1-1-1992

Achievement of differentially prepared, nontraditional students in developmental mathematics at a community college : a study of modality (learning styles) preferences.

Joan Czaja Marsh
University of Massachusetts Amherst

ACHIEVEMENT OF DIFFERENTIALLY PREPARED, NONTRADITIONAL STUDENTS IN DEVELOPMENTAL MATHEMATICS AT A COMMUNITY COLLEGE: A STUDY OF MODALITY (LEARNING STYLES) PREFERENCES

A Dissertation Presented

by

JOAN CZAJA MARSH

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

February 1992
School of Education

ACHIEVEMENT OF DIFFERENTIALLY PREPARED, NONTRADITIONAL STUDENTS IN DEVELOPMENTAL MATHEMATICS AT A COMMUNITY COLLEGE: A STUDY OF MODALITY (LEARNING STYLES) PREFERENCES

A Dissertation Presented

by

JOAN CZAJA MARSH

Approved as to style and content by:

Portia C. Elliott, Chairperson

Edward J. Harris, member

Warren F. Schumacher, member

Bailey W. Jackson, Dean
School of Education

DEDICATION

To my parents, Joseph and Josephine Czaja, who always advocated higher education for women, and who supported the educational efforts of their daughters, Joan and Carolyn.

ACKNOWLEDGEMENTS

The completion of my dissertation would not have become a reality without the encouragement and support of my committee, my colleagues, and my family.

Dr. Portia C. Elliott has been a concerned, encouraging and supportive advisor to me since my first meeting with her in 1985 when I was accepted into the doctoral program.

As my dissertation chairperson, Dr. Elliott has continued to give the guidance and encouragement to persevere throughout the dissertation proposal and through this final effort, the doctoral dissertation. As an advocate of active participation by students in the learning of mathematics, Dr. Elliott has been an inspiration and an influential role model on me since I have participated in her methodology of teaching mathematics courses, her workshops, and read her publications. I appreciate and thank her for the time, concern, attention, and guidance she has offered throughout my doctoral program.

Dr. Edward Harris has been dedicated to assisting me and certainly has given me the concerned, consideration and attention needed by this nontraditional student. His unique role in my dissertation committee has been his contributions in his area of expertise, adult lifelong learning. Dr. Harris was able to identify and focus my attention on important issues of the nontraditional students, who were the subjects of my research study. I thank him for the respect, encouragement, and compliments which he gave me in my efforts throughout the dissertation writing.

Dr. Warren Schumacher has played an important role in helping me to focus on the importance of teaching to every learner. With his expertise in human relations, he has broadened my understanding and helped me to translate more clearly the importance of teaching to every individual who as a learner is unique and has different needs.

Dr. Schumacher's sparkling personality, has inspired me to persevere throughout the entire dissertation process. I thank him for making me feel important about my doctoral contribution to education.

I would like to thank the professor at the community college and the students in the Algebra I class for their cooperation in serving as research subjects for my study.

My professional colleagues, Stephen Paterwic and Linda Levister, who have been both editor and sounding board, have been available, helpful, and encouraging throughout my writing. I am forever grateful for their continuous contributions and support.

My family has been caught up in my educational efforts as well as their own. My husband, George has encouraged me and has managed the home front so that my study and research time could be realized. My daughter, Catherine, has been an inspiration to me and has encouraged me to persevere and certainly has helped me focus on a time line of target dates. Additionally, she has assisted my editorial computer efforts by formatting this dissertation and by construction the finished tables and figures. Through these past years of my doctoral program, my husband and each of my children have continued their educational efforts as well. My husband, George, Sr., completed certification in vocational education in Engineering Drafting. George, III, received a B.S. in Medical Technology; Catherine received a Ph. D. in Chemistry; Elizabeth received a B.F.A. in Fine Arts; Christopher continues his studies in Food Management. Their educational accomplishments have not only been their reward for their efforts, but also an inspiration to me to complete my doctoral degree. The concern, assistance, efforts, and cooperation of my family are expressions of their love and consideration for me.

The completion of this dissertation has been a united effort of all of you. I thank each of you for your contributions which have assisted me in reaching my goal.

ABSTRACT

ACHIEVEMENT OF DIFFERENTIALLY PREPARED,
NONTRADITIONAL STUDENTS IN DEVELOPMENTAL MATHEMATICS
AT A COMMUNITY COLLEGE:
A STUDY OF MODALITY (LEARNING STYLES) PREFERENCES

FEBRUARY 1992

JOAN CZAJA MARSH, B. S., UNIVERSITY OF MASSACHUSETTS

M.A., AMERICAN INTERNATIONAL COLLEGE

M. S., CENTRAL CONNETICUT STATE UNIVERSITY

Ed. D., UNIVERSITY OF MASSACHUSETTS

Directed by: Professor Portia C. Elliott

This is a study of modality preferences in learning styles of successful and unsuccessful nontraditional community college students while they were enrolled in developmental mathematics. The purpose of examining the learning style preferences was to look for visual, auditory, and/or kinesthetic patterns in learning that differentially prepared students used while studying Algebra I. To better understand students' learning styles, modality strengths and learning strategies had to be identified for each participant in the research project. Questionnaires were administered to obtain self-reported data from students. Personal interviews with this researcher provided additional information. The Swassing-Barbe Modality Index, SBMI, was administered to identify modality strength. From these research tools, student profiles on learning style preferences were assembled.

Students in the research project were enrolled in Algebra I class which was taught in traditional lecture style at an urban community college. The students who voluntarily participated were nontraditional and differentially prepared individuals .

The study showed that successful visual, auditory, mixed modality students had high correlation between their identified modality strengths and matching study strategies in class and in private study. These modality groups utilized additional modality based strategies other than their strength to enhance their learning.

However, successful kinesthetic students were not correlated and did not use study strategies that matched their identified modality strength in class or in private study. These students depended upon their developed visual and auditory preferences in learning algebra. The data revealed that students were unaware of applications of kinesthetic strategies in studying mathematics.

There were two unsuccessful students, one identified by SBMI as auditory and the other as kinesthetic. The data on these students revealed that there was no correlation between their identified modality strengths and use of matched study strategies.

An important aspect of this study that may influence community college faculty is awareness of success of students who used learning strategies that matched their modality strength. By incorporating a variety of modality based teaching methods, instructors of mathematics will provide a learning environment in which students can construct their own learning of mathematics.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

During the past twenty years community college enrollments have increased significantly. Community college enrollments also are becoming more diverse than in the past. At community colleges now, the typical traditional students, 18-22 years old, are being replaced by students who are 25 years or older. Many of these older students are minorities; some are bilingual; and others have English as their second language (Roueche, 1977; Watkins, 1989).

Since the mid-nineteen seventies, open enrollment of students has been the practice at public community colleges. The policy has allowed students who have a great variety of academic preparation to enter into higher education at local community colleges. This open door policy provides access to higher education for all persons who are high school graduates or have the General Education Development (GED) who declare themselves ready for college level courses. The community colleges must provide a preparatory program of studies which enables students to enter a two year college program leading toward certification, a terminal associate's degree, or transfer to a four year college. Often, such programs take substantially longer than two years, because students cannot attend full time and they often lack the necessary preparatory foundation courses that must be completed prior to college level classes (Watkins, 1989; Nowick, 1989a).

Since the enactment of the open admission policy in Massachusetts in 1973, the quantity and quality of the entering college students have changed drastically (Massachusetts Board of Community Colleges, 1973). Many of the students who are enrolled are re-entering education after a lapse of five years or more. A vast majority of these re-entering students are underprepared academically in mathematics and therefore, are not ready for college level mathematics courses (Nowick, 1988; Roueche & Roueche, 1977). Many of these entering college students have poor academic records as high school

students and some are high school dropouts (Rank, 1979). Others have recently passed the high school equivalency test that leads to a GED. Bilingual Hispanic and Asian adults are seeking employment opportunities that require college level training and need to improve their oral and written English skills.

As the enrollments during these past years have been changing, community colleges have re-focused their programs to accommodate the different needs of these differentially prepared students. Provision of adequate and appropriate courses to meet this diversity is the challenge that community colleges must meet in order to be successful with these new students (Crepin, 1981; Cupkie, 1980).

Since these students are so differentially prepared for the basic foundation courses, the community colleges must provide testing for placement in appropriate level courses in English and mathematics. As a result, curricula for mathematics at community colleges typically must include a series of developmental mathematics courses that begin with foundations of arithmetic and algebraic concepts and continue to trigonometry (Cullen, 1980; McDonald, 1989; Smith, 1988). Many community colleges have also accommodated Hispanic and English as a Second Language (ESL) students and provide the same developmental mathematics series in the ESL program using bilingual mathematics instructors (Czalejan, 1989).

The placement tests that all entering students take identify students' level of conceptual understanding of mathematics. Based upon the results, some proficient students are placed in college level mathematics courses. Other students are placed in the developmental mathematics program at a level of understanding from which they can proceed with success (Cullen, 1989).

Elements in the teaching/learning process have been examined by Cross and have been shown to be important factors in bringing about successful learning for nontraditional students. For example, to provide the best conditions for learning to take place the faculty must offer some developmental mathematics courses using varied teaching styles (Cross,

1976; Dunn, 1978). As Cross has stated, the curricula in mathematics in and of itself may be very well developed, but the implementation and presentation of these developmental mathematics classes must be given in varied modes to reach the individual differences in learning styles of nontraditional students so that more students using their strengths can be successful (Cross, 1976).

Research evidence is inconclusive and opinions are mixed on the subject of whether or not matching teaching techniques to learning styles will increase academic achievement of students. In one camp researchers, Domino (1970), Farr (1971), Hill (1971), and Reinert (1976), claim that the practice of matching teaching styles to students' learning styles has influenced positively academic performances. Researcher Cross (1976) extends this claim to include the population of college students she studied. Taking an opposing position of the value of matching teaching techniques and learning styles and getting positive results with college students are researchers, Cupkie (1980) and Heitmeyer (1985). Their studies found that "no appreciable difference in student achievement was noticed when compatible teaching styles and learning styles were matched or mismatched". At the elementary and secondary levels and in cases where the researchers' population was nontraditional college students there has been more unanimity of responses when the question whether or not matching teaching and learning styles will improve achievement. (Berenson, 1990; Corn, 1989; Davis, 1983; Dunn, 1978; Gregorc, 1979a; Hill, 1971, 1976; Joyce, 1979; Kolb, 1979; Roueche, 1976).

Even in the midst of the controversy over the advisability of matching styles of teaching and learning, many community colleges are providing staff development opportunities for instructors to learn how to diversify their teaching methods (Cullen, 1980; Greenwood & Anderson, 1983; Groeneveld, 1990; Yawin, 1981). In addition to this practice, some colleges are presenting workshops on teaching styles and learning styles to keep the faculty informed of advancements in these areas. Some departments of mathematics, in keeping with these practices, are revamping their instructional facilities and

are diversifying teaching techniques in hopes that these changes will meet the needs of the differentially prepared, nontraditional students (Burns, 1988; Crepin, 1981; Groeneveld, 1990; Smith, 1988).

The Statement of the Problem

"Work Force 2000" (Johnston, 1987; National Research Council, 1989) will be made up of students we are preparing now in our college classrooms. For these students to be ready to assume their rightful places in the technologically-oriented society they will inherit, mathematics courses must be designed and taught that will optimize mathematical capabilities of all learners. The country can ill-afford to lose any of these minds to mathematical indifference, avoidance or failure.

So what role will community college play in the preparation of mathematically capable students? It will be the task of these colleges to take differentially prepared, nontraditional students and find ways to awaken mathematical curiosities and successes. There is no "tried and true" method for doing this. The National Council of Teachers of Mathematics (1989) in its Curriculum and Evaluations Standards book would have us teach the K- 12 curriculum so that students can construct their own meaning to mathematical ideas and propositions. The NCTM constructivist notions should be inspirational for community college teachers too because now the issue of matching and not matching students' learning styles with teaching styles can be re-evaluated in the context of the constructivists' philosophy that says environments should be arranged and interactions encouraged so that students can "act on" the mathematics they are trying to make meaningful for themselves. This means teachers must be willing to allow students to use modality preferences students feel suit their attempts at constructing mathematical meaning.

The researchable problem that challenges the entire mathematical community, not just community college professors, is whether or not we can provide mathematics

instruction to students so that all can learn using whatever capabilities they possess to construct mathematical meaning. The physical environment in which this happens must be properly arranged. The classroom interactions, student materials, and modalities strengths that each student brings to the learning tasks must be respected as must the personally constructed knowledge each creates.

The Purpose of the Study

This research study described in this document revisits the question of whether or not it is advisable to attempt to match teaching techniques to learning styles of differentially prepared community college students when the goal is to improve mathematic achievements. The question is being revisited in light of the newly adopted NCTM Curriculum and Evaluation Standards (1989) and the NCTM Professional Teaching Standards (1991).

More specifically, this study examined the modality preferences and strengths of successful and unsuccessful community college students enrolled in a developmental mathematics class. This examination of preferences and strengths yielded data that were further scrutinized to determined if there were discernable patterns in similarities or differences in modalities strengths of successful and unsuccessful students.

Research Questions

This study was conducted to answer the following question and its corollary:

Question:

Can success in mathematics (defined as a grade of ≥ 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students utilize their modality strengths as they study their mathematics?

Corollary:

Can non-success in mathematics (defined as a grade of < 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students do not utilize their modality strengths as they study their mathematics?

Subsidiary Questions:

Since both the question and its corollary were so broad in scope, the following subsidiary questions were posed:

1. According to the Swassing-Barbe Modality Index (SBMI), what are the visual, auditory, and/or kinesthetic modality strengths of students in this study?

2. According to self-reports, what modality based strategies do students in this study use in class and are these self-reports positively correlated with SBMI data?

3. According to self-reports, what modality based strategies do students in this study use in private study and are these self-reports positively correlated with SBMI data?

4. According to self-reports of students classified in different modality groups what are their preferences in the following learning style categories:
   a. environmental conditions i.e., light, sound, temperature, and room design;
   b. student behaviors i.e., responsibility and motivation;
   c. social behavioral aspects i.e., studying by oneself, with peers, with competent adults;
   d. physical elements i.e., requires food, functions best in the morning or evening, needs to be mobile? (Students were grouped by SBMI data).

5. Do academic achievement, modality strengths and self-reported modality based strategy preferences positively correlate for unsuccessful and successful students in the study ?

6. Do patterns exist in modality based strategies used by unsuccessful and successful students in the study ?

To be able to answer these questions the following kinds of data were collected:

1. modality strengths of the students, using the Swassing-Barbe Modality Index Test (Appendix C);
2. modality based strategies used by students in the classroom using QUESTIONNAIRES #2, #3, (Appendix D) and INTERVIEW QUESTIONS #1, #2, #3 (Appendix E);
3. modality based strategies used by students in private study using QUESTIONNAIRES #1, #4 (Appendix D) and INTERVIEW QUESTIONS #1, #2, #3 (Appendix E);
4. environmental conditions, i.e., light, sound, temperature, and room design as elements of learning style using QUESTIONNAIRES #1, #2, #3, #4 (Appendix D) and Learning Style Preference Charts (Appendices F and G);
5. student behaviors, i.e., motivation, responsibility as elements of learning style using QUESTIONNAIRES #1, #2, #3, #4 (Appendix D) and Learning Style Preference Charts (Appendices F and G);
6. social behavioral aspects, i.e., studying by oneself, with peers, with competent adults, as elements of learning style using QUESTIONNAIRES #1, #2, #3, #4 (Appendix D) and Learning Style Preference Charts (Appendices F and G);

7. physical conditions, i.e., food intake, time of day and mobility as elements of learning style using QUESTIONNAIRES #1, #2, #3, #4 (Appendix D) and Learning Style Preference Charts (Appendices F and G);
8. current mathematics grades of students from instructor's grade records.

Definition of Terms

Developmental Mathematics: Developmental mathematics is a series of mathematics courses that build conceptual foundations and skills in arithmetic, algebra and trigonometry, usually at community colleges (Yawin, 1981). In secondary school, remedial mathematics is the term associated with improving mathematics skills and building arithmetic foundations (Driscoll, 1986).

Differentially Prepared Learners: Students who are underprepared in mathematics and language skills, have been schooled in foreign countries, are adults more than twenty five years old, and have not attended school for ten years or more.

Learning Styles: Learning styles, are characteristic cognitive, affective and psychological processes which effect how learners receive and interact with new information, and respond to learning environment. Elements of environment conditions, social factors, emotional aspects and physical conditions including modality preferences are factors in learning style (Dunn, Dunn & Price, 1978), (Appendix G).

Modalities: Modalities are channels through which people receive and retain information. This implies that sensations or perceptions as auditory, visual and/or kinesthetic or touching constitute what are known as modalities (Barbe & Swassing, 1979).

Modality Based Instruction: Modality based instruction is founded on the premise that methods of presentation should focus on auditory, visual and kinesthetic strengths of the learners (Barbe & Swassing, 1979).

Modality Based Strategies: Modality based strategies are techniques used in learning that call upon visual, auditory or kinesthetic aids or behaviors.

Modality Preferences: Modality preferences reflect an individual's personal differences concerning modality by which the person learns best; by seeing, by hearing, or by doing (Barbe & Swassing, 1979).

Modality Strengths: Modality strengths are defined operationally as the ability of individuals to perform academically relevant task in one of the major modalities; auditory, visual, and/or kinesthetic (Barbe & Swassing, 1979).

Nontraditional Students: Nontraditional students are those college students who are twenty-five years or older who are differentially prepared for college (Watkins, 1989)

Significance of the Study

There are at least three populations who might benefit from the research finding of this work. An obvious beneficiary would be community college mathematics instructors who are grappling with ways to vary instruction so that achievement levels will improve. The mathematics community-at-large stands to benefit whenever research sheds some light on the teaching/learning process. Most importantly, the differentially prepared college students can benefit from these findings just by being alerted to the fact that they can become consciously aware of their own modality strength and with awareness can make

informed choices about how and under what conditions meaningful mathematics is possible for them.

If research finding are conclusive, the question of advisability to matching teaching techniques to learning styles to improve mathematics achievement can be reconsidered and mathematics teachers can focus themselves on the task of arranging environments and guiding interactions so that students can construct their own mathematical understandings.

Delimitations of the Study

This study has been delimited in the following ways:

1. The sample of students was not representative of all differentially prepared, nontraditional students at a community college.
2. This sample was delimited to students enrolled in one course in developmental mathematics, namely Introductory Algebra I.

Limitations of the Study

This study had the following limitations associated with it:

1. This study was limited to one urban community college.
2. The profiles of the students which identified modality based strategies were limited to those strategies used in learning mathematics.
3. The patterns in modality based learning that were described in each of the modality groups were limited to those used by participants.
4. The focus of the study was centered on modalities (learning styles) of students, the impact of the environment on their learning of mathematics and cognition. It did not include volitional, affective or psycho-motor issues.
5. Teaching styles of instructors were not addressed in this study.

The study analyzed students' modalities and individual differences in modality strategies in an attempt to understand their possible effect on students' achievement. This study tracked one section of students during one semester in developmental mathematics, Algebra I, as presented at the urban community college of this study. No generalizations from these results are appropriate beyond the surveyed, nontraditional students of developmental mathematics at the community college in the study. This study may, however, have value for other researchers with similar interests.

Outline of the Remainder of the Dissertation

The remaining four chapters look at different related areas that bear on the researcher project.

Chapter II reviews the literature in five main areas: (1) The Nature of the Nontraditional Learner; (2) Community College Solutions to Differential Preparedness of Students; (3) Learning Style Theory; (4) Modalities: One Aspect of Learning; (5) Modality Based Instruction.

Chapter III gives a detailed plan for this study, including the design, the participants, methods of data collection, and presents the questionnaires and instruments used to gather data in this study.

Chapter IV presents the data collected from the study organized into students profiles, the comparisons of modality strengths, and modality based study strategies relative to success in the mathematics course, and offers an analysis of this data.

