3-12 during the 1979-80 school year. He analyzed the results from the twenty-two item LSI and found:

(1) The higher the grade level, the more a student preferred sound and light.

(2) The higher the grade level, the less preference a student had for a formal design.

(3) Self motivation decreased during the 7 & 8th grade year, but then increased slightly in the grades after.

(4) The higher the grade level, the less teacher-motivated a student was.

(5) There was less of a need for structure in higher grades.

(6) The younger the student, the more tactile and kinesthetic they seemed to be.

Lynch (1981) looked at time of day learning style preference and school attendance. He found that the matching of individuals' schedules on the basis of learning style preferences affected attendance more significantly than matching students with preferred types of teachers. He also found that a correlation did