Chapter V explores the implications and the conclusions of the study and makes recommendations for future studies.

CHAPTER II

LITERATURE REVIEW

Introduction

A literature search was completed to gain background knowledge of previously published research in six areas: (1) The Nature of the Nontraditional Learner; (2) Community College Solutions to Differential Preparedness of Students; (3) Learning Style Theory; (4) Modalities: One Aspect of Learning; (5) Modality Based Instruction.

In order to meet the needs of the academically underprepared students, the mathematics curricula at selected community colleges have changed from a more traditional program, beginning with pre-calculus and leading to other advanced level mathematics courses, to a developmental mathematics curricula beginning with fundamentals of arithmetic and continuing through algebra, geometry, and then to college level mathematics courses. This literature review discusses the nature of differentially prepared, nontraditional students, current developmental mathematics curricula, and methodologies to effectively instruct these students at community colleges.

The Nature of the Nontraditional Learner

The Identity of the Nontraditional Students

During the past twenty years, the role of the community college has grown and evolved to meet the ever changing needs of its students. The open enrollment at many community colleges includes an increasing number of students who are older adults, bilingual, and/or minorities. Many entering college students are also academically underprepared in the fundamentals of English, mathematics, and science (Roueche, 1977). Furthermore, at the community college level, the total enrollment of typical traditional

students, 18 to 22 years old is being increasingly replaced by nontraditional students who are over twenty five, some of whom are minorities and/or bilingual (Roueche, 1977; Watkins, 1989). In addition, for descriptive purposes, students can also be considered nontraditional when they continue their education after a lapse of time of five years or more (Rose, 1989; Roueche, 1977). Rose clearly explained that the range in age of these nontraditional students may be from the mid-twenties with no upper limit on age; "in 1978, one seventy-eight year old woman received an Associate Arts degree" (Rose, 1989).

A group of nontraditional students may include: single self-supporting parents, "displaced homemakers" in need of training, women planning to return to the work force after rearing their children, veterans returning from the service, people seeking education to obtain a more secure, higher-paying career, and men and women making career changes or upgrading their skills. Therefore, the nontraditional students are as Rose (1989) defined them: "adults who are twenty five years old or older, seeking further education to improve themselves academically and develop skills and training that can lead to career level employment".

The Academic Background of Nontraditional Students

Nontraditional students are re-entering education after a lapse of five years or more and a vast majority of them are academically underprepared in basic mathematics. Therefore, many are not ready for mathematics at the college level (Roueche, 1977). Janice Rank noted that some students had poor academic records in high school; in fact, some may never have completed high school and had dropped out (Rank, 1979). Some nontraditional students have recently passed the high school equivalency tests that qualifies them for General Education Development (GED) certificate. Many bilingual Hispanic and Asian adults are seeking the opportunity of college, to improve their oral and written English skills, and then to continue on to advanced education. Many of the bilingual

students have academic deficiencies due to poor educational opportunity in their native countries and also due to poor development of English as a second language (Adickes, 1980; Rank, 1979).

However, some nontraditional students are not underprepared in mathematics. Some of the more able nontraditional students have taken college courses or have other college degrees. Since some of the adults have better educational backgrounds, they may need only concentrated review classes to polish some skills (Nowick, 1989a). Perhaps the best phrase to describe these entering students, therefore, is "differentially prepared". They have varied academic, cultural, ethnic, and linguistic backgrounds, and span a wide age range. It is this differentiality in background that is the challenge to community colleges (McIntyre, 1981).

Basic Differences Between Differentially Prepared Nontraditional Students and Traditional Students

Many nontraditional students lack strong foundations of English and reading comprehension skills which further restricts these students in the reading of college level texts, as McIntyre (1981) found in her research. These reading deficiencies interfere with comprehension of mathematics texts and workbooks. In addition, McIntyre also stated that basic fundamentals in mathematics are inadequate so college level mathematics courses are beyond students' reach (McIntyre, 1981). The academic inadequacies of differentially prepared students must be recognized and remedied, so that these students may succeed in a community college setting.

Conversely, Nowick stated that traditional students have more recently completed high school and have had continuous and connected training in both English and mathematics. Therefore, these traditional students can usually succeed in freshman level courses in both English and mathematics (Nowick, 1988).

At the annual meeting of the Association of American Colleges, Stocker (1989) referred to the lessons learned over the last twenty years from the increasing number of nontraditional students attending colleges. Experiences discussed at this conference as well as the published research data indicate that these nontraditional students have many strengths that make them very good students. Many of these students have developed a mature attitude toward the importance of education (Rank, 1979; Thompson & Fiske, 1984). This attitude results in a serious, positive motivation toward learning. Nontraditional students are ready to work hard to achieve specific academic goals. Stocker also pointed out that another strength of the nontraditional students is life experience. Because these students are older and have lived in the "real world" for a number of years, they have gained more insight about themselves because of their varied life experiences (Stocker, 1989). At community colleges, Nowick found that mature adults realize their personal deficiencies that they may address and correct with advanced education in order to reach career and personal goals (Nowick, 1989a).

Many nontraditional students have an inner, personal drive to make something better of themselves through education as Rose (1989) stated from the many interviews of potential enrollment candidates at the community college. This desire motivates them to enroll in college programs. Smith (1988) earlier had stated that throughout the whole educational process, as nontraditional students are successful, the experience helps to enhance their personal self-esteem and self-worth. Gourgey (1985) contends that these internal drives act as strong motivators for the differentially prepared, nontraditional students in the pursuit of education. Rose (1989) and Smith (1988) concur that all of these strengths of nontraditional students can be drawn upon in the community college setting to aid these students in their academic achievement .

Stocker (1989) further compared the life experiences of the traditional students and nontraditional and the wealth of knowledge that the older students bring to class from their many years of experiences. Therefore, the strengths that nontraditional students have

gained through experience and age are not ones that younger students can call upon to guide them through their educational program. Comparing the attitudes of the two camps of students, Stocker stated,..."the nontraditional adult students are in class because they want to be there and are eager, active learners. They are not like 18-year-olds who are more likely to be a lethargic group that you have to energize" (Stocker, 1989, p. A27). Furthermore, Nowick (1989a) stated that many younger students lack the perseverance that comes with maturity. Many of the shortcomings of the traditional students often interfere with successful completion of their college education.

Identifying traits of successful students who may be traditional or nontraditional students, Rose stressed that those who possess strengths in character as positive, responsible, and enthusiastic attitudes toward their courses of study can indeed reach their educational goals (Rose, 1989).

Basic Needs of Differentially Prepared Students for Re-Entry into Education

Nontraditional students with a realization that a better way of life can be achieved with more education and training or that there is a need for a change in career, return to school. However, these students are often high risk students because of many basic skills deficiencies (Bohr & Bray, 1980). In addition to their academic deficiencies, Adickes (1980) also stated in her research that there are some similar affective behaviors that are characteristic of re-entry college adults such as low-esteem and feelings of inferiority which have also been expressed in varied workshops at different community colleges conducted by Nowick (1988, 1989a) and Rose (1989) for students entering college. In research by Roueche (1977) on older returning college students, the combination of both of these factors, that of low-esteem and of inferiority, has been identified with failure in nontraditional students. Furthermore, Crepin (1981) stated that older students evince a high degree of apprehension about their ability to enroll in college and to continue on a long term basis toward graduation. These adults realize the rigor and self-discipline that is

needed to proceed with the demands of a college program. However, they often realize that they lack study skills and organizational techniques that help in studying. In addition, developing listening skills, note-taking, and other communication skills may need to be sharpened. Crepin (1981) advocates establishing workshops for entering nontraditional learners to develop and sharpen learning techniques and skills to lessen anxiety towards college classes.

Learning Styles of Differentially Prepared Students

Nontraditional adults have many life experiences that aid them in understanding new material using varied methods of learning. Fennema (1976) and Smith (1988) claim that learning styles can be matched with appropriate teaching styles so that differentially prepared students can learn more readily A series of learning styles surveys have been used to try to identify the characteristics of specific learning styles that nontraditional students may possess (Canfield, 1980; Fennema, 1978; Gregorc, 1981; Kolb, 1976). Corn (1989) concurs with Gregorc (1981) that students enrolled in classes that feature teaching methods which utilize the pertinent characteristics of their learning style may be aided in their learning.

Many students are very good listeners and readily use their auditory sense to learn. Some students are adept readers who follow written instruction, review the written examples and proceed on their own in a self-taught, visual learning process (Burns, 1988; McDonald, 1989). Furthermore, Burns and McDonald consider these students to be independent learners.

According to Smith (1988), the majority of students need to be shown as well as told in order to learn at their fullest capacity. These audio-visual learners often benefit from lecture and demonstrations for a more thorough understanding. Smith further advocates that for total conceptualization, many differentially prepared students need concrete models, diagrams or other visual aids to give them concrete experiences to help the learning

process. As McKinnon has expressed in The College Student and Formal Operations, "Some students need to have manipulative pieces and demonstration models that allow for hands-on experiences to conceptualize ideas" (McKinnon, 1976, p.115). These students who learn most readily through concrete, tactile experiences are kinesthetic learners.

According to research at their community college, Bohr and Bray (1980) found that students' interactions with the instructors, through supervised questioning initiated to promote discussions, may lead to explanations of a variety of points of view and solutions to problems. These open discussions are of value because they permit all students to gain knowledge from each other. Peer or team problem solving sessions under an instructor's guidance allows for yet another style of learning experience that is interactive. All of these learning styles: auditory, visual, audio-visual, kinesthetic and interactive, involve students as active participants in the learning process.

Quite a few nontraditional students have indicated, according to Rank (1979) and Groeneveld (1989), a need for the traditional lecture format with strong instructor directives. As a result, maximum instructor direction in a traditional classroom may best serve the needs of some of the nontraditional learners whom Rank (1979) also found were insecure and differentially prepared students. Smith (1989) and Appleman (1989) both have espoused that positive classroom experiences, which effectively utilize audio and visual aids demonstrated by the instructor, also will benefit some differentially prepared students. Through questioning, Bohr and Bray (1980) have found that much class interaction can be stimulated which furthers participation based on students' experiences. As the students build confidence through the participation in discussions, Smith (1989) states that further interactive experiences which calls for team problem solving can be incorporated into the classroom. Furthermore, as the self-confidence factor grows stronger in students, more independent learning can take place (Smith, 1989).

Mathematics can be taught incorporating varied learning and teaching styles. Thus, Appleman (1989), Burns (1988), and Smith (1989) have utilized varied instructional tools

such as audio tapes, cassettes players, video tapes, television, computers and manipulative materials, so that differentially prepared students can experience mathematical concept presentations that call upon the use of auditory, visual, and kinesthetic learning styles that aid in gaining mathematics understanding. Cullen (1980) and Pilsarski (1988) found that guided classroom lessons that utilize audio-visual aids and manipulative materials to illustrate mathematics concepts give varied learning experiences to students. Variations of presentations and experiences in mathematics teaching reach the diversity of modality learning styles of these differentially prepared students as well as the regular students (Bohr & Bray, 1980; Burns, 1988; Cleveland, 1990; Cullen, 1980).

Community College Solutions to Differential Preparedness of Students

Community Colleges Meet the Basic Needs

The individual needs and differences of nontraditional students have made an important impact on curriculum development at the community colleges. Colleges have developed programs for differentially prepared students, because as McIntyre (1981) states, the open door policy could well become a revolving door for students who cannot succeed in General Studies Programs at community colleges. An open enrollment policy at many public community colleges has encouraged differentially prepared students to attain a higher education. Many new programs have been developed for nontraditional students. A small sample of special new courses named by Nowick (1988) and Rose (1989) include programs in health services as dental hygiene, nursing, biomedical technology, and pre-school child care all of which have basic requirements of mathematics and English (Groeneveld, 1990).

The counseling services of the college according, to Rose (1989) and Nowick (1989a), provide assistance programs for nontraditional students, many of whom are high

risk. Workshops are presented that teach basic study skills and organizational skills which are important to differentially prepared students for success in college.

Research indicates, as Tobias (1978) discussed in Overcoming Math Anxiety, students who are anxious about mathematics cannot perform adequately. The counseling staff may have workshops that not only identify mathematics anxiety, but also provide classes and services to lessen these anxious feelings of students. A significant portion of anxious mathematics students have low mathematics self-concept which Gourgey (1985) found to imply that there is a personal fear of failure in mathematics classes. Continued failure produces such fears and negative feelings according to Elliott (1983) that a defensive attitude develops which leads to total avoidance of mathematics. Because of these factors, it is imperative that nontraditional students be placed in the proper level of developmental mathematics to maximize their success. Thompson and Fiske (1984) state that these students must also continue the workshops with the counselors to help to improve their self-image and their attitude toward mathematics. The different counselling programs can prepare nontraditional students emotionally to cope with the mathematics classes which they must have as part of the college program. Both Cullen (1980) and Smith (1988) agree that as community colleges make the effort to provide additional services to meet the needs of high risk nontraditional students, these students will be more readily prepared to succeed in college level classes.

Meeting Academic Needs

Community colleges offer a wide variety of programs to meet the interests of the students and to prepare them for a variety of careers. Faculty members recognize the varied levels of difficulty associated with various majors. Cullen (1980) and McIntyre (1981) have stated that they realize that students must have a strong foundation in the basic skills of mathematics for most college programs and that without a strong foundation in mathematics basics, the students are doomed at the outset. Therefore, community colleges

must identify the level of the ability in mathematics for all entering college students as Groeneveld (1989) states. The colleges must also organize a series of courses that will develop basic skills to enable students to successfully embark in a college level program of mathematics.

Many community colleges offer a total program in which students work toward improvement of fundamental skills in both mathematics and English. Roueche (1976) has advised students to enrolled concurrently in liberal arts courses and character-building classes to improve self-esteem and attitude. Prior to the freshman class enrollment, according to Yawin (1981) and Crepin (1981) many community colleges administer basic skills tests so that students can be evaluated and placed in appropriate mathematics and English skills courses. For those students who have test results that show deficiencies in foundations, developmental mathematics classes are available. The developmental courses are often taken with regular college courses and may be integrated within the liberal arts classes. Because the skill levels of the differentially prepared students are so diverse, the classes are often self-paced under instructor guidance (Bohr & Bray, 1980; Crepin, 1981).

Meeting Learning Style Needs of Differentially Prepared Students

Effective teaching styles for nontraditional students are numerous and varied. Smith (1988) states that nontraditional students make important contributions to a class because of their life experience. Instructors can provide opportunities for students to share these personal experiences. For example, a home-maker might explain a problem that was solved using fractions when changing a recipe to one half the original. Another student, a veteran, might share an experience from a foreign country dealing with monetary exchange that is an appropriate contribution to the class discussion in problem solving. Bohr , Bray (1980) and Taylor (1982) agree that this interaction not only enriches class content, but also helps to build self-confidence in the students through oral class participation.

It is helpful for instructors to be knowledgeable about affective behavior patterns and their implication in the mathematics classroom (Thompson & Fiske, 1984; Tobias, 1978). Both Appleman (1989) and Smith (1988) agree that instructors should maintain a casual environment that is non-threatening and should invite students to ask questions. Such concerned teachers are supportive and favorably acknowledge student efforts. Adickes (1980) has found that teachers who maintain a positive and supportive attitude will find it reflected in their students.

A positive environment in the classroom is important, according to Bohr, Bray, (1980) and Burns (1988), especially if the instructor is conducting a mathematics laboratory where students are co-operatively solving problems. In some classes of developmental mathematics courses, instructors conduct their classrooms as a working laboratory. In this format, the teacher presents mathematics concepts, using visual aids as models to explain and demonstrate concepts. Subsequently, the students practice the concept with more problems as individuals and in teams. In group work, the students support and assist one another in skills review as well as in problem solving. To further stimulate the students, challenging word problems are introduced to help the students develop critical thinking skills. Furthermore, calculators can be integrated as a help with solutions to story problems. Halloran (1977) states that the calculator plays a significant role in mathematics courses, as students can easily process different types of problems with the quick facility of the calculator. Therefore, adult students must master the use of the scientific calculator as needed in the developmental mathematics classes. In Curriculum and Evaluation Standards for School Mathematics, the NCTM (1989) advocates the use of calculators. Through repeated use, the calculator can prove to be an indispensable tool for easy verification and for solutions to complex mathematics problems.

Interactive teaching allows interesting and motivating lessons to be presented. For example, as Bohr and Bray (1980) stated, using the overhead projector allows the instructor to illustrate diagrams, graphs, and geometric figures with greater precision.

Specially prepared transparent, equipment such as rulers, protractors, cuisenaire rods, as well as calculators are now available to present lessons using an overhead projector onto a large screen. Thompson and Fiske (1984) have promoted the idea that by teaching with precise, visual, illustrative lessons, students are able to visualize easily a total concept. Therefore, using different presentation styles makes lessons more interesting and allows for individual differences of the adult students who are also visual learners.

Pilsarski (1989) and Appleman (1989) urge students to take advantage of the services in the mathematics laboratory. Student tutors and instructors who foster a nurturing environment can attract deficient students who might otherwise be hesitant about seeking additional help. Tutorial laboratories can specialize in one-on-one tutoring. Also available are mathematics lessons presented through audio tapes and recorders or as video tapes demonstrations on the VCR (Appleman, 1989; Thompson & Fiske, 1984). Moreover, Burns (1988) and Pilsarski (1989) have included Computer Assisted Instruction (CAI) with appropriate software for developmental mathematics to their mathematics laboratories. Students are encouraged to utilize these technical presentations because they present mathematics using different teaching styles. Appleman (1989) has developed with his staff, audio and VCR tapes of mathematics concepts that are important resources for students to review or to obtain for make up classes. The availability of demonstration tapes in the mathematics laboratory for personal use offers opportunities for students to meet some of their own learning needs. Audio and visual tape equipment have the replay feature which is very helpful in repeated, review and practice activities for greater understanding. If a variety of instructors are used as the demonstration teachers in these taped classes, students may find that they relate better to one teacher than another. In addition, these variations in instructors make the presentations more interesting for most students (Appleman, 1989).

Directing concept understanding through hands-on manipulatives, diagrams, puzzles and games assists in bridging the gap of understanding mathematics between

concrete mathematical presentations to abstract mathematics attainment. Mathematics can be shown, perhaps, as "fun", according to Thompson and Fiske (1984) by using puzzles and games through which many mathematical skills can also be enhanced. The students build confidence through their successes of mathematics concept attainment. With each new accomplishment, the hierarchic foundations of mathematics grow broader and stronger according to Smith (1988) who also states that nontraditional students develop mathematics skills, mathematics applications and critical thinking throughout the developmental mathematics classes. The strength of these foundations courses give students the background and confidence to take advanced classes in mathematics.

According to Watkins (1989), many colleges have changed mathematics curricula to meet the needs of traditional as well as nontraditional students through developmental mathematics series. Furthermore, Appleman (1989) and Smith (1988) have stated many colleges recognize that varied modality based instruction can bring positive results and have adopted methods of instruction to meet the preferential learning styles of students.

Learning Style Theory

Learning Style is an umbrella term which encompasses cognitive, affective, and physiological environment dimensions of the learning process as a broad interpretation proposed by Keefe (1986). A Task Force on Learning Styles was formed after a major national conference in 1981 sponsored by National Association of Secondary School Principals (NASSP) and St. John's University that joined practitioners and scholars interested in cognitive/learning styles and brain behavior. The main objectives of the task force according to K. Dunn and R. Dunn (1978) were to research the field in depth, to appraise the assessment technology and to develop a conceptual model for a state-of-the-art

look at learning style. Therefore, from this broad foundation base of NASSP, this researcher was able to compile informative research materials that guided the Task Force.

The Center for Learning and Teaching at St. John's University, Jamaica, N.Y., under the direction of Dr. Rita Dunn, has made available current research and journal articles as an in depth annotated bibliography which is updated as articles become available (Dunn & Dunn, 1988). Furthermore, an ERIC search found more than 3000 entries under Learning/Cognitive Styles since 1970. In addition, Perceptual/Learning Modalities yielded over 700 citations in the same search. This researcher would like to summarize the comprehensive efforts that have been researched to aid the development of the current learning style theory (Barbe & Swassing, 1979; DeBello, 1989; R. Dunn, 1983; Dunn, Dunn, & Price, 1975; Keefe, 1979; Kolb, 1976; Letteri, 1980; Messick, 1976; Reinert, 1976) and limit the parameters of this study to learning modalities of differentially prepared, nontraditional students and the impact of the environment on learning mathematics.

Research on learning styles of students in elementary, secondary schools, and colleges has been conducted by more than sixty universities over the past fifteen years. This investigative research has added significant findings concerning the effects that modality, cognitive, environmental, physical and sociological preferences have on students (Canfield, 1980; Dunn, 1988; Gregorc, 1981; Hill, 1971; Kolb, 1976).

At the start, one must be made aware of the unorganized beginnings of the elemental principles that are now the underpinning philosophies of the theory of learning styles. In 1967, the New York State Department of Education commissioned Dr. Rita Dunn to design a graduate program that would train liberal art college graduates who would teach "educationally disadvantaged" students to learn. Over a three year period, six hundred teachers were trained under the direction of eight college professors, worked together with twenty classroom teachers in five public school districts to develop teaching techniques to facilitate learning for children who had not responded well in traditional

classrooms. As the program evolved it was found that selected methods such as learning activity packages, programmed learning, and games worked well for some children but failed to produce progress or even interest in others. Interestingly, some children worked diligently on an activity by themselves while others blossomed figuring things out with other classmates. Many children spent their time changing activities, showing a short attention span as well as a need for variety, while other students sat "endlessly" using the same materials showing neither boredom nor fatigue (Dunn & Dunn, 1977b).

All this evidence indicated that each of these students could learn but different methods needed to be developed that would appeal to students' needs while at the same time be effective with selected types of learners. It was also apparent that regardless of the subject matter the students were attracted by the presentation methods used. After attempting alternative methods, most children selected a specific method to use repeatedly after they had successful experiences. This was the early stage of individualized teaching methods to meet individual student learning styles (Dunn & Dunn, 1978).

An extensive search of research on how children and adults learn reviewed by the Dunns during 1971, revealed that knowledge on methods of learning, accumulated since the turn of the twentieth century, repeatedly verified that learners acquired knowledge and skills through a variety of methods. Furthermore, the literature revealed many broad categories, which could be arranged specifically, to indicate that learners are affected by (1) their environment, (2) their emotions, (3) their social or interactive needs, and (4) their physical requirements (Dunn & Dunn, 1978) Appendix G.

The environmental factors that affect how much students achieve at any given time are temperature, sound, light, and classroom design. Emotional factors that influence how much students learn at a given time are responsibility, persistence, and motivation. Social factors that influence learning are elements such as students working in groups, as pairs, or by themselves. While some students need an adult as an authority figure who is a teacher or expert, other students shy away. Modality elements that affect the learning of students

are visual, auditory, and kinesthetic leaning styles of students. Varied teaching processes, reach each modality make learning enjoyable for students. Teachers can design their lessons in varied presentation styles to stimulate students. Physical factors that influence students during learning are elements such as time of day, mobility, and food intake.

Since children have their own sets of elements that make up their total learning style, it became evident that these should be identified. These factors could then be used to formulate teaching methods for successful learning by individual students. The ideal teaching situation would be complementary teaching and learning styles for students, thus encouraging improved achievement by students according to K. Dunn and R. Dunn (1977b). Here, one sees the basic importance of developing a valid instrument for identification of learning styles. During 1968-1969, Rita and Kenneth Dunn developed the first Learning Styles Inventory (LSI) which indicated 21 features within the four major categories of environment conditions, behavioral, social aspects and physical needs. Over the next five years the LSI instrument was administered in eight school districts in Nassau County of the State of New York. By 1974, reliability and validity had been established and much empirical data collected (K. Dunn & R. Dunn, 1978).

Domino (1970) and Farr (1971), reported some important findings in their studies using the LSI which indicated that (1) students' scores were higher on tests and factual knowledge when teaching styles complement students' learning styles, (2) students can identify their own learning styles, (3) students have an improved attitude toward school in a matched teaching /learning situation and (4) there is an advantage to test for as well as teach to modality preferences of students.

In 1975, Gary Price conducted a content analysis and isolated those items that achieved 90% or better consistency (Dunn, Dunn & Price, 1978), in Appendix F. This LSI instrument has been most valuable in gathering data on learning styles and student achievement. Results have helped to identify how well students will function in traditional, individualized, or open program at schools. Additional resources such as audio tapes,

VCR tapes, Computer Assisted Instruction activity packages, films as well as games have been developed to assist teaching toward individualized students learning style to improve achievement of students. Also, teaching environment can be adjusted to allow mobility in the classroom. Some students can place themselves according to their own temperature and light needs and can also work together on team projects (Dunn & Dunn, 1977a, 1977b).

With this concerted effort paving the way and with the impact of the results that were garnered for improved student achievement, in 1982, a national task force of National Association of Secondary School Principals (NASSP) was formed. Under the direction of Dr. James Keefe and Dr. John Monk, Learning Styles Profile (LSP) was developed. Eight research scholars contributed to the Learning and Teaching Styles Theory that formed the basis of LSP (Keefe, Monk et al., 1986). The LSP instrument was constructed over a three period and then validated by data collected from thousands of scores of students in several hundred school districts across the nation. At present, the LSI of Dunn, Dunn and Price (1978), and the LSP of NASSP of Keefe, Monk et al. (1986) are the only two comprehensive learning style instruments that are widely used assessment tools in elementary and secondary schools. Both comprehensive learning style instruments identify the variable factors in the cognitive, affective and physiological domains associated with learning.

In the early developmental stages of learning style theory, many researchers were gaining their own perspectives on learning styles. So it is important to review these theories of learning style that have added important contributions.

There are many learning style theorists who have focused their attention into topical areas of learning such as: Bi-dimensional models, abstract/concrete, sequential/random (Kolb, 1976; Gregorc, 1982); Right-Left Brain 4-MAT (McCarthy, 1981); Perceptual Modalities (Barbe & Swassing, 1979; Reinert, 1976); Cognitive Mapping of symbols, of cultural determinants, and of modalities of inference (Hill, 1976); Field dependent or independent, GEFT (Witkin, 1976); Bi-polar mental processes sensing / intuition and

thinking / feeling (Myers-Briggs, 1967); Cognitive Profiles, of scanning / focusing, reflective / impulsive, leveling / sharpening, tolerance / intolerance (Letteri, 1980), Appendix H.

Kolb bases his learning style theory on an experiential learning model. In the Kolb model which has been influential to other researchers, adults' experiences are translated into concepts which then act as guides to understanding new experiences. A four stage cycle evolves as: (1) an immediate concrete experience stage; (2) an observation and reflection stage; (3) a theory for new implications and development stage; (4) a formulation of new experience stage.

Kolb's Learning Style instrument is a tool in which a person rank orders nine terms into four categories. Kolb created four learning style categories as: *Converger,* one with learning abilities of Abstract Conceptualization (AC) and Active Experimentation (AE), as indicated by practical application of ideas; *Diverger*, one with learning abilities opposite to that of converger, Concrete Experimental (CE) and Reflective Observer (RO) indicated by imaginative ability; *Assimilator*, one with learning ability of Abstract Conceptualization (AC) and Reflective Observation (RO) indicated by creation of theoretical models; and *Accommodator*, one with learning ability of Concrete Experience (CE) and Active Experimentation (AE) indicated by doing things and carrying on experiments (Kolb, 1976, 1979).

Several variations of Kolb's model are in use today. Learning theory of Gregorc (1979a) is also based on bi-polar dimensions, i.e., abstract/concrete and and random/sequential which are combinations of dualities of perception and ordering. Gregorc has combined these bi-polarities into four predominant pairs: "Concrete Sequential" learners gain knowledge through hands-on experiences using step by step instruction; "Concrete Random" learners gain knowledge by experimentation with ideas by using trial and error with intuitive strides; "Abstract Sequential" learners gain knowledge from written, verbal and image symbols abstractions in a rational, ordered procedure with

well informed adults; "Abstract Random" learners gain knowledge from other human beings and with intuitive responses in an informal discussion using multi-sensory experiences.

Gregorc believes that these learning styles are inborn. He recommends matching of instructional materials and methods of instruction to meet individual learning style preferences. However, he also states that one has the ability to "flex" or grab onto other learning styles. By exposing students to all learning style preferences students are encouraged to stretch and strengthen features of other learning styles (Gregorc, 1979a, 1979b, 1981).

Bernice McCarthy's (1981) model of learning style draws upon Kolb's Learning Style Theory, i.e.: all people learn through sensing and feeling; observing and thinking; experimenting and acting. McCarthy further states that learners move between abstract conceptualization and concrete experience while learning. Through research, pattern sequences were observed which led to four learning style clusters: "Innovators" being learners who are curious, perceptive and aware; "Analytics" being learners who are critical thinkers, seek facts, and theorize; "Common-sense" persons being hands-on/practical and in tune with current trends; "Dynamic" persons being risk-takers, adaptive, inventive and enthusiastic.

Furthermore, McCarthy developed an overlay of brain hemisphere theory: that of the left-brain association with verbal, intellectual, and fact organizing which are considered field independent activities, and right-brain association with spatial, visual and creativity which are considered field dependent activities.

Putting the two sets of ideas together in each theory has developed a spiral learning process that advocates building a new idea on a creative activity to motivate the learner. This creative approach arouses the sensing/feeling for innovative learners. The next step breaks the activity into small sections to be investigated which appeals to the analytical learner. As the left brain goal is reached, there is a mastery of the concept. One also has

hands-on experiences which are personalized. Finally learners make right-brain choices of many alternatives for application of concepts in the real world. This final learning exercise challenges dynamic learners who are able to implement a whole project (McCarthy, 1981).

In the late nineteen sixties, Hill (1971) investigated learning styles. From his research, he contends that learning style is a unique way that individuals search for meaning. Hill further believes that the learning process is reflected by the conversion of theoretical and qualitative symbols, modalities of inference, and cultural determinants. The theoretical symbols are subdivided into auditory and visual symbols which are further divided into linguistic and qualitative symbols that are effective perceptual modalities. Other elements such as empathy, social aspects, and intuition, the sixth sense, are also combined in this subdivision. Modalities of inference are the formats that individuals prefer in the learning process. These inference modalities include critical thinking, contrasting and comparisons, relationships between measures and hypothesis development. The third element of this learning theory is referred to as cultural determinants. In Hill's theory, cognitive style is seen in terms of individual culture with peers and family as important influences on learning.

Through Hill's instrument for determinants of learning style, "Cognitive Style Mapping", learning style attributes are revealed as a cognitive style profile from an Interest Inventory. This early attempt to develop a comprehensive diagnosis of learning style is commendable for it reviews underlying principles of learning theory (Hill, 1971, 1976).

Thus, these learning style theorists have developed and used these instruments extensively with adults to provide much research data, the results of which reveal important findings. This research validates and/or broadens the scope of their original theories. Having reviewed these factors, this researcher intends to focus on the aspect of learning style known as modality learning style, of visual, auditory and/or kinesthetic senses which are the paths through which people receive knowledge. The following section of this literature review will focus on modality learning style.

Modalities: One Aspect of Learning

Learning styles according to Messick (1976) are the information processing habits which represent a person's typical modes of perceiving, thinking, remembering and problem solving. These are the cognitive elements which are the internal controls of the information processing system that are trainable for effective level of skills and knowledge. General Operation Model, Appendix H, by Letteri (1980) has a primary basis for relating cognitive/ learning style to information processing theory which states that all subject matter is information that passes through the process system to be learned, retained, and recalled. This information is received from the external environment through the perceptual senses.

Furthermore, following the path of a new idea or experience from beginning to end one can see how the entire brain is brought into play from the perceptual beginning to the cognitive processing end that translates environmental stimuli into conceptualization of the thoughts and/or actions. Here is how:

> The sensory cortex (back half of the brain housing the kinesthetic, auditory, and visual receptors) receives sensory stimuli from the various sense organs of the body. These impulses are sent to the front of the brain for action (psychomotor treatments) and/or thought production (cognitive treatments). For sensory information and motor activity to be useful in the future, thought impulses must be sent to the prefrontal lobe where...volitional (purposeful) acts are planned...Bringing the brain into synch from back to front, therefore allows for perceptual, psychomotor, cognitive and volitional potentialities to be actualized. (Elliott, 1987, pp. 133-4)

Perceptual preferences show reliance on one of the sensory modes for learners to understand their experiences. These perceptual modalities are: (1) auditory or verbal, (2) visual or spatial, (3) kinesthetic or psychomotor (Messick et al., 1976). Dependence on the ears, eyes, and/or touch for total understanding is a concept associated with learning and teaching for centuries. " Tell me and I hear; Show me and I observe; but involve me and I understand" is an old Chinese proverb that is illustrative of this point.

Historically, Fernald (1943) in Remedial techniques in basic school subjects, looks at early instruction in ancient Greece and finds that the spoken word was the principal means of transmitting information. When writing appeared, the auditory methods were first used to teach its complement, reading. Thus, the phonetic methods of teaching reading by sounding words is a legacy from the ancient Greeks, Romans, and Sumerians. The scholars of those times were threatened by the written word for they felt it would interfere with recall from rote memory. The auditory-visual methods employed by students were that they say words or letters aloud while looking at the printed copy of the words or letters. Today, Gillingham and Stillman (1988) state that in training students to read and spell, this simple, but effective, phonetic method prevails. Furthermore, kinesthetic methods similar to those in practice today originated in pre-Christian times. The Greeks taught writing by guiding students' hands through movements representative of the shape of letters. As a further extension, the Romans developed a tactile method for forming letters by having students trace the finger in the shape of letters that were carved into wax tablets. The students were encouraged to sound out the letters also. Eventually, carved letters were made three dimensionally and could be manipulated by the pupil, sounded out and arranged into visual word spellings. Thus, through gross and fine psychomotor movements, oral sounding and visualization of letters, words could be processed, learned and recalled (Kramer, 1976).

As learning evolved through the middle ages and Renaissance, additional changes in didactic techniques took place according to Kramer (1976). Even though the kinesthetic methods were available to teach basic skills, there was a decided preference for visual and auditory methods based on memorization. Since the Church was the only organized educational institution during this period, the methods advocated by them were the only accepted methods. The Church believed that rote learning was superior to any methods, even those that called upon kinesthetic or combined modalities. Repetition and reliance on auditory and visual stimuli were the "rule" in mid-eighteenth century classrooms.

Furthermore, Kramer makes further reference to proponents of natural education which included modality based teaching philosophy of Rousseau and Pereira who argued that sense experiences were the basis of all knowledge. These educators were aware of individual characteristics of students and were interested in the process of learning rather than the subject matter that was to be learned (Kramer, 1976).

The use of different perceptual modalities to learn was put into great practice by Pestalozzi in Switzerland. Also Froebel, Condillac, and Sicard furthered understanding of perceptual modality and learning when they worked with deaf children and others who were mentally deficient (Kramer, 1976). Itard was impressed with the results from implementing techniques that emphasized perceptual teaching and learning. Thus, Itard working with deaf-mute children using kinesthetic and visual modality, successfully taught his students (Lane, 1976). These successful techniques were studied further by Eduard Sequin who adapted developmental learning techniques that focused on all the senses for mentally retarded children. The sequence of perceptual learning was first to use kinesthetic modality for motor coordination skills, followed by tactile discrimination. Next, visual training proceeded with eye muscle control, and then focused on distinctive characteristics. Lastly, auditory and speech training was implemented and proceeded after the stronger modalities were thoroughly learned. Whereas Itard had used perceptual learning/training on a one-to-one basis with the deaf, Sequin was able to to adapt his techniques for use in large groups (Kramer, 1976).

A further application of the sensual learning methods was adopted within an educational environment for handicapped children in Italy by Maria Montessori. Her philosophy of promoting learning through perceptual strengths was based on the tradition of Itard of teaching through knowledge of physiology: first educate the senses, then educate the intellect (Kramer, 1976). Montessori further expanded the learning/teaching perceptual theory by methodically observing and recording students at play. Then, the students were provided opportunities to capitalize on these same perceptual strengths to

learn (Montessori, 1912). Furthermore, additional learning experiences were provided that help to develop and strengthen the other modalities. The same observation techniques along with diverse perceptual opportunities for learning are the philosophies in practice in the Montessori pre-schools today.

In 1940 and 1950, modality based instruction was supported by Strauss and Lehtinen (1947) and Kephart (1960). These educators noted that vision was the most important sensory mode in learning, but expanded that notion further by stating that learning came about through exploration and curiosity. They also implied that integration of all perceptual modalities in learning progressed with age. However, Kephart further noted that sensory motor activities were the basis for later academic and survival skills. He also stated that this notion held true for all students not only those persons with learning problems (Kephart, 1960).

In retrospect, perceptual modality based learning has been associated with special education whose goals are to meet the learning disabilities of young children as well as adults (Kirk, 1961; (Dunn & Dunn, 1977a). Kirk popularized perceptual learning in special education by developing his techniques around his contention that the language problems of learning disabled children that interfered with their learning of reading and writing was based upon perceptual deficiencies. Kirk and his colleagues then developed the Illinois Test of Psycholinguistic Abilities, ITPA, to identify perceptual deficits, and devise methods to remedy them. Kirk described intra-individual differences to illustrate variation in perceptual learning strengths in children (Kirk, McCarthy & Kirk, 1961).

Also in the early nineteen seventies, Harry Reinert developed a total perceptual learning style identification based upon immediate perceptual response to an orally presented word list. His interpretation of an individual learning style is, "the way a person is programmed to learn most effectively; i.e., to receive, understand, remember and be able to use new information" (Reinert, 1976, p. 161).

The development of his instrument of individual students' perceptual strengths is the Edmonds Learning Style Identification Exercise, ELSIE. Interestingly, since the native tongue is always learned in its oral form prior to written, Reinert believes that with the spoken language, one has a better chance of getting the fundamental programming of learning of the individual. Thus, the ELSIE is read aloud to the participants. A list of fifty words are read aloud. An initial, immediate response by participants to each word places the reply in one of the following categories: (1) have a mental picture of the word, (2) have a mental image of the spelling of word, (3) receive meaning from the sound of the word, (4) have a fleeting kinesthetic reaction (emotional or physical) to the word. When results are tabulated participants' responses fall into bands or ranges as +/- visual norm, +/- written word, +/- audio norm, +/- feeling norm (Reinert, 1976). The extended, repeated use of this perceptual identification tool proved to be valid. It is this format lists of words, that both LSI (Dunn, Dunn & Price, 1978) and LSP of NASSP, (Keefe, Monk et al., 1986) currently use, but as written format in their comprehensive learning style tests.

As the multisensory approach to learning and teaching was receiving more recognition, the Learning Methods Test (LMT), (Mills (1970), the Swassing-Barbe Modality Index (SBMI), (Barbe & Swassing, 1979), along with Dunn and Dunn (1978) Learning Styles Inventory (LSI), were evolving so that students' perceptual preferences and/or strengths could be known, and thus used to enhance and identify methods of teaching and learning that addressed their modality needs.

Even with this long rich history, it is surprising that modality based instruction has not become an integral part of contemporary education, even though the LSI and LSP are comprehensive learning style identifiers which are easy to administer and can be electronically read and analyzed (Dunn, Dunn, & Price, 1978; Keefe, Monk et al., 1986). The simpler SBMI of Barbe & Swassing (1979) and ELSIE of Reinert (1976) which are perceptually modality focused can be self scored giving immediate results. Thus, these tools can be administered to identify learning styles of both pupils and teachers. Since

many teachers instruct using the modality strengths of their learning styles according to Barbe & Swassing (1979), instructors would profit from having a profile of their own learning strengths and preferences.

Having looked at the development of perceptual learning, we will now turn to implications of the research and discuss application of these findings in the teaching to the modality strengths and preferences of students.

Modality Based Instruction

The fundamentals of modality based instruction are centered upon the perceptual presentation methods that meet students individual modality strengths for understanding new information according to Barbe and Swassing (1979) and Reinert (1976). Using instructional methods that address the modality strengths and/or preferences of students is an important issue. However, this study will not review modality based teaching methods used by the professor in the community college classroom. None-the-less, this researcher includes many ideas on modality based instruction found in the literature. Teachers need to examine their own teaching strategies and make additions and modifications to adapt lessons so that the audio, visual, and kinesthetic learners can benefit from these lessons. These are necessary and important modifications if one is to teach to all perceptual modalities of students. As one observes the teachers in the elementary and secondary classroom, Barbe and Swassing (1979) note that it is apparent that teachers do indeed teach from their own learning strengths. As stated by Montessori (1912) and more recently with Barbe and Swassing (1979) and Dunn and Bruno (1982) concurring, in the early years of child training, much of the teaching is bi-perceptual using physical body movement and activities with auditory-led activities as dancing, story listening and singing. Furthermore, kinesthetic teachers are often found in preschools, kindergartens, and gymnasiums where children are involved in large muscle activities which are an important,

integrated part of the learning for young, growing children (Dunn & Dunn, 1977b). One finds many elementary grade teachers are highly auditory and also many are highly physical. and use appropriate teaching techniques which involve students in many kinesthetic activities that are a combination of large muscle, small muscle and tactile experiences. As students learn to read, Fernald (1943) found that students' visual perception is increasingly called upon, resulting in less auditory teaching (Orton, 1937).

Kinesthetic oriented teachers in regular classrooms in elementary and secondary schools tend to have classes that are informal, with students engaged in activities that keep them moving about, talking with classmates and generally a hub of activity, well above the normal noise level but all under the watchful eye of the teacher as the director. According to Dunn and Bruno (1982), kinesthetic teaching methods are not always in line with commonly accepted practices in elementary schools and are often misunderstood and rejected by teachers with more conventional teaching approaches.

As students progress through the upper grades, more teaching and in turn learning is based upon visual perceptions as Barbe and Swassing (1979) stated. In secondary school, teachers use more conventional techniques of presentation that call upon reading and oral discussion. Thus, they continue to teach to the visual and auditory perceptual modalities of the learners. Through maturation, modalities of children become integrated as they fine-tune and expand their perceptual sensitivity. Additionally, students develop overlapping learning strategies that allow transfer from one modality to another according to Spires (1983). Teachers should be aware of maturation of modality crossover and during that critical period develop teaching styles and techniques that are best suited to the learner needs. This process enhances the relationship of teacher/learner and facilitates greater skills attainment at a greater rate for students.

The effectiveness of matching learning styles and teaching styles is summarized by Dr. Rita Dunn in her report before the American Education Research Association in 1979. An extensive research review has verified that, "there is significance improvement in both

achievement and motivation of students when both teaching and learning styles are matched". (Dunn, 1979a, p. 242)

Keeping these major factors in mind, the teacher must also be cognizant of the perceptual modality strengths of their students. Through these awarenesses, teachers can organize lessons that focus on these modality strengths. Research by DeBello (1989) and Dunn, Beaudry and Klavas (1989) has repeatedly shown that visual and auditory instructional methods and involvement with concrete materials, all of which are consistent with modality strengths of students, have a great probability of success as enjoyable classroom experiences.

Using multisensory modality instruction has been advocated in order to reach all students with their differing and individual learning strengths. Conversely, Barbe and Swassing (1979) and Cafferty (1981) also warned that teachers must realize that some modalities are not effective for instruction in all instances, and that some mixed modality instructions interfere with learning. For example, in teaching art, one can provide visual materials to develop observation skills and certainly have tactile activities that are complementary to learning and participation in creative art activities. But what degree of learning in art is accomplished if the art lesson is presented solely as a lecture and calls only upon the listening skills of the auditory modality?

Often, as information is disseminated and presented using more than one modality, most students can adapt and perhaps even be enriched through multisensory presentations as Cafferty stated (1981). These students may have focused on the lesson through their modality strengths and/or integrated the multiple-modality stimuli into a single message. Other students will simply tune-out the modality that is not their strength or preference. However, Barbe and Swassing (1979) as well as Cafferty (1981) found that some students are unable to cope with the multisensory presentation. Parallel presentations cause confusion and anxiety and thus prevent some students from learning the information at all! Therefore, teachers who are sensitive to certain students' confusions in multisensory

teaching can make adjustments so that these situations can be modified or avoided. For example, a complex lesson can be restructured into small pieces of information, which are then presented in modalities to meet needs of these students (Barbe & Swassing, 1979; Cafferty, 1981).

Teachers' awareness of their own modality strength as well as their students' perceptual strengths and preferences serve as a solid framework on which to build effective instruction. Furthermore, Cafferty (1981) states that awarenesses such as these can influence the curricula adjustments that will benefit students in reaching higher levels of achievement. In modality focused teaching, one type of perceptual modality is neither better nor worse than another. All modalities of learning, visual, auditory, and kinesthetic are evident at all levels of intelligence. One perceptual sense cannot be labeled as most important or superior than another. Most students can master the same content; however, how they master it, is determined by their individual modality style. The key to individual mastery is the complementary teaching modality linked with the student learning modality (Barbe & Swassing, 1979; Cafferty, 1981; Dunn, Beaudry & Klavas, 1989).

The implications of modality based instruction are far reaching. Research conducted in elementary and secondary mathematics has repeatedly shown that teaching techniques that are employed to reach students through their modality strengths have encouraged students to demonstrate continual improvement and advancement (Bruno, 1982; Hodges, 1985; Martini, 1986; Spires, 1983). In the community college setting, this researcher has explored college students learning styles to look for some implications that may be applicable to modality based instruction for mathematics instruction.

For teachers of mathematics, a new role is in the making according to Keefe (1987). The teacher will no longer act as the autocratic source of all mathematics knowledge, nor will the classroom be a "chalk and talk" environment where students are passive receivers of knowledge. As updated methodologies are developed to encourage modality strength teaching that will promote effective learning, Dossey (1989) advocates

that the mathematics teacher will be a facilitator, coach and partner. Mathematics teachers will no longer be givers of facts, but people who facilitate discussion, and who provide activities for discovering principles of mathematics. Thus, the teacher must guide students through mathematics concepts by employing classroom strategies that target visual, auditory, and kinesthetic senses so that students are active participants in their own learning (NCTM, 1989; Steen, 1989a).

In summation, this researcher has assimilated much of the research findings on learning styles, i.e., modality based learning to investigate the application of their use in learning of developmental mathematics by differentially prepared, nontraditional community college students. Much research on modality based learning and teaching has been validated by successful achievements of students in elementary and secondary schools. One looks to these findings on teaching to individual modality preferences to make adaptations in community college instruction to gain similar successful achievement by using modality styles of differentially prepared, nontraditional students as a basis for developmental mathematics instruction. Furthermore, community colleges need to develop their instructional capacities by employing individuals who understand modality based instruction if successful programs are to produce successful students.

CHAPTER III

METHODOLOGY

Introduction

This chapter discusses the overall design of the study which was conducted at an urban community college during the fall semester of 1990. Specifically, the chapter includes: the design of the study, the selection of the community college, the selection of the participants, the instruments for data collection, and the methodology for data collection and analysis. An overview of the developmental mathematics program at the college is also given.

The goals of this study were to identify the modality strengths and modality based strategies of learning used by successful and unsuccessful differentially prepared, nontraditional students in the mathematics classroom and in private study. By modality strength in learning, this researcher means that students have perceptual strengths in the visual, auditory, and/or kinesthetic modality which facilitate understanding. Therefore, this investigation has attempted to look for patterns of modality based strategies used in the classroom and in private study by the differentially prepared students who have been tested and classified as visual, auditory and/or kinesthetic learners. Additionally, environmental conditions, behavioral and social aspects as well as physical factors have been investigated as "elements of learning style".

The Study

Design of the Study

This is a descriptive study designed to explore modality based strategies and other elements of learning style of differentially prepared students of developmental mathematics at an urban community college. This study identified modality strengths using the Swassing-Barbe Modality Index test. Data were collected on modality based strategies and elements of learning style through questionnaires, personal interviews, and classroom observations. This study looked for patterns in modality based strategies of participating students who were unsuccessful as well as successful in an Algebra I course.

Selection of Community College

The community college selected for this study had two important attributes which made it a good choice: (1) a large population of differentially prepared, nontraditional students and (2) a developmental mathematics series of courses: arithmetic, introductory algebra, and algebra II with trigonometry. The community college staff administered a mathematics placement test for all entering students who were then placed in a level of mathematics based upon the results of the test. Developmental mathematics courses were offered as a lecture, or lecture with Computer Assisted Instruction and as a self paced tutorial laboratory with an instructor. In order to obtain permission to conduct this study, a letter was drafted and was sent to the Dean of Academic Affairs at the community college (Appendix A).

Selection of Participants

After a discussion with the mathematics department chairperson concerning my interest in the developmental mathematics program at the community college and my focus of this study of unsuccessful and successful differentially prepared students and modality

based strategies of learning, he agreed to participate. The developmental class he suggested for the study was Introductory Algebra I which he taught in a lecture format. This class was selected because there was a self-paced tutorial laboratory in Introductory Algebra I held concurrently. Students who elected to transfer to the self-paced tutorial laboratory class would be able to continue to participate in the study.

The participants were enrolled in a lecture course in developmental Introductory Algebra I, which was a three module, three credit course. It was an evening division class held on Tuesday from 6 to 9 p.m. There were twenty-five students in the class. The instructor informed the students of the forthcoming research study. On the same evening, this researcher gave a detailed summation to inform the class of the nature of the study (Appendix B), their participation, contribution, and responsibility to the study. Incentives to participate were offered by the professor who gave a five point bonus to students' final average, and by this researcher who offered to give tutorial assistance upon request by students. This researcher discussed the consent form (Appendix B) with the students. After this class discussion, students interested in participating signed the consent form. Twenty students of the twenty-five enrolled in the developmental Algebra I class elected to participate and signed the consent form. The participating students are shown in Table 1.

All students who consented also completed a questionnaire of personal background information (Appendix D). Students were later grouped as successful or unsuccessful based upon results of two quizzes given the first few weeks of classes. The students in the successful group had a quiz average of seventy percent or better. The unsuccessful group had less than a seventy percent quiz average. Furthermore, to identify modality strengths of students in both successful and unsuccessful group, the Swassing-Barbe Modality Index test was administered (Appendix C). These sets of information provided data to make groupings of successful students and unsuccessful students who were also identified by modality: strength: visual, auditory and/or kinesthetic.

Table 1 Summary of Subjects' Consent Form

SUBJECT	CONSENT	NOT CONSENT
S 1	•	
S 2	•	
S 3	•	
S 4	•	
S 5	•	
S 6	•	
S 7	•	
S 8	•	
S 9	•	
S 10	•	
S 11		•
S 12	•	
S 13	•	
S 14	•	
S 15		•
S 16	•	
S 17	•	
S 18		•
S 19		•
S 20	•	
S 21	•	
S 22	•	
S 23	•	
S 24		•
S 25	•	
TOTAL	20	5

Description of Population

Even though twenty-five students were enrolled in the developmental Algebra I course used in this study, only twenty signed consent forms and became actual participants in the study. All students who consented also completed a questionnaire of personal background information (Appendix D). A summary the demography of this participating population is displayed in Table 2. As determined from this table, sixty percent of the students were male; forty percent were female. Seventy percent of the class were twenty-five years of age or older. All twenty students had full time responsibilities either at home as a homemaker rearing children or at a work place in an occupation. Most of these students receive a high school diploma many years prior to enrollment in community college. One student was educated out of the country and chose to take refresher courses leading to a GED as proof of high school completion. Only five students had taken any college courses after completing high school. The courses were Continuing Education classes through evening school, community college or as part of military training. Even though three students were bilingual, specifically Polish, Greek and Creole French, their ability to speak and read English well was revealed in the first interview and during the administration of the Swassing-Barbe Modality Index, both of which were done on a one to one basis with this researcher. Therefore, no special arrangements were necessary to accommodate these students. One additional factor indicated that eighteen of the twenty, 90%, were enrolled by choice in mathematics/science majors that required high level mathematics competency. An analysis of this information revealed the diverse background of these students who can accurately be described as differentially prepared, nontraditional community college students.

The next phase of the study was the students' participation in the Swassing-Barbe Modality Index. Students' participation was important as identification of modality strength of each student was essential baseline data necessary for the analysis and comparison of all other data collected throughout the study.

Table 2 Summary of Participants' Demographics

CHARACTERISTICS	NUMBER OF SUBJECTS
GENDER	
FEMALE	8
MALE	12
AGE	
20-24	8
25-30	5
30-35	1
ABOVE 35	6
FULL TIME WORK	
IN INDUSTRY & BUSINESS	17
IN THE HOME	3
EDUCATION	
HIGH SCHOOL DIPLOMA	19
G.E.D.	1
H.S. EDUCATION IN UNITED STATES	19
H.S. EDUCATION IN FOREIGN COUNTRY	1
ENROLLMENT IN COLLEGE COURSES	5
NO ENROLLMENT IN COLLEGE COURSES	15
LANGUAGE ABILITY	
ENGLISH ONLY	17
BILINGUAL (GREEK, POLISH, CREOLE FRENCH)	3
ANTICIPATED COLLEGE MAJOR	
TECHNOLOGY	11
ALLIED HEALTH	4
ACCOUNTING	2
GRAPHIC DESIGN	1
UNDECIDED	2

The students signed up to take the SBMI before class between 5 p.m. and 6 p.m. for four consecutive weeks. Alternative appointments were made for a few students who were unable to come before class. Participating students are listed in Table 3.

Table 3 Summary of Subjects' Participation in SBMI

SUBJECT	PARTICIPATE	NOT PARTICIPATE
S 1		•
S 2	•	
S 3	•	
S 4	•	
S 5		•
S 6	•	
S 7	•	
S 8	•	
S 9	•	
S 10	•	
S 12	•	
S 13	•	
S 14	•	
S 16		•
S 17	•	
S 20	•	
S 21	•	
S 22	•	
S 23	•	
S 25	•	
TOTAL	17	3

By the fifth week of the semester, the SBMI tests were completed. During this same period of time the subjects had also take quizzes. Table 4 displays the QPA which

Table 4 Status of QPA and SBMI for Consenting Subjects

SUBJECT	QPA		SBMI	
	SUCCESSFUL	UNSUCCESSFUL	PARTICIPATED	NOT PARTICIPATED
S 1		•		•
S 2	•		•	
S 3	•		•	
S 4	•		•	
S 5		•		•
S 6	•		•	
S 7	•		•	
S 8		•	•	
S 9	•		•	
S 10	•		•	
S 12	•		•	
S 13	•		•	
S 14	•		•	
S 16		•		•
S 17	•		•	
S 20	•		•	
S 21	•		•	
S 22	•		•	
S 23		•	•	
S 25	•		•	
SUB TOTAL	15	5	17	3
TOTAL	20		20	

S ≡ SUCCESSFUL QPA > 70 US ≡ UNSUCCESSFUL QPA < 70

was based upon the monitored average of quizzes and exams. The status of the students was determined as follows: successful, QPA score ≥ 70; or unsuccessful QPA score< 70. Academic performance of the twenty participants after the fifth week has been listed in Table 4. A study of this list indicates that S1, S5, S8, S16, and S23 were unsuccessful. It should also be noted, that three students, S1, S5, and S16 no longer attended class and did not take the Swassing-Barbe Modality Index test. As a result, only seventeen students remained as participants throughout the research study.

Selection of Instruments

Commercial Test. The Swassing-Barbe Modality Index, SBMI, was used to identify modality strengths of differentially prepared community college students. This instrument was chosen for the following reasons:

1. Administration time was approximately 20 minutes per student.
2. Only brief training was needed for proper administration.
3. Modality strengths were identified.
4. Test produced a profile of relative modality strengths for student.
5. The instrument was standardized and does not vary from student to student.
6. Consistent stimuli were used for each modality subtest.
7. The same response was required for each modality subtest.
8. The instrument had applications in the classroom and in research setting (Barbe & Swassing, 1979).

> The Standardization of the SBMI was sufficiently valid and reliable to merit use by educational professionals. Face validity, construct validity did fall within acceptable range +/- 0.05. In terms of reliability, the instrument has shown to be stable over time and does possess the characteristics of a satisfactory Guttman scale. (Barbe & Swassing, 1979, p. 54).

The SBMI instrument used in this study was obtained from the Zaner-Bloser Inc. of Columbus, Ohio (1979). Permission was given in October, 1990, by Walter Swassing

of Ohio State University (Appendix A). This instrument examined modality strengths of the participants by "matching-to-sample task. In this type of task, the sample is presented and the respondent is asked to duplicate the sample". (Barbe & Swassing, 1979, p. 35).

The SBMI test consisted of (1) sixteen, white plastic pieces in the shape of a circle, square, triangle, and heart, approximately the same size, and (2) nine, black plastic flat bars on which were fused the white shapes. The shapes are arranged on these nine bars in varied sequences, increasing in length with the first bar of only one individual shape, to bars with an increasing number two, three etc. to the most complex sequence of nine shapes. The objective of the test was for the subject to duplicate with the loose shapes of test pieces, the ordered sequence of shapes on black bars after seeing, hearing, or touching the shapes on the bars (Appendix C).

Testing was done in three subsets, each addressed one of the three modalities; visual, auditory, or kinesthetic. The same set of flat bar sequences was used to assess each modality. The test was done while seated at a large table that accommodated the examiner, this researcher, the subject, and all test pieces.

The Visual Test was first. The examiner and subject were seated at a long table. On the table was placed a pile of sixteen loose, white plastic pieces of the various shapes. A sample demonstration was conducted by the examiner as follows: the first of two black bars with fixed shapes was placed on the table for the participant to see for a short time period, following the timing guidelines in the directions. The bar was removed from sight. Then the participant assembled the white shapes from the pile in the sequence just seen. The second trial bar was also shown and then the subject reconstructed the pattern just seen. This trial demonstration allowed participants to familiarized themselves with the expected routine of the test.

The remainder of the visual test routine continued with observation of longer sequences and assembly of the increased number of shapes in the sequence. The count of

the correct number in the sequence assembled by the participant was recorded for each bar shown in the visual subset. The test was stopped when participants made errors in two consecutive sequences.

The Auditory Test was second. The same set of bars was used in this modality subtest. Again, the sample demonstration was conducted using the auditory presentation. The flat bars with fixed shapes were only used by the examiner to orally recite the shapes in sequence. The bars were kept from view of student participants. In this subset, the researcher spoke aloud the shape of the arranged pieces in sequence on the bars from left to right at a rate of one per second. Once the sequence was stated aloud completely, the participant assembled the sequence of shapes just heard from the loose shapes on the table. This routine of examiner vocalizing the longer sequences of shapes and subject assembling increased number of shapes in the set continued with a record of correct number positioned in each sequence. The test stopped if errors were made in two consecutive sets.

The Kinesthetic Test was last. A rectangular piece of polyfoam was used to shield sequence on the bars from sight during the touching/feeling portion of this subtest. This shield was slightly elevated above the table top to allow the participant's hands to touch the bar behind the shield. To assist the participant at the start, the dominant hand was placed on the first shape on the left edge of the bar. The subject was able to use both hands to touch the sequence set. No talking was allowed during this test. The bar was presented behind the shield. The timing guidelines as outlined in the administration folder were followed while the participant touched shapes on the bar. The bar sequence and shield were removed from the table top. Then, the participant assembled from the loose shapes, the sequence of shapes as just touched. This routine of touching the sequence and reconstructing the sequence with each increased number of shapes in the set continued. The score of correct number in each reconstruction was recorded. The test was stopped when participants made errors in two consecutive sets. The number of items correctly

reproduced for each test was recorded on the record sheet as each sequence in the subset was performed.

The results of the Swassing-Barbe Modality Index are based upon the comparison of individual student's modality subset score to his/her own total score of the three subsets. The scores for each modality are therefore considered independent for the individual. This procedure of tabulation of scores allows a student's relative modality strengths, auditory, visual and/or kinesthetic, to be compared to each other, but does not involve or permit student's performance to be compared to that of another student.

To score each subset, the count of each series was totaled. Then, the sums of all responses for the three subsets were totaled. To established the score as a percent, each subset total was divided by the sum of the three subsets of the subject's responses and multiplied by 100. The highest percentage indicated the strongest modality. If two scores were within five points or less, results indicated mixed modality. A more detailed description of scoring the Swassing-Barbe Modality Index is explained as follows:

> The student's score for each subset is the number of shapes that are correctly placed in sequence. When the administration of the test is complete, all correct responses are marked on the record sheet. (Appendix C). Tabulate the number of correct responses in each modality; this is the raw score for that modality. The three modality raw scores, when added together, equal the total raw score. To identify the relative strength of each modality, it is necessary to compute the percentage of the total score each modality represents. This can be done by dividing the raw score for each modality by the total raw score. The interpretation of modality percentage is based upon observation that a difference of about five points corresponds to an educationally relevant difference. What this means is that if the percentage score in one modality is at least five points greater than that of another modality, the first modality is the stronger of the two. If one modality is five percentage points greater than each of the remaining modalities, it is the dominant modality. If two high scores are within five points of each other, the subject is classified as mixed modality. (Barbe & Swassing, 1979, pp. 39-40)

Questionnaires. Students participants were asked to fill out individual questionnaires throughout the study. The first questionnaire was a personal

background inquiry about each student participant. This confidential information gave insight into specific factors of their former schooling and personal life that might prove helpful in analysis.

Four additional questionnaires were given to obtain responses from student participants about learning strategies that they used in the classroom and in private study. Also, some statements addressed perceptual preferences, environmental conditions, behavioral and social aspects, and physical conditions as elements of learning style. Some statements in the questionnaires inquired about classroom instruction and student/teacher interaction.

The QUESTIONNAIRES had a list of fourteen statements each one of which addressed elements of learning style, Table 5. The statements were categorized as follows: (1) modality preferences as auditory, 3, visual, 5, kinesthetic, 7; (2) environmental conditions as light, 1, sound, 2, temperature, 4, room design, 11; (3) behavioral aspects as responsibility, 12, self motivation, 14; (4) social aspects as study by oneself, with peers, 9, study with adults, 13; (5) physical conditions as food, 6, time of day, 8, mobility, 10. Responses to these statements indicated preferences that ranged from **never**, **once in a while**, **sometimes**, **many times**, or **every time** (Appendix D).

A series of four QUESTIONNAIRES were administered one each week after each quiz, beginning with the third quiz. The results of each of fourteen statements of four QUESTIONNAIRES have been reported as follows: H for a high score $\geq$ 60%; L for a low score $\leq$ 40%; Mid for a score 40% < Mid < 60%. The response choices to the statements were each given a value as follows: **never**, 1; **once in a while**, 2; **sometimes**, 3; **many times**, 4; or **every time**, 5. The total score was determined by the sum of the four raw scores to the same numbered statement on the four QUESTIONNAIRES. The highest raw score for one set of four of the same numbered statements was 20. The percent score was determined by dividing the total raw score sum

by 20 and then multiplying by 100. These scores were then recorded in students' profile charts of QUESTIONNAIRE results, Appendix I, and categorized as H for a high score ≥ 60%; L for a low score ≤ 40%; Mid for a middle score 40% < Mid < 60%. A single item response to a specific statement was scored directly as a percent as follows: **never**, 20%, **once in a while**, 40%, **sometimes**, 60%, **many times**, 80%, or **every time**, 100%.

In addition, an interpretation of the scores for a few of the statements needs to be explained. A high score for light, sound, and temperature signified that bright light, some noise tolerance and a warm temperature were preferred where as a low score for these same elements indicated dim light, quiet environment and cool temperature were preferred.

Table 5 Questionnaire Statements Grouped into Five Main Learning Style Categories

LEARNING STYLE CATEGORIES	QUESTIONNAIRE STATEMENTS	ELEMENTS
MODALITY	3	AUDITORY
	5	VISUAL
	7	KINESTHETIC
ENVIRONMENTAL	1	LIGHT
	2	SOUND
	4	TEMPERATURE
	11	ROOM DESIGN
STUDENT BEHAVIOR	12	RESPONSIBILITY
	14	SELF MOTIVATION
SOCIAL BEHAVIOR	9	STUDY BY SELF / PEER
	13	STUDY WITH ADULT
PHYSICAL ELEMENTS	6	FOOD
	8	TIME OF DAY
	10	MOBILITY

A high score for room design reported a preference for a formal, conventional classroom with desks and chairs in rows and a low score indicated a preference for informal setting with casual, nonconformity in furniture, placement, and room design.

Interviews

During the study, personal interviews were held with each of the participants. At these times, a set of open ended questions was used to inquire further into modality strategies used in the class room and in private study. Additionally, some questions addressed experiences in the classroom, with the professor, with the tests, as well as other elements that had taken place while students were learning mathematics. The purpose of the interviews was to elicit from students personal insights into the learning of mathematics. During these confidential interviews, students were able to express more personal feelings. Also, other issues of learning mathematics that were not addressed in the questionnaires were discussed in the Interviews Questions (Appendix E).

Classroom Observation

Classroom observations gave this researcher opportunities to see students in various classroom interactions. The students were observed, specifically, to determine whether or not the strategies they used were compatible with their modality strengths determined by SBMI. Environmental conditions of the classroom were noted. Students' behavioral and social activities while learning were also observed in an attempt to corroborate results of the questionnaires. In addition to classroom observations, students were observed during interviews. Observational data were recorded to identify modality strategies that the researcher observed students used during class. These data were recorded as descriptive journal entries and reported in students' profiles.

Confidentiality

Each participant in this survey was assigned a code number, Table 1. All data compiled during the study were reported using this coding system. Additionally, each student's profile was reported by code number in the study. Personal profiles were supplied for all students requesting them.

Method of Data Analysis

Each SBMI test was scored to identify modality strengths (visual, auditory, kinesthetic or mixed modality) of students. Modality strength was indicated by the highest percent based upon correct responses of subset compared to total of three subset correct responses. Thus, the result for each subject was an independent score as it was computed based only upon the individual's responses.

The questionnaires responses were reviewed. Modality based strategies as well as environmental, behavioral, social and physical preferences on each questionnaire were noted on the fourteen items. This produced data on modality based strategies used in the classroom and in private study. Data was also collected on preferences in environmental conditions, behavioral and social aspects, and physical factors of learning style. These modality based strategies and preferences were then compared to results of the SBMI. A profile of each student was compiled in a table that identified the following: (1) modality strength; (2) modality based strategies; (3) environmental preferences; (4) behavioral, preferences; (5) social preferences; (6) physical preferences of learning. Also a descriptive summary of modality based strategies used in class and in private study was included. This researcher, an editor and two other graduate students scored the SBMI and questionnaires to check scoring and corroborate data results. All student profiles (Appendix I) and tables of data displayed in chapter IV have also been reviewed for accuracy by these persons.

Throughout the study, the achievement of students was monitored to determine the successful (seventy percent or better) and the unsuccessful (below seventy percent) students. The academic performance after each unit test was noted to determine whether or not students' status as the successful or unsuccessful learning had changed. The on-going review of questionnaires and personal interviews attempted to identify changes in learning strategies and preferences used by individuals as the content in algebra course became more difficult or as students' grade-point average changed.

From the interview questions, this researcher was able to infer something about students' insights into the learning of mathematics. Supplementary information became part of the descriptive summary in the student profile. The personal interviews did yield additional information that had not been included in the issues covered in the questionnaires.

Finally, an examination of students' profiles of modality strengths and modality based strategies used by all successful students was undertaken to discern patterns of modality based strategies in each modality i.e., visual, auditory and/or kinesthetic. In a detailed summary report, patterns of the successful students were explained for each modality. The profiles of the unsuccessful students were examined to determine if patterns of modality based strategies used by students existed in each modality group. The patterns in modality based strategies of unsuccessful students were summarized in a detailed report. Comparative summations of patterns of modality based strategies were made in each modality group between (1) successful and unsuccessful visual learners, (2) successful and unsuccessful auditory learners, (3) successful and unsuccessful kinesthetic learners, and (4) successful and unsuccessful mixed modality learners.

The results of this study have attempted to answer the following questions previously proposed as:

Research Question:

Can success in mathematics (defined as a grade of $\geq$ 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students utilize their modality strengths as they study their mathematics?

Corollary:

Can non-success in mathematics (defined as non passing grade a grade of < 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students do not utilize their modality strengths as they study their mathematics?

Subsidiary Questions:

Since both the research question and its corollary were so broad in scope, the following subsidiary questions were posed:

1. According to the Swassing-Barbe Modality Index (SBMI), what are the visual, auditory and or kinesthetic modality strengths of students in this study?

2. According to self-reports, what modality based strategies do students in this study use in class and are these self-reports positively correlated with SBMI data?

3. According to self-reports, what modality based strategies do students in this study use in private study and are these self-reports positively correlated with SBMI data?

4. According to self-reports of students classified in different modality groups what are their preferences in the following learning style categories:

a. environmental conditions i.e., light, sound, temperature, and room design;
b. student behaviors i.e., responsibility and motivation;
c. social behavioral aspects i.e., studying by oneself, with peers, with competent adults;
d. physical elements i.e., requires food, functions best in the morning or evening, needs to be mobile? (Students were grouped by SBMI data).

5. Do academic achievement, modality strengths and self-reported modality based strategy preferences positively correlate for unsuccessful and successful students in the study ?

6. Do patterns exist in modality based strategies used by unsuccessful and successful students in the study ?

Summary

In summation, each instrument gathered pertinent information of all participants through out the semester while they were learning Introductory Algebra I. While the Swassing-Barbe Modality Index identified the modality strength, QUESTIONNAIRES #1, #2, #3, #4 indicated preferences using modality based strategies in learning in class and in private study and shed light upon many learning style elements that fall into the environmental factors, behavioral and social aspects and physical conditions associated with learning. The personal interviews gave students freedom to express personal opinions and feelings as well as to ask questions about the learning mathematics. Classroom observations gave this researcher opportunities to watch the students and to make notations about their behaviors that might be associated with modality preferences, and other elements of learning style. In cooperation with the instructor, scores on each quiz and hour examinations were made available to this researcher. Using multiple instruments, observations and interviews methods to gather data about the participants, gave this researcher access to much information on modality strengths and preferences of subjects to provide a rich context in which to view modality patterns of successful and unsuccessful students. These results were organized and examined as a profile of each participant. Additionally, tables which were compiled according to modality were reviewed to find patterns of similarities and differences in learning strategies within modalities used by unsuccessful and successful students.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

To determine whether success in mathematics can be attributed to utilization of one's personal modality strengths during mathematics study, this researcher sought to determine the modality preferences of nontraditional, differentially prepared community college students; to examine the various aspects of their learning styles; and to discern patterns that might be considered predictors of mathematical success. In this chapter, the findings of these queries will be presented along with an analysis of these findings.

Specifically in this chapter the following research question, its corollary, and its six subsidiary questions will be answered.

Research Question:

Can success in mathematics (defined as a grade of ≥ 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students utilize their modality strengths as they study their mathematics?

Corollary:

Can non-success in mathematics (defined as a grade of < 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students do not utilize their modality strengths as they study their mathematics?

Subsidiary Questions:

1. According to the Swassing-Barbe Modality Index (SBMI), what are the visual, auditory, and or kinesthetic modality strengths of students in this study?

2. According to self-reports, what modality based strategies do students in this study use in class and do these self-reports positively correlated with SBMI data?

3. According to self-reports, what modality based strategies do students in this study use in private study and are these self-reports positively correlated with SBMI data?

4. According to self-reports of students classified in different modality groups what are their preferences in the following learning style categories:

a. environmental conditions i.e., light, sound, temperature, and room design;

b. student behaviors i.e., responsibility and motivation;

c. social behavioral aspects i.e., studying by oneself, with peers, with competent adults;

d. physical elements i.e., requires food, functions best in the morning or evening, needs to be mobile? (Students were grouped by SBMI data).

5. Do academic achievement, modality strengths and self-reported modality based strategy preferences positively correlate for unsuccessful and successful students in this study ?

6. Do patterns exist in modality based strategies used by unsuccessful and successful students in this study ?

Since the answers to the research question and its corollary are based upon subsidiary question findings, the analysis of the data will begin with the subsidiary questions and conclude with the overarching research question and its corollary.

Findings

Subsidiary Question One

According to the Swassing - Barbe Modality Index (SBMI), what are the visual, auditory and or kinesthetic modality strengths of students in this study?

Analysis. The modality strength of each student was determined by the highest percent scores of the three subsets: visual, auditory, kinesthetic modality. The subjects that received scores within five percentage points on any of the subsets were classified as mixed modality. Results of subjects' modality strength by SBMI are displayed in Table 6.

Table 6 Summary of Subjects' SBMI Modality Scores

SUBJECT	SBMI MODALITY STRENGTH	VISUAL %	AUDITORY %	KINESTHETIC %
S 2	M (V/A)	37	35	28
S 3	K	29	31	40
S 4	K	30	32	38
S 6	A	31	44	25
S 7	V	40	27	33
S 8	A	30	40	30
S 9	A	24	41	35
S 10	M (V/A)	35	38	27
S 12	V	42	28	30
S 13	M (V/A/K)	36	31	33
S 14	K	31	28	41
S 17	K	30	30	40
S 20	A	25	48	27
S 21	M (V/A)	37	38	25
S 22	M (V/A)	35	36	29
S 23	M (V/A)	37	38	25
S 25	V	50	17	33

SBMI KEY: V ≡ VISUAL A ≡ AUDITORY K ≡ KINESTHETIC M ≡ MIXED

Interpretation. The subjects were grouped by modality as follows: visual modality, S7, S12, S2; auditory modality, S6, S8, S9, S20; kinesthetic modality S3, S4, S14, S17; mixed modality, S2, S10, S13, S21, S22, S23. The distribution of students grouped by modality strength was as follows: visual modality strength was 3 out of 17, or 18%; auditory modality was 4 out of 17, or 23%; kinesthetic modality was 4 out of 17, or 23%; and mixed modality was 6 out of 17, or 36%. This is shown in Table 7.

Table 7 Subjects Grouped by SBMI Modality Strength

	SBMI MODALITY STRENGTH			
	VISUAL	AUDITORY	KINESTHETIC	MIXED
SUBJECTS	S 7 S 12 S 25	S 6 S 8 S 9 S 20	S 3 S 4 S 14 S 17	S 2 S 10 S 13 S 21 S 22 S 23
TOTAL 17	3	4	4	6

Subsidiary Question Two

According to self-reports, what modality based strategies do students in this study use in class and are these self-reports positively correlated with SBMI data?

Analysis. In the QUESTIONNAIRES used in this study (Appendix D), statement 3 on each questionnaire centered on auditory modality based strategies; statement 5 on each questionnaire addressed visual modality based strategies; statement 7 on each questionnaire focused on kinesthetic modality based strategies used to study mathematics. From the QUESTIONNAIRES, data results that have been collected on modality strategies used by the subjects in the classroom are displayed in Table 8. The data have been reported as follows: H for a high score $\geq 60\%$; L for a low score $\leq 40\%$; Mid for a score $40\% <$ Mid $< 60\%$. Table 8 also has displayed the correlation between the use of modality based strategies and the SBMI data.

The data collected from the QUESTIONNAIRES on classroom use of modality based strategies will be discussed first, followed by correlational findings. Specifically, statement 3 on QUESTIONNAIRES #2, and #3 centered on the use of auditory based strategies used in the classroom. Table 8 shows that all seventeen students scored High on

the use of auditory based strategies in the classroom when statement 3 on QUESTIONNAIRES #2 and #3 were considered. In Table 9 are reported the percentages that the students scored in specific modality strategies used by students of this study in the classroom. As seen in Table 9, the reported data of statement 3 on QUESTIONNAIRE #2, show that 16 out of 17, or 94%, of the students scored High which indicated that the students liked the teacher to explain the problems aloud as he wrote them out on the board. Further review of the break down of these results shows the degree of preference that students stated that they liked oral explanation as the teacher wrote them out on the board as follows: eleven students scored 100% or **every time** preference; two students scored 80% or **many times** preference; three students scored 60% or **sometimes** preference. The one student who scored a Low of 40% indicated a **once in a while** preference for the teacher to explain aloud as the teacher wrote out the problem.

The results of the statement 3, on QUESTIONNAIRE #3 that centered on auditory modality based strategies used in the classroom by the students indicated that as a class, all seventeen students scored $\geq$ 80, High, which indicates that students listened attentively to the instructor's explanation of algebraic ideas and procedures during lectures, Table 9. Further review of the break down of results shows the degree of preference that students stated that they listened attentively to the instructor's explanation of algebra as follows: eleven students scored 100% or **every time** preference; six students scored 80% or **many times** preference.

Classroom observations of students corroborated these findings. In the classroom this researcher observed that students often asked the professor to repeat explanations, thus allowing students to grasp the concept more completely. A few times, the professor gave students the opportunity to explain to the class their method of solution to a problem . The explanations gave students the chance to share different solutions to the same problem.

Table 8 Modality Based Strategies Used in the Classroom

(Based on Data from QUESTIONNAIRES)

SUBJECT	SBMI	AUDITORY BASED STRATEGIES	VISUAL BASED STRATEGIES	KINESTHETIC BASED STRATEGIES	CORRELATE WITH SBMI
S 7	V	H	H	H	YES
S 12	V	H	H	H	YES
S 25	V	H	H	H	YES
S 6	A	H	H	H	YES
S 8	A	H	Mid	L	YES
S 9	A	H	H	Mid	YES
S 20	A	H	H	H	YES
S 3	K	H	H	Mid	MODERATE
S 4	K	H	H	L	NO
S 14	K	H	H	L	NO
S 17	K	H	H	Mid	MODERATE
S 2	M (VA)	H	H	H	YES
S 10	M (VA)	H	H	Mid	YES
S 13	M (VAK)	H	H	Mid	YES
S 21	M (VA)	H	H	H	YES
S 22	M (VA)	H	H	H	YES
S 23	M (VA)	H	H	Mid	YES

SBMI KEY:
V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

STRATEGY SCORE KEY:
L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

CORRELATION KEY:
YES ≡ **H** ≡ **High** Modality Strategies correlated with **SBMI**
MODERATE ≡ **Mid** ≡ **Middle** Modality Strategies correlated with **SBMI**
NO ≡ Λ ≡ **Low** Modality Strategies NOT correlated with **SBMI**

Also, this researcher observedthat first some students listen to the professor completely explain solutions to problems and then proceed to copy blackboard notes.

Statement 5, of the four QUESTIONNAIRES, addressed visual modality based strategies. Specifically, statement 5 on QUESTIONNAIRES #2, and #3 addressed the use of visual based strategies used in the classroom. Table 8 shows that 16 out of 17, or 94%, of the students scored High on the use of visual based strategies in the classroom when statement 5 on QUESTIONNAIRES #2 and #3 were considered. On Table 9 is reported a further break down of the results of statement 5. On QUESTIONNAIRE #2 , the reported data on statement 5 show that 16 students scored $\geq$ 60%, High, which indicates that students understood problems better if the instructor used diagrams and charts to illustrate a problem. Further break down of these results shows the degree of preference that students stated that they understood problems better if the instructor used diagrams and charts to illustrate a problem was as follows: three students scored 100% or **every time** preference; eight students scored 80% or **many times** preference; five students scored 60% or **sometimes** preference. One student scored 40% which suggests a **once in a while** preference.

Results of statement 5 on QUESTIONNAIRE #3 showed that 16 students scored $\geq$ 60%, which expressed a high preference toward watching step by step written examples done out on the blackboard by the professor. Further review of results of these students shows the degree of preference that students stated that they watched step-by-step written examples done out on the blackboard by the professor was as follows: 11 students scored 100% or **every time** preference; four students scored 80% or **many times** preference; one student scored 60% or **sometimes** preference and one student scored a low of 40% which indicated a **once in a while** preference.

Interviews and classroom observations of the students corroborated these finding. In anecdotal comments students stated that they understood integer concepts and operations

Table 9 Specific Modality Based Strategies Used in Classroom

(Based on Data from QUESTIONNAIRES)

SUBJECT	SBMI	AUDITORY 3		VISUAL 5		KINESTHETIC 7	
		QUEST #2	QUEST #3	QUEST #2	QUEST #3	QUEST #2	QUEST #3
		%	%	%	%	%	%
S 7	V	100	100	100	100	60	80
S 12	V	100	80	40	80	80	60
S 25	V	100	80	80	80	100	60
S 6	A	100	100	100	100	80	60
S 8	A	40	80	60	40	20	40
S 9	A	60	100	60	100	60	40
S 20	A	100	100	80	100	100	80
S 3	K	80	100	80	80	40	60
S 4	K	60	80	80	100	40	20
S 14	K	100	80	80	60	40	40
S 17	K	100	100	80	100	60	40
S 2	M (VA)	80	100	60	80	100	60
S 10	M (VA)	100	100	80	100	60	40
S 13	M (VAK)	100	100	80	100	60	40
S 21	M (VA)	100	100	100	100	80	80
S 22	M (VA)	100	100	60	100	100	20
S 23	M (VA)	60	80	60	100	40	60

KEY: **V** ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

20%, NEVER; **40%,** ONCE IN A WHILE; **60%,** SOMETIMES; **80%,** MANY TIMES; **100%** ,EVERY TIME

AUDITORY 3
QUEST #2 I LIKE TEACHER TO EXPLAIN A PROBLEM ALOUD AS HE WRITES IT OUT ON BOARD.
QUEST #3 IN CLASS, I LISTEN TO INSTRUCTOR AS HE EXPLAINS MATH IDEA OR PROCEDURE.

VISUAL 5
QUEST #2 I UNDERSTAND PROBLEM S BETTER IF INSTRUCTOR USES DIAGRAMS & CHARTS.
QUEST #3 I WATCH STEP -BY -STEP SOLUTIONS TO PROBLEMS WHEN WRITTEN ON BOARD.

KINESTHETIC 7
QUEST #2 I LEARN BETTER IF I PICK UP A MODEL, HANDLE I T AND WORK WITH I T.
QUEST #3 IN CLASS, I FIND THAT I RECREATE DEMONSTRATIONS AS DRAWINGS.

more completely by line drawings of the positive and negative integer number line. Additionally, this researcher observed that students copied into their notes the diagrams used by the professor to illustrate word problems.

Statement 7, of the four QUESTIONNAIRES, focused on kinesthetic based strategies. Specifically, statement 7 on QUESTIONNAIRES #2, and #3 focused on the use of kinesthetic based strategies used in the classroom. Table 8 shows that 8 out of 17, or 47%, of the students scored High; 6 out of 17, or 35%, of the students scored Mid; 3 out of 17, or 18%, of the students scored Low on the use of kinesthetic based strategies in the classroom when statement 7 on QUESTIONNAIRES #2 and #3 were considered. In Table 9 is reported a further break down of the results of statement 7. The reported data on statement 7 from QUESTIONNAIRE #2, show that 12 students scored $\geq$ 60, High, which indicated that students learned from picking up a model, handling it and working with it. Further review of these results showed the degree of preference that students stated that they learned from picking up a model, handling and working with it was as follows: four students scored 100% or **every time** preference; three students scored 80% or **many times** preference; five students scored 60% or **sometimes** preference. Five students scored a low of $\leq$ 40% as follows: four students scored 40% or **once in a while** preference; one student scored 20% which indicated a **never** preference.

The reported data on statement 7 from QUESTIONNAIRE #3, show that nine students scored $\geq$ 60, High, which indicated that students stated that they recreated demonstrations as diagrams in class notes. Further review of results of these nine students shows the degree of preference that students stated that they recreated demonstrations as diagrams in class notes was as follows: three students scored 80% or **many times** preference; six students scored 60% or **sometimes** preference. Eight students scored a low of $\leq$ 40% as follows: six students scored 40% or **once in a while** preference; two students scored 20% or a **never** preference.

Corroboration of these results was revealed in interviews and from class observations. The students stated that they never remembered that manipulative materials were ever used in high school mathematics classroom instruction. Furthermore, this researcher noted that the professor never utilized demonstration models or manipulative devices to explain word problems or algebraic procedures in the college classroom.

Results of statements that addressed visual and auditory strategies used in the classroom indicated that the students as a class showed high preferences for visual aids (16 out of 17) and auditory explanations (17 out of 17) as seen in Table 8 and Table 9 However, results of statement 7 that focused on the use of kinesthetic strategies in the classroom showed that only eight students out of 17 showed a high preference for hands-on, concrete activities associated with learning mathematics.

Interpretation. The data collected from the QUESTIONNAIRES on classroom use of modality based strategies were compared finally to the modality strength of students. In Table 8, SBMI modality strengths of the individual students are correlated with classroom use of modality based strategies. The following correlations were found: 13 out of 17, or 76%, of the students showed a high correlation between the use of modality based strategies in classroom and SBMI modality strength; 2 out of 17, or 12%, of the students had a moderate correlation between the use of modality based strategies in classroom and their modality strength; and 2 out of 17, or 12%, of the students had no correlation between the use of modality based strategies in classroom and their modality strength.

Correlations within the modalities showed that 100% of the visual students, 100% of the auditory students, and 100% of the mixed modality students had a high correlation between the SBMI strength and use of modality based strategies in the classroom. Review of the four kinesthetic students' scores showed that 50% had a moderate correlation and 50% showed no correlation between kinesthetic modality strength and use of kinesthetic based strategies in the classroom.

Subsidiary Question Three

According to self-reports, what modality based strategies do students in this study use in private study and are these self-reports positively correlated with SBMI data?

Analysis. In the QUESTIONNAIRES used in this study (Appendix D), statement 3 on each questionnaire centered on auditory modality based strategies; statement 5 on each questionnaire addressed visual modality based strategies; statement 7 on each questionnaire focused on kinesthetic modality based strategies used to study mathematics. From the QUESTIONNAIRES #1 and #4, data results that have been collected on modality strategies used by the subjects in private study are displayed in Table 10. The data have been reported as follows: H for a high score $\geq$ 60%; L for a low score $\leq$ 40%; Mid for a score 40% < Mid < 60%. Table 10 also has displayed the correlation between the use of modality based strategies in private study and SBMI data. The data collected from the QUESTIONNAIRES on use of modality based strategies in private study will be discussed first followed by a discussion of correlation findings.

Auditory modality based strategies were the center of statement 3 on the four QUESTIONNAIRES. Specifically, statement 3 on QUESTIONNAIRES #1 and #4 centered on the use of auditory based strategies used in private study. Table 10 shows that ten students or 59% scored High, five students or 29% scored Mid and two students, 12%, scored Low on the use of auditory based strategies in private study when statement 3 on QUESTIONNAIRES #1 and #4 were considered. The results of specific modality strategies used by the students of this study in private study are reported in Table 11. As seen in this table, the reported data on statement 3 on QUESTIONNAIRE #1, show that 9 of 17, or 53%, of the students scored $\geq$ 60 High which indicated that in private study students read class notes aloud to understand them better. Further review of the break down of these results shows the degree of preference that students read class notes aloud in private study to understand them better was as follows: four students scored 80% or

many times preference; five students scored 60% or **sometimes** preference; six students scored 40% or **once in a while** preference; two students scored 20% or a **never** preference.

Statement 3 on QUESTIONNAIRE #4 was centered on reading word problems aloud to oneself to interpret the problems better. This strategy was a practice that 16 out of 17 students used, shown by the $\geq$ 60%, High score. A review of the break down of the results shows the degree of preference for reading word problems aloud to oneself during private study was as follows: four students scored 80% or **many times** preference; 12 students scored 60% or **sometimes** preference; one student scored a 40% or **once in a while** preference.

Tutorial sessions and interviews with students corroborated these finding. While tutoring some students, this researcher found that they not only listened intently while problems were explained, but also asked questions and listened to additional clarification. During these tutoring sessions, this researcher asked the students to explain the procedure they used in solving the problem. This process allowed the students to hear themselves explain their thinking while reviewing the solution steps.

Two of the students stated that they had memorized certain formulae that helped them to do word problems, for example: area of a rectangle, circumference of a circle, and volume of a cylinder. Then, the strategy used by one student was to repeat these formulae aloud to himself until he was sure of the relationships in the appropriate formula equations. The other student wrote up cue cards with the formulae on the reverse side. He reviewed and practiced these aloud during his private study time.

Table 10 Modality Based Strategies Used in Private Study

(Based on Data from QUESTIONNAIRES)

SUBJECT	SBMI	AUDITORY BASED STRATEGIES	VISUAL BASED STRATEGIES	KINESTHETIC BASED STRATEGIES	CORRELATION WITH SBMI
S 7	V	H	H	L	YES
S 12	V	Mid	H	L	YES
S 25	V	H	H	L	YES
S 6	A	H	H	H	YES
S 8	A	Mid	L	L	MODERATE
S 9	A	L	Mid	L	NO
S 20	A	H	H	L	YES
S 3	K	H	H	Mid	MODERATE
S 4	K	Mid	H	Mid	MODERATE
S 14	K	H	Mid	L	NO
S 17	K	L	Mid	Mid	MODERATE
S 2	M (VA)	Mid	H	L	MODERATE
S 10	M (VA)	Mid	H	L	MODERATE
S 13	M (VAK)	H	H	Mid	YES
S 21	M (VA)	H	H	L	YES
S 22	M (VA)	H	H	L	YES
S 23	M (VA)	H	H	L	YES

SBMI KEY:
V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

STRATEGY SCORE KEY:
L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

CORRELATION KEY:
YES ≡ **H** ≡ **High** Modality Strategies correlated with **SBMI**
MODERATE ≡ **Mid** ≡ **Middle** Modality Strategies correlated with **SBMI**
NO ≡ **L** ≡ **Low** Modality Strategies NOT correlated with **SBMI**

Statement 5 of the four QUESTIONNAIRES addressed visual modality based strategies. Specifically, statement 5 on QUESTIONNAIRES #1, and #4 addressed the use of visual based strategies used in private study. Table 10 shows that 13 out of 17, or 76%, of the students scored High on use of visual based strategies in private study, 3 out of 17, or 18%, received a Mid score and one student received a Low score when statement 5 on QUESTIONNAIRES #1 and #4 was considered. A break down of results of statement 5 is reported on Table 11. On QUESTIONNAIRE #1, reported data on statement 5 show that fifteen students scored ≥ 60%, High, which indicates that students drew diagrams to help in solving homework problems. Further break down of these results is as follows: one student scored 100% or **every time** preference; nine students scored 80% or **many times** preference; five students scored 60% or **sometimes** preference; two students scored 40% or **once in a while** preference.

Results of statement 5 on QUESTIONNAIRE #4 showed that 11 students scored ≥ 60% which expressed preference toward studying charts and graphs in the text to help understand problems. Further review of the results of these 11 students shows the degree of preference that students stated that they studied charts and graphs in private study as follows: four students scored 80% or **many times** preference; seven students scored 60% of **sometimes** preference; five students scored 40% or **once in a while** preference; and one student scored 20% or a **never** preference.

Interviews with the students corroborated these finding and revealed other pertinent information. The majority of students generally complained that the algebra text used for the course was difficult to follow while studying because it did not have the thorough step-by-step procedures which the professor demonstrated in class. While doing homework problems, students found many errors in the solution manual which caused confusion about correct answers and procedures in problem solution. When these errors were brought to the attention of the professor, correct solutions were worked out.

Table 11 Specific Modality Based Strategies Used in Private Study

(Based on Data from QUESTIONNAIRES)

SUBJECT	SBMI	AUDITORY 3		VISUAL 5		KINESTHETIC 7	
		QUEST #1	QUEST #4	QUEST #1	QUEST #4	QUEST #1	QUEST #4
		%	%	%	%	%	%
S 7	V	40	80	80	80	20	20
S 12	V	40	60	100	60	20	40
S 25	V	60	80	80	60	20	60
S 6	A	60	60	60	60	80	60
S 8	A	40	60	40	40	20	20
S 9	A	20	60	40	60	20	60
S 20	A	80	80	80	60	20	20
S 3	K	60	60	80	40	40	60
S 4	K	40	60	60	60	40	60
S 14	K	80	60	60	40	20	40
S 17	K	20	60	80	20	40	60
S 2	M (VA)	60	40	80	80	20	60
S 10	M (VA)	40	60	80	40	20	40
S 13	M (VAK)	80	60	80	40	60	40
S 21	M (VA)	40	80	80	80	20	20
S 22	M (VA)	60	60	60	80	20	20
S 23	M (VA)	80	60	60	60	40	20

KEY: **V** ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

20%, NEVER; **40%,** ONCE IN A WHILE; **60%,** SOMETIMES; **80%,** MANY TIMES; **100%** ,EVERY TIME

AUDITORY 3
QUEST #1 I READ MY CLASS NOTES ALOUD TO UNDERSTAND THEM BETTER
QUEST #4 I CAN INTERPRET WORD PROBLEMS BEST IF I CAN READ THEM OUT LOUD TO MYSELF

VISUAL 5
QUEST #1 I DRAW DIAGRAMS TO HELP SOLVE MATH PROBLEMS
QUEST #4 STUDYING CHARTS & GRAPHS IN THE TEXT HELPS ME TO UNDERSTAND PROBLEMS

KINESTHETIC 7
QUEST #1 I USE COINS, PAPER CLIPS ETC.TO HELP ME UNDERSTAND A MATH PROBLEM
QUEST #4 I FOLD PAPER OR TEAR IT UP INTO PIECES TO HELP SOLVE PROBLEMS

Statement 7 of the four QUESTIONNAIRES focused on kinesthetic based strategies. Specifically, statement 7 on QUESTIONNAIRES #1 and #4 focused on the use of kinesthetic based strategies in private study. Table 10 shows that one student, or 12%, scored High; 4 out of 17, or 23%, of the students scored Mid; 12 out of 17, or 71%, of the students scored Low on the use of kinesthetic based strategies in private study when statement 7 on QUESTIONNAIRES #1 and #4 were considered. In Table 11 is reported a further break down of the results of statement 7. The reported data on statement 7 from QUESTIONNAIRE #1 show that two students scored ≥ 60 High, and 15 students scored ≤ 40 on this statement which stated that coins and paper clips were used to help understand a math problem. Further review of results of these 17 students is as follows: one student scored 80% or **many times** preference; one student scored 60% or **sometimes** preference; four students scored 40% or **once in a while** preference; 11 students scored 20% or a **never** preference.

The reported data on statement 7 from QUESTIONNAIRE #4, show that six students scored ≥ 60 High which indicated that students stated that they folded paper or tore it up into pieces to help solve problems. Further review of these results is as follows: seven students scored 60% or **sometimes** preference. Ten students scored $\leq 40\%$ as follows: four students scored 40% or **once in a while** preference; six students scored 20% or a **never** preference.

In interviews and tutoring sessions two students revealed an initiative in the use of manipulatives during private study. One student obtained several library algebra books which showed the use of graph paper and blocks as manipulatives materials for finding area and volume respectively. This student used similar hands-on materials to help understand area and volume word problems.

While tutoring a student on word problems about the volume of boxes, this researcher utilized a manipulative piece (a piece of paper became a box when equal squares were removed from the four corners and remaining flaps folded upward) to demonstrate

this concept. For this student, creating a demonstration piece from paper as part of understanding and solving the problem was a new learning experience using kinesthetic based strategy.

Results of statements that addressed visual and auditory strategies used in private study indicated that the students as a class showed high preferences for visual based strategies (13 out of 17) and auditory based strategies (10 out of 17) as seen in Table 10. However, results of statement 7 that focused on the use of kinesthetic strategies in private study showed that only one student showed a high preference for hands-on, concrete activities associated with learning mathematics. The rest of the students as a class scored in the middle or low range in modality based strategies used in private study as follows: for visual based strategies, three students scored middle and one scored low; for auditory based strategies, five students scored middle and two students scored low; for kinesthetic based strategies four students scored middle and twelve students scored low.

Interpretation. The data collected from the QUESTIONNAIRES on private study time use of modality based strategies were compared to the modality strength of students. In Table 10, SBMI modality strengths of the individual students are correlated with classroom use of modality based strategies. The following correlations were found: 9 out of 17, or 53%, of the students, showed high correlation between the use of modality based strategies in private study and SBMI modality strength; 6 out of 17, or 35%, of the students had a moderate correlation between the use of modality based strategies in private study and their modality strength; and 2 out of 17, or 12%, of the students had no match between use of modality based strategies in private study and their modality strength.

Correlations within the modalities showed that 100% of the visual students had a high correlation between the SBMI strength and use of modality based strategies in private study. Two of the four of auditory students, 50%, showed a high correlation while one

other was a moderate correlation and the fourth student showed no correlation between auditory strength and use of auditory based strategies. Correlation of the kinesthetic students showed that 75% had a moderate correlation and 25% showed no correlation between kinesthetic modality strength and use of kinesthetic based strategies in private study. Mixed modality students showed that 67% had a high correlation and 33% a moderate correlation between their SBMI strengths and use of their appropriate modality based strategies.

The results of the students' modality preferences as elements of learning style have just been reported in Subsidiary Question Two and Three. Subsidiary Question Four concerns elements of learning style.

Table 5, page 55 shows that the fourteen statements of "elements of learning style" of the QUESTIONNAIRES were organized into five main categories: environmental conditions, students behaviors, social behavioral aspects, physical elements, and modality preferences which have just been enumerated in detail.

Subsidiary Question Four

According to self-reports of students classified in different modality groups what are their preferences in the following learning style categories:

a. environmental conditions i.e., light, sound, temperature, and room design;

b. student behaviors i.e., responsibility and motivation;

c. social behavioral aspects i.e., studying by oneself, with peers, with competent adults;

d. physical elements i.e., requires food, functions best in the morning or evening, needs to be mobile? (Students were grouped by SBMI data).

Analysis of Environmental Conditions. A series of four QUESTIONNAIRES were administered one each week after each quiz beginning with the third quiz. Statements 1, 2, 4, and 11 specifically addressed light, noise level, temperature, and room design

respectively, which are elements of environmental conditions of learning style. The results of students' preferences have been displayed in Table 12. In reviewing this table, results showed that 14 out of 17 students, or 82%, preferred moderate to bright lights while studying in the classroom or in private study, while three, 18%, of the students preferred dim lighting in the classroom and at home while studying. Fourteen out of 17 students, or 82%, indicated that some noise and/or background music were acceptable conditions while studying. However, only three students out of 17, or 18%, preferred quiet learning conditions both in class and at home. A further review of Table 12 indicated that the 14 students who preferred a higher degree of lighting were not the same 14 that tolerated some background noise while studying.

A large percentage of the students, 88%, 15 out of 17, expressed preference to study in a warm room. However, four of these students occasionally like to freshen the room by opening the window for a short time. Two students, 12%, liked a cool room and fresh air while in the classroom or in private study.

The formal conventional classroom with desks in rows was preferred by 15 out of 17, or 88%, of the students. These same people also preferred to study at a desk or table in private study time. The two remaining students, 12%, preferred less formal classroom and informal private study conditions.

Preferences by modality grouping were reviewed for intergroup comparisons. In a further examination of Table 12, for preferences of students grouped by modality, two thirds of the visual subjects showed a preference for dim lighting, while the auditory, kinesthetic and mixed modality indicated the they preferred to study in brightly lighted area. Some noise was tolerated while studying by most of students in each modality. However, one student in each visual, auditory and kinesthetic group did prefer quiet study area.

Table 12 Environmental Conditions; Elements of Learning Style

(Based on Data from QUESTIONNAIRES)

SUBJECT	SBMI	LIGHT		NOISE LEVEL		TEMPERATURE		ROOM DESIGN	
		Bright	Dim	Sound	Quiet	Warm	Cool	Formal	Not Formal
S 7	V	H			L	H		H	
S 12	V		L	H		H		H	
S 25	V	H		Mid		H		H	
S 6	A	Mid		H			L	H	
S 8	A	H			L	H		Mid	
S 9	A	H		H			L	H	
S 20	A	H		H		Mid		H	
S 3	K	H		Mid		H		H	
S 4	K	H			L	H		H	
S 14	K		L	H		H		H	
S 17	K	Mid		H		H		H	
S 2	M (VA)		L	Mid		H		H	
S 10	M (VA)	H		H		H		H	
S 13	M(VAK)	H		H		H		H	
S 21	M (VA)	H		Mid		H		H	
S 22	M (VA)	H		Mid		H		H	
S 23	M (VA)	H		Mid		Mid			L

SBMI KEY:

V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

KEY:

L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

The auditory subgroup preferred moderately cool temperatures while studying, while the visual, kinesthetic and mixed modality subgroups preferred environments with warmer temperatures as indicated by Table 12.

Only two auditory students expressed a preference for an informal learning environment unlike the balance of the subjects in the auditory subgroup and in all visual, kinesthetic and mixed modality subgroups who preferred the more formal classroom design.

Interpretation of Environmental Conditions. As a class, these students preferred bright lights, soft, background sounds, a warm room and a more formal study area.

Analysis of Student Behaviors. The specific statements of elements of learning that were included in this category of student behavior were: statement 12, responsibility; and statement 14, self motivation.

The results of behavioral preferences of students are presented in the Table 13. In reviewing the four specific statements 12, in the QUESTIONNAIRES #1, #2, #3, #4, Appendix D, the high scores of the results showed that the students were prepared for class, had completed homework lessons which were passed in on time. These were expressed preferences of all students in the study. All 17 participants reported that they persevered over homework.

The individual profiles, Appendix I, showed that 82% of the students completed entire homework lessons. The data indicate that students took responsibility toward learning seriously in private study and therefore applied themselves aptly.

Furthermore, 14 out of 17, or 82%, of the students were motivated sufficiently to ask additional questions of the professor during class. Some of the highly motivated students even made individual appointments to seek out assistance from the professor, while some students came early to class to get additional help. Additionally, the results of

statements that addressed the self-motivation element of learning style showed that the highly motivated students set aside plenty of time to do homework.

In interviews, the three students with a low score in self-motivation remarked that they never came for extra help and stated they were confident about their work. These students further stated that other classmates often initiated questions about the most difficult problems. As a result, it was not necessary for them to question further or to contribute to the class discussion.

Intergroup comparisons of the data reveal that all modality groups acted responsibly toward class work and were very conscientious about completing home assignments. In review of the elements of self-motivation the intergroup comparisons showed differing relationships. The visual and mixed modality student subjects expressed that they were moderately to highly motivated. Both the kinesthetic and auditory modality groups had students who scored moderate to low in self-motivational elements. However, in the kinesthetic and auditory modality groups there were two kinesthetic and two auditory students who were highly motivated.

Interpretation of Students Behaviors. As a total class, students acted responsibly toward home work assignments, were persistent in completion of assigned lessons and were self motivated to ask questions in class and to seek additional help as needed from the instructor.

Analysis of Social Behaviors. Questionnaire statements 9 and 13 focused on students' preferences in studying by oneself, with peers, and/or with competent adults. In Table 14, the results of the data are displayed.

Fifteen of the 17 students, or 88%, stated that they usually studied by themselves. The students did not look to their peers or the students tutoring center for help. The data indicated that 11 out of 17, or 65%, of the students expressed low preference for studying with peers. Four students had studied sometimes with peers. Occasionally, they took

Table 13 Student Behaviors; Elements of Learning Style
(Based on Data from Questionnaires)

SUBJECT	SBMI	RESPONSIBILITY	MOTIVATION
S 7	V	H	Mid
S 12	V	H	H
S 25	V	H	Mid
S 6	A	H	H
S 8	A	H	L
S 9	A	H	Mid
S 20	A	H	H
S 3	K	H	Mid
S 4	K	H	L
S 14	K	H	L
S 17	K	H	H
S 2	M (VA)	H	H
S 10	M (VA)	H	Mid
S 13	M (VAK)	H	H
S 21	M (VA)	H	Mid
S 22	M (VA)	H	Mid
S 23	M (VA)	H	Mid

SBMI KEY:
V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

KEY:
L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60%
H ≡ High ≡ ≥ 60%

advantage of the peer tutoring center for assistance with difficult problems. One student with the high score stated that he would rather drive the distance to the center for assistance rather than be frustrated and never figure out the problem on his own! During classroom observation, it was noticed occasionally as the semester progressed, a few students came to class early and discussed some problems with classmates. Also during class, some students discussed difficult problems openly with each other and with the professor.

The data results in Table 14 showed that 13 out of 17, or 76%, of the students expressed a high preference and four students a moderate preference for assistance from competent adults. As stated earlier in results of student behaviors, students were motivated to come to class or make appointments with the professor to seek assistance for solutions to home work problems. The students stated repeatedly that they preferred professor's explanations and step-by-step procedures written on the blackboard. Additionally, four students made appointments with this researcher. This assistance was offered to all students at the beginning of the study. On several occasions before class, a few students asked this researcher for help on difficult homework problems. The few students who did not seek help were confident learners.

Interpretation of Social Behaviors. When intergroup comparisons of results of behavioral study preferences were made only a few differences were noted. Regardless of modality grouping, the students did private study by themselves and looked to the professor to give a detailed written and oral explanation of problems. Most students in each modality group looked to a competent adult for assistance in understanding difficult algebra problems. Most students did not study with peers. A few students, one visual, two auditory two kinesthetic and one mixed modality, sometimes studied with others as well as used the tutor center once in a while.

Table 14 Social Behavioral Aspects; Elements of Learning Style
(Based on Data from Questionnaires)

SUBJECT	SBMI	STUDY: SELF	STUDY: PEERS	STUDY: COMPETENT ADULT
S 7	V	H	L	Mid
S 12	V	H	L	H
S 25	V	H	Mid	H
S 6	A	H	H	Mid
S 8	A	Mid	Mid	Mid
S 9	A	H	L	H
S 20	A	H	L	H
S 3	K	H	L	H
S 4	K	H	Mid	Mid
S 14	K	H	L	Mid
S 17	K	Mid	Mid	H
S 2	M (VA)	H	L	H
S 10	M (VA)	H	L	H
S 13	M (VAK)	H	L	H
S 21	M (VA)	H	L	H
S 22	M (VA)	H	L	H
S 23	M (VA)	H	Mid	H

SBMI KEY:
V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

KEY:
L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60%
H ≡ High ≡ ≥ 60%

Analysis of Physical Elements. Physical elements that were associated with learning styles of students were revealed by students' self-reported answers to specific statements 6, 8, and 13 in the QUESTIONNAIRES. Preference of having food or drink while studying was revealed by statement 6. Time of day that was best for studying by participating students was reviewed by statement 8. Mobility of students during study time was reviewed by statement 10 in the QUESTIONNAIRES. The data are displayed in Table 15.

In reviewing students food requirements during study time, only six students, or 35%, indicated a high preference for coffee, soda or other foods during class time or private study time. Five students, or 29%, never bothered with any refreshments during study time. The six remaining students, or 35%, with a middle score sometimes indicated a preference for food or drink while studying or while taking a break away from studying.

A high percent, 71%, 12 out of 17, of the students did not mind going to class from 6:00-9:30 p.m. or studying algebra in the evening at home. Five out of 17, or 29%, of the students indicated evening hours for school and study time were difficult. However, during interviews, many students stated they were tired after a day's work, but still spent the necessary time in the evening to get the homework lessons done. Some students were enrolled in another course during the semester, and found little free time to do more than attend classes and do assignments in the evening. Several students stated that they were more refreshed early on weekend mornings, and often did homework at this time. The five students who scored in mid-range stated that sometimes it was difficult to stay alert in class in the evening or that they were tired in class after a hard day at work. However, these five students did attend the algebra class on time, regularly and returned to class after the break. In the students' profiles, the individual preferences of the physical elements involved in this research question are recorded in Appendix I.

Table 15 Physical Aspects; Elements of Learning Style

(Based on Data from Questionnaires)

SUBJECT	SBMI	FOOD		TIME		MOBILITY	
		Required	Not Required	A.M.	P.M.	Required	Not Required
S 7	V		L		H	Mid	
S 12	V	H			H	H	
S 25	V	Mid			H	H	
S 6	A		L		H	H	
S 8	A		L		H	H	
S 9	A	H			H	H	
S 20	A		L		H	Mid	
S 3	K	Mid			H	H	
S 4	K	H		Mid		H	
S 14	K	H			H		L
S 17	K	H			H	H	
S 2	M (VA)		L	Mid		Mid	
S 10	M (VA)	H		Mid		H	
S 13	M (VAK)	Mid		Mid		H	
S 21	M (VA)	Mid			H	H	
S 22	M (VA)	Mid			H	Mid	
S 23	M (VA)	Mid		Mid			L

SBMI KEY:

V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

KEY:

L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

Many students expressed a preference to be mobile. Eleven of 17 students, 65%, needed to take a break away from their private study place. The students often stated that they would go for a short walk, or just get up and stretch. The four students with moderate scores did not feel a great need to get up and move about but did express that they might break from studying occasionally. Two students with a low mobility score preferred to stay seated until all their homework was completed.

Classroom observations corroborated these results. This researcher observed that all students got up and left the room during the ten minute lecture break. Some just stood in the hallways, while others walked the corridors or went to the lounge. Occasionally, students purchased soda or coffee at break time and finished it before returning to class.

In making intermodality-group comparisons of students' preferences of physical elements, many differences were found between the groups. Some students in each modality group expressed a preference to include refreshments during study time but that preference appeared to be a very individual choice. The auditory group did have 3 out of 4 students, 75%, who did not include eating or drinking while studying. In consideration of time of day for studying preferences, all the visual and auditory learners indicated evening hours were preferred, while the kinesthetic and mixed modality groups had students who indicated an occasional dislike for evening class and/or study time during the evening. The mobility preference of the modality groups was as follows: 2 out of 3, 67%, visual students; 2 out of 4, 50%, auditory students; 3 out of 4, 75%, kinesthetic students; 4 out of 6, 67%, mixed modality students received a high mobility score and preferred to take a stretch or walking break from studying. The most mobile group was the kinesthetic modality group of students.

Interpretation of Physical Elements. In general, all 17 students applied themselves in class time and private study time during the evening hours. These students had a wide range of preferences concerning refreshments while studying. The requirement of food while studying appeared to be a very personal preference. Additionally, these

subjects were mobile and needed to take a break from studying by moving about after a long period of intense classroom work as well as from long concentrated study efforts in private study.

Subsidiary Question Five

Do academic achievement, modality strengths and self-reported modality based strategy preferences positively correlate for unsuccessful and successful students in this study ?

Analysis. As part of the course syllabus, the professor provided a schedule of quizzes and exams for the semester. The students' grades, QPA, were provided four times during the semester; after the first two quizzes, after three quizzes and one exam, again after five quizzes and two exams, and last after seven quizzes, three exams in Table 16.

In the following text, the tracking of students' academic achievements as successful, S, QPA $\geq$ 70 or unsuccessful, US, QPA < 70, is explained. Review of Table 16 after the first two quizzes, three weeks into the semester, there were 15 students classified as successful and two students were unsuccessful.

The next quiz and exam period changed the mix of successful and unsuccessful so that fourteen students were successful and three students were unsuccessful. However, the two students, S8 and S21, who were unsuccessful after two quizzes improved their QPA to be successful. Three students, S3, S17, and S2, who had been successful after the first two quizzes, received test scores on quiz three and exam one that reduced their QPA below 70 points. These three students received an unsuccessful rating.

By the eighth week of the semester, the students had taken quiz 4 and quiz 5 and the second exam. After this third grading period, the break down of students' grades had changed so that two were unsuccessful and fifteen were successful. Examination of the Table 16 showed that S3 and S8 had grades that fluctuated between successful and

Table 16 Subjects' Academic Achievements

QUALITATIVE REPORT OF QUIZZES AND EXAMS

SUBJECT	SBMI	2 QUIZZES		3 QUIZZES 1 EXAM		5 QUIZZES 2 EXAMS		7 QUIZZES 3 EXAMS	
		US	S	US	S	US	S	US	S
S 7	V		•		•		•		•
S 12	V		•		•		•		•
S 25	V		•		•		•		•
S 6	A		•		•		•		•
S 8	A	•			•	•		•	
S 9	A		•		•		•		•
S 20	A		•		•		•		•
S 3	K		•	•		•		•	
S 4	K		•		•		•		•
S 14	K		•		•		•		•
S 17	K		•	•			•		•
S 2	M		•	•			•		•
S 10	M		•		•		•		•
S 13	M		•		•		•		•
S 21	M	•			•		•		•
S 22	M		•		•		•		•
S 23	M		•		•		•		•
TOTAL	17	2	15	3	14	2	15	2	15

Academic Achievement:

S ≡ SUCCESSFUL QPA **≥70** **US** ≡ UNSUCCESSFUL QPA **< 70**

SBMI KEY:

V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC **M** ≡ MIXED

unsuccessful, while S17 improved and continued to maintain a successful QPA for the remainder of the semester. After 13 weeks into the semester, the students had taken the third exam and quiz 6 and quiz 7. The two students, S3 and S8, remained unsuccessful while the other fifteen students were successful. The is the academic achievement status of the students that is to be used for this study. The graph in Figure 1 displays the distribution of academic achievements of the students throughout the semester.

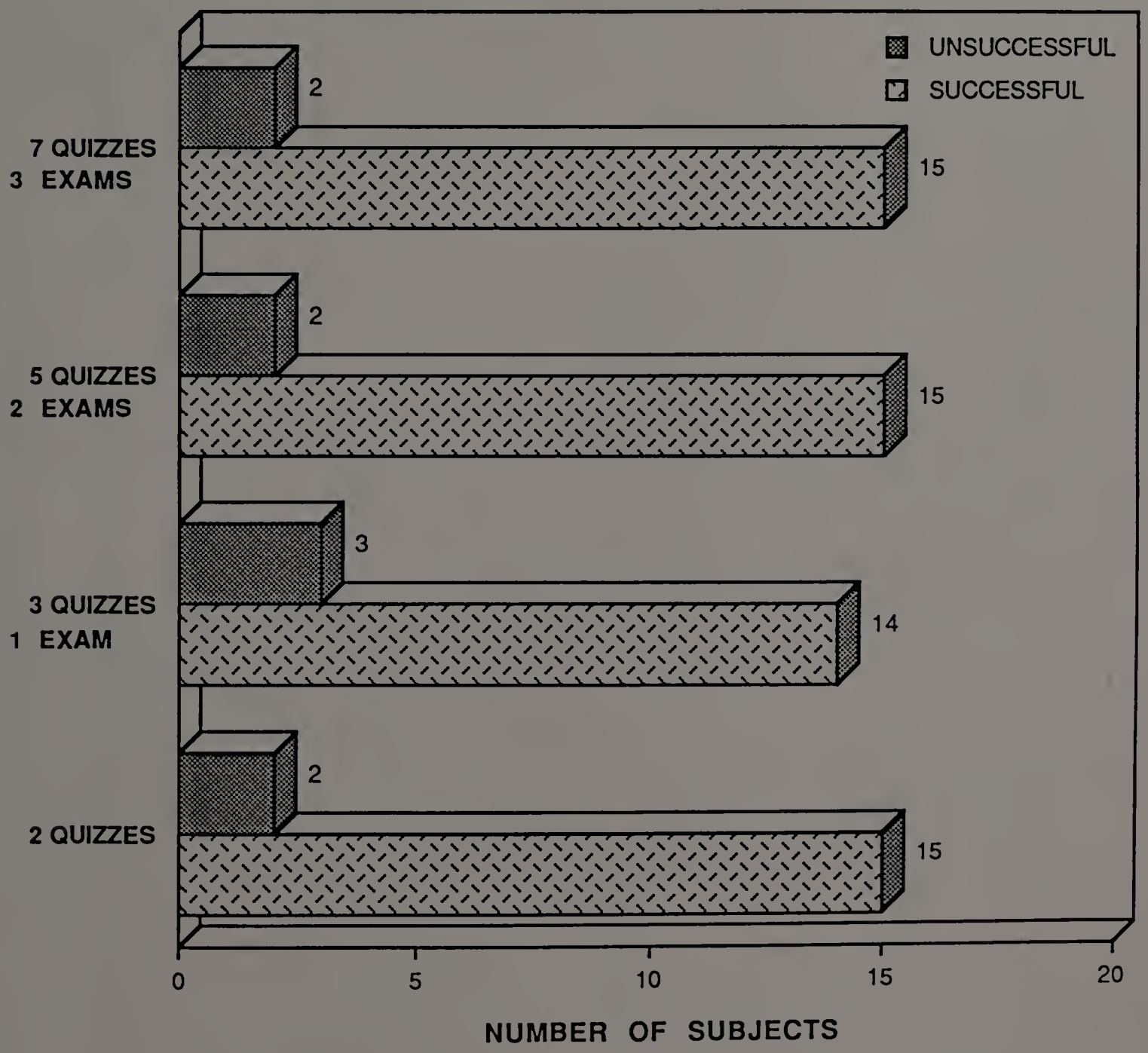


Figure 1: Distribution of Academic Achievement of Subjects

Table 17 Correlation of Academic Achievement of Subjects with SBMI Modality Strength and Self-Reported Modality Strategies

SUBJECT	SBMI	MODALITY BASED STRATEGY		ACADEMIC ACHIEVEMENT		CORRELATION
		IN CLASS	PRIVATE STUDY	US	S	
S 7	V	YES	YES		•	YES++
S 12	V	YES	YES		•	YES++
S 25	V	YES	YES		•	YES++
S 6	A	YES	YES		•	YES++
S 8	A	YES	MOD	•		NO-
S 9	A	YES	NO		•	MOD
S 20	A	YES	YES		•	YES++
S 3	K	MOD	MOD	•		NO-
S 4	K	NO	MOD		•	NO-
S 14	K	NO	NO		•	NO- -
S 17	K	MOD	MOD		•	MOD
S 2	M (VA)	YES	MOD		•	YES+
S 10	M (VA)	YES	MOD		•	YES+
S 13	M (VAK)	YES	YES		•	YES++
S 21	M (VA)	YES	YES		•	YES++
S 22	M (VA)	YES	YES		•	YES++
S 23	M (VA)	YES	YES		•	YES++
REF TABLE	TABLE 6	TABLE 8	TABLE 10	TABLE 16		

SBMI KEY:
V ≡ VISUAL **A** ≡ AUDITORY **K** ≡ KINESTHETIC M ≡ MIXED

ACHIEVEMENT:
S ≡ SUCCESSFUL QPA **≥70** **US** ≡ UNSUCCESSFUL **QPA < 70**

CORRELATION KEY:
YES ≡ **H** ≡ **High** Modality Strategies correlated with **SBMI**
MODERATE ≡ **Mid** ≡ **Middle** Modality Strategies correlated with **SBMI**
NO ≡ **L** ≡ **Low** Modality Strategies NOT correlated with **SBMI**

Interpretation. To further answer the research question of correlation between students' academic achievement and SBMI modality strength and self reported modality based strategy preferences, relevant data have been organized in Table 17. Upon review of the visual modality students, first is noted that all three students were successful. One further noted that all three visual students were positively correlated with visual based strategies as displayed Tables 8 and 10, pages 66 and 73 respectively. The comparison indicates a strong correlation of visual students' academic success and use of visual based strategies in learning Algebra I in the classroom and in private study.

A review of the auditory students' data showed that three of the four reached successful academic achievement. Two successful students, S6 and S20, show strong correlation of use of auditory based strategies in class and home study and successful achievement. The third student, S9, was successful.even though he was only moderately correlated with the use of auditory based strategies in learning algebra and academic achievement There was no correlation for the fourth auditory student, S8, between the unsuccessful academic achievement and the "YES" correlation in the use of auditory based strategies in the classroom, Table 8, and the "MOD" correlation in private study, Table 10.

Examination of data of the kinesthetic group of students indicated that three of the four students were successful. Both S3 and S17 showed a moderate correlation between kinesthetic strategies and SBMI strength. From Table 17, the data for student, S17, show a moderate correlation between successful academic achievement and moderate correlation of the modality based strategies. However, the data for S3 show no correlation between unsuccessful achievement and moderate correlation of the modality based strategies. The two remaining kinesthetic students, S4 and S14, show no correlation between successful achievement and no correlation and/or moderate correlation of modality based strategies.

All mixed modality students had a positive correlation between successful academic achievement and the use of appropriate relevant mixed modality based strategies in studying and learning algebra.

Subsidiary Question Six

Do patterns exist in modality based strategies used by unsuccessful and successful students in the study ?

Analysis. To find patterns of modality based strategies that unsuccessful and successful students utilized it was necessary to combine the results of self-reported preferences of relevant modality from specific statements from the QUESTIONNAIRES. The data on Table 18 show the score from the QUESTIONNAIRES, Appendix D, of the specific modality strategies associated with the identified SBMI strength. These scores are reported as percent based upon students selected responses to the modality statements on the QUESTIONNAIRES.

There were two unsuccessful students: one auditory student, S8; and one kinesthetic student, S3. The auditory student, S8, showed a Mid score of 55% in use of auditory based strategies in learning algebra as shown in student profiles, Appendix I. On one questionnaire the student expressed that she followed the professor explanations as he wrote out solutions to problems only **once in a while**. This was scored as 40%. On another questionnaire, the same student expressed that she listened to the professor explain algebra processes **many times**, reported as 80%. Furthermore, during private study, the student read aloud class notes **once in a while** or 40% and read aloud word problems for better interpretation and understanding only **sometimes** or 60% of the time. Also the student scored a Mid score of 45% on visual based strategies used in class and private study and Low score of 20% for use of kinesthetic based strategies in learning algebra. During tutoring sessions this researcher learned from this student that diagrams confused her and interfered with her understanding of the procedure of problem solving.

Table 18 Specific Modality Based Strategies of Unsuccessful Subjects

UNSUCCESSFUL AUDITORY S 8	
MODALITY BASED STRATEGIES FROM QUESTIONNAIRES	SCORES AS %
SPECIFIC AUDITORY STRATEGIES	
READ CLASS NOTES ALOUD IN PRIVATE STUDY	40
PREFER PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEM	40
LISTEN TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURE	80
READ WORD PROBLEMS ALOUD FOR BETTER INTERPRETATION	60
AVERAGE	55

UNSUCCESSFUL KINESTHETIC S 3	
MODALITY BASED STRATEGIES FROM QUESTIONNAIRES	SCORES AS %
SPECIFIC KINESTHETIC STRATEGIES	
USE MANIPULATIVE PIECES *i.e.*, COINS OR CLIPS TO UNDERSTAND PROBLEM	40
LEARN FROM PICKING UP AND HANDLING A MODEL	40
RECREATE DEMONSTRATION AS DRAWINGS IN CLASS NOTES	60
FOLD OR TEAR PAPER TO MAKE MANIPULATIVE PIECES	60
AVERAGE	50

Key:

20%, NEVER; 40%, ONCE IN A WHILE; 60%, SOMETIMES; 80%, MANY TIMES; 100% ,EVERY TIME

Modality Key:

L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

The other unsuccessful student was a kinesthetic learner, S3, who showed a Mid score 50% for use of kinesthetic based strategies for learning algebra in class and in private study, Table 18 and student profiles, Appendix I The data show that the student reported that she recreated demonstration models as drawings **sometimes** or 60% in class notes and stated that she did learn from handling models to understand concepts only **once in a while** or 40%. During private study time, the student reported that **once in a while**, 40%, materials as folded or torn paper, coins or clips were used as manipulatives to solve word problems. This student did have high score of 70% for use of visual based strategies as well as 75% for use of auditory based strategies in learning algebra. Table 17 shows that there was no correlation for either student S3 and S8 when modality strategies were compared to academic achievement.

To find patterns of modality based strategies used by successful students the results of statements on the QUESTIONNAIRES were organized by modality associated with students' SBMI modality strength, Tables 19, 20, 21, and 22.

Each modality group had successful students, Table 16. The first modality group to be reviewed is the visual group. The reported scores of the successful students have been obtained from the student profiles, Appendix I, which charted scores from the self-reported responses to the QUESTIONNAIRES. The specific factors of visual modality based strategies are from statement 5 in the QUESTIONNAIRES, Appendix D. Table 19 reveals data collected on successful students.

In review of this Table 19 and student profiles, this researcher found that all these visual students not only received high score for visual based strategies but also obtained high score for additional modality based strategies beyond their identified modality

Table 19 Specific Visual Modality Based Strategies of Successful Visual Subjects

MODALITY BASED STRATEGIES FROM QUESTIONNAIRES	SBMI VISUAL SUBJECTS S 7	S 12	S 25	
SPECIFIC VISUAL STRATEGIES	SCORES AS %			ITEM AVERAGE %
DRAW DIAGRAMS TO SOLVE PROBLEMS	80	100	80	87
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS	100	40	80	73
WATCH STEP BY STEP SOLUTION WRITTEN ON BLACKBOARD	100	80	80	87
STUDY CHARTS & GRAPHS IN TEXT	80	60	60	67
AVERAGE	•90	•70	•75	

KEY:

20%, NEVER; **40%**, ONCE IN A WHILE; **60%,** SOMETIMES; **80%,** MANY TIMES; **100%** ,EVERY TIME

Modality Key:

L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

strength. One specific visual strategy that students reported was that these students better understood the professor if he drew diagrams to picture algebra concepts and/or word problems. As a group all three visual learners had an averaged High score of 73% . These students expressed a preference of 87% to watching the professor write out a step-by-step solutions to problems on the blackboard. These visual learners followed diagrams and charts easily shown by an averaged score of 67% . Furthermore, these students drew diagrams in their class notes and studied these visuals illustrations in their notes during private study time by a score of 87%. Evidence of using diagrams for understanding was also found on the work sheets that accompanied their quizzes and exams. Visual students also scored high in auditory based strategies which were that in the classroom they listened intently while the professor explained the algebra fundamentals and when he explained problem solving. During private study, these visuals students read their class notes, drew diagrams in solutions to word problems and did many problems until they were sure that they understood the concept and procedure. These three visual students, S7, S12 and S25, showed a strong correlation between visual modality strength and use of visual based strategies in the learning of algebra and their academic achievement in Table 17.

The next successful group of students to be reviewed for modality based patterns of learning algebra was the auditory learners in Table 20. While these auditory learners attended class, they expressed that they preferred to listen closely **every time** or 100 % of the time that the instructor explained math procedures. They also preferred that the professor complete the explanation of the algebraic process without interruption. Many of the auditory students did not take notes while he was explaining. They often asked him to review the explanation and they continued listening while the professor was solving problems to be sure they understood the concepts and/or procedures, reported 87% of the time. When the instructor completed the explanation, then these students would copy the notes from the board. Some students asked that he not erase the board notes so that they could write down a complete copy of all board notes.

In private study, the auditory learners stated that 53% of the time, they read their notes aloud to themselves. Word problems were read aloud 67% of the time in order that students grasp the total understanding. These auditory learners did repeated drill of fundamentals. Some rewrote the class notes. Several auditory learners memorized

Table 20 Specific Auditory Modality Based Strategies of Successful Auditory Subjects

MODALITY BASED STRATEGIES FROM QUESTIONNAIRES	SBMI AUDITORY SUBJECTS S6	S9	S20	
SPECIFIC AUDITORY STRATEGIES	SCORES AS %			ITEM AVERAGE %
READ CLASS NOTES ALOUD IN PRIVATE STUDY	60	20	80	53
PREFER PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEM	100	60	100	87
LISTEN TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURE	100	100	100	100
READ WORD PROBLEMS ALOUD FOR BETTER INTERPRETATION	60	60	80	67
AVERAGE	•80	•60	•90	

KEY:

20%, NEVER; **40%,** ONCE IN A WHILE; **60%,** SOMETIMES; **80%,** MANY TIMES; **100%** ,EVERY TIME

Modality Key:

L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

procedures and formulae for later recall. The memorization was done with oral repetition sometimes in conjunction with cue cards. The auditory students showed preferences for use of visual based strategies in studying algebra. These auditory students used the number line quite extensively in studies of integers as well as they used diagrams and other drawing for problem solving. The results reported in Table 17, indicate that students, S6 and S20, have a strong correlation and S9, a moderate correlation, between SBMI auditory strength, use of auditory based strategies in studying algebra, and academic achievement.

The third modality group to be review is the kinesthetic group of three successful students, S4, S14, S17. The data listed earlier in Tables 8 and 10, pages 66 and 73, indicate that the correlation between kinesthetic modality strength and use of kinesthetic based strategies was only moderate to low.

Specifically, the kinesthetic students did express that they learned from picking up and handling models 47% of the time as stated on Table 21 However, in class, models or manipulative materials were not used. An averaged score of 33% indicated that the students drew diagrams in their class notes to recreate word problems that were presented by the professor. During private study, the kinesthetic students reported that they **never** used or only **once in a while** used manipulative pieces to aid in understanding algebra problems and this was reported as 33%. They also stated that they used manipulative techniques of folding and tearing paper to recreate models or concepts occasionally and reported by a score of 53%. One kinesthetic student did explore other resources in response to the need to find a text that was easier to follow and as well as to better understand difficult explanations of algebraic concepts. This student found some volume formulae in the resource book that were presented as drawings of three dimensional models as well as presentations of algebra concepts with the use of manipulative pieces.

Further review of students profiles, shows that kinesthetic learners also had obtained high scores for use of visual and auditory based strategies in the study of algebra.

Additionally, a study of Tables 9 and 11, pages 68 and 75, shows specific visual and auditory strategies that kinesthetic students used. The visual strategies for which these students scored high were that they used diagrams for word problem and watched the professor do step-by-step solutions to problems. These kinesthetic students received a high score for listening to professor explain procedures and problems solving techniques.

Table 21 Specific Kinesthetic Modality Based Strategies of Successful Kinesthetic Subjects

MODALITY BASED STRATEGIES FROM QUESTIONNAIRES	SBMI KINESTHETIC SUBJECTS S 4	S 14	S 17	
SPECIFIC KINESTHETIC STRATEGIES	SCORES AS %			ITEM AVERAGE %
USE MANIPULATIVE PIECES *i.e..* COINS OR CLIPS TO UNDERSTAND PROBLEM	40	20	40	33
LEARN FROM PICKING UP AND HANDLING A MODEL	40	40	60	47
RECREATE DEMONSTRATION AS DRAWINGS IN CLASS NOTES	20	40	20	33
FOLD OR TEAR PAPER TO MAKE MANIPULATIVE PIECES	60	40	60	53
AVERAGE	•40	•35	•50	

KEY:

20%, NEVER; **40%**, ONCE IN A WHILE; **60%**, SOMETIMES; **80%**, MANY TIMES; **100%** ,EVERY TIME

Modality Key:

L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

In the data displayed on academic achievement in Table 17 on the kinesthetic students, S4, S14, S17 showed that there was no correlation or moderate correlation between successful academic achievement and use of kinesthetic based learning strategies. Despite this poor correlation, these three kinesthetic students were successful.

The display in Table 22, Specific Mixed Modality Based Strategies of Successful Students, is extensive as the four auditory based strategies as well as the four visual based strategies have been listed with the appropriate scores of each student in mixed modality group. A High score of 97% of the time, was shown by all six mixed modality students for the use of auditory strategies that encompassed listening to the professor as he reviewed algebra procedures and 90% of the time listened as he explained solutions to problems he wrote on the board. During private study time these students read class notes aloud 60% of the time. Also as part of interpreting and understanding word problems, these students read aloud the word problems 67% of the time.

These mixed modality students integrated many visual based strategies into the classroom and private study time. All six mixed modality students watched the professor do problems in a step-by-step format 97% of the time. Furthermore, the students reported a score average of 73% that they had a better understanding of word problems if the professor used diagrams to illustrate the problems. The students incorporated diagrams into their home lessons, which averaged 73% of the time, for the students expressed that visual aids helped to give a clear picture of the problem to be solved. The text diagrams were used less or 63% of the time during private study by the mixed modality students.

One of the mixed modality students, S13, was also shown to have a strong kinesthetic modality score, Table 6, page 63. Upon review of this student's profile, the combined kinesthetic scores (statements 7 on the QUESTIONNAIRES) for use of kinesthetic based modality in learning algebra is a Mid score of 50%. The two kinesthetic strategies that this student used were that she recreated demonstrations as drawing in class notes and that she occasionally used coins or clips as manipulative pieces to illustrate or

Table 22 Specific Mixed Modality Based Strategies of Successful Mixed Subjects

MODALITY BASED STRATEGIES FROM QUESTIONNAIRES	SBMI MIXED MODALITY SUBJECTS S2	S10	S13	S21	S22	S23	
SPECIFIC AUDITORY STRATEGIES							**ITEM AVG %**
READ CLASS NOTES ALOUD IN PRIVATE STUDY	60	40	80	40	60	80	60
PREFER PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEM	80	100	100	100	100	60	90
LISTEN TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURE	100	100	100	100	100	80	97
READ WORD PROBLEMS ALOUD FOR BETTER INTERPRETATION	40	60	60	80	60	60	67
AVERAGE	70	75	85	80	80	70	
SPECIFIC VISUAL STRATEGIES							**ITEM AVG %**
DRAW DIAGRAMS TO SOLVE PROBLEMS	80	80	80	80	60	60	73
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS	60	80	80	100	60	60	73
WATCH STEP-BY-STEP SOLUTION WRITTEN ON BLACKBOARD	80	100	100	100	100	100	97
STUDY CHARTS & GRAPHS IN TEXT	80	40	40	80	80	60	63
AVERAGE	75	75	75	90	75	70	

KEY:
20%, NEVER; **40%**, ONCE IN A WHILE; **60%**, SOMETIMES; **80%**, MANY TIMES; **100%**, EVERY TIME

Modality Key:
L ≡ Low ≡ ≤ 40% **Mid** ≡ Middle ≡ 40% < Mid < 60% **H** ≡ High ≡ ≥ 60%

understand an algebra concept. Table 16 shows that the mixed modality students, S2, S10, S13, S21, S22, S23, have a high correlation between use of visual, auditory and/or kinesthetic modality based strategies and academic achievement.

Interpretation. In summation, patterns of modality based strategies that unsuccessful and successful students in the study are described in the following text.

Unsuccessful students were only represented by the auditory and kinesthetic groups. The modality strengths of these unsuccessful students were not correlated with use of matching modality based strategies. A review of individual responses to statement 3 on auditory based strategies of each of these unsuccessful students showed that both students responded **many times,** or 80%, to "listened to instructor as he explain math procedures". There were no other discernible patterns of modality based strategies that either of these students followed in their own modality or in another modality.

Successful students were represented by all four modality groups, visual,auditory, kinesthetic, and mixed groups. The patterns in modality based strategies used in each modality are follows:

Visual students used diagrams in problem solving, preferred that the instructor use step-by-step solutions to problems as well as diagrams when appropriate;

Auditory students listened to the instructor while he explained the problem, preferred an oral discussion and explanation to problem solving, and during study time, read aloud class notes and word problems;

Kinesthetic students did not use manipulative materials, but they did listen in class and drew diagrams and followed step-by-step solutions to problems;

The mixed modality students used diagrams, preferred that the instructor use step-by-step solutions to problems, listened in class to the professor's explanations, and read word problems aloud for better understanding.

Research Question

Can success in mathematics (defined as a grade of ≥ 70 in quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students utilize their modality strengths as they study their mathematics?

Corollary

Can non-success in mathematics (defined as a grade of < 70 in quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students do not utilize their modality strengths as they study their mathematics?

Analysis. By reviewing and correlating the data which was collected from the six subsidiary questions, much information was available to be analyzed to give a comparison of the modality based strategies used or not used by successful and unsuccessful students.

Interpretation. The study showed that successful visual, auditory, mixed modality students had high correlation between their identified modality strengths and matching study strategies in class and in private study. This high correlation of successful students was true for 11 out of 15 students, or 73.3%. There were 2 out of 15 students that received a moderate correlation, representing 13.3%. As a result, 87% of the successful students in this study had a positive correlation, either as a moderate or high score. Two students were successful despite no correlation between modality strength and use of modality based strategies. Observation of the data in students' profiles reveals a pattern that all successful students utilized additional modality based strategies as well as those that matched their strength to enhance their learning. The results indicate that success in mathematics can be attributed to utilization of modality based strategies that match modality strength.

The two unsuccessful students were represented by only the auditory and the kinesthetic groups. The modality strengths of these unsuccessful students did not correlate with use of matching modality based strategies. However, in the auditory group, there was another student who had a low correlation for use of auditory strategies in private study; yet this student was successful. Also, this student's, S9, individual profile reveals a moderate

or high score in use of kinesthetic and visual based strategies. The profile of unsuccessful student, S8, reveals a low score both in the use of kinesthetic and visual based strategies. It appears that the use of additional strategies in studying outside of the auditory strength helped the student, S9, be successful.

The other unsuccessful student was a kinesthetic learner with no correlation between modality strength and use of matching strategies. However, there were other kinesthetic students who were successful despite a moderate or no correlation between use of modality based strategies in class/private study and modality strength. The students' profiles reveal that all four kinesthetic students scored a high of ≥ 60 for use of auditory and visual based strategies. No conclusion can be drawn on this basis, since both successful and unsuccessful kinesthetic students scored high on use of modality based strategies outside of their own modality strength; three were successful and one was unsuccessful.

CHAPTER V

DISCUSSION OF RESULTS, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

Introduction

In this chapter, a summary of this research study will be presented with a review of the purpose, the underlying theoretical framework, and analysis of the results. A discussion of this research indicates the practical merits as well as the limitations of the study. Recommendations for future research studies will also be made.

Through a review of recent literature of learning style theory, it was concluded that different people learn in different ways. The visual, auditory, and kinesthetic modalities are relied upon as an essential part of the learning process. However, learners utilize those perceptual modality preferences that promote successful learning for themselves; this is usually from a position of modality strength. Learning theory researchers have examined how people of all ages learn. Based upon their findings, many theories have evolved. Letteri, Kolb, Dunn and the many researchers who followed them based their theory of learning on varied ideas. Thus, the available research on learning theory is very diversified and broad. Many theories have overlapping perspectives, while others are expansions of earlier theorists basic suppositions. This research study has looked at many aspects of learning theory, with more concentration on the modality learning style preferences. Perceptual modality learning style preferences show reliance on one of the sensory modes for learners to understand their experiences. These perceptual modalities are auditory, visual, and/or kinesthetic. Modality strength for learning can be identified in a person and has been shown to be a single modality strength or a combination of modality strengths i.e., mixed modalities.

Reinert had a strong belief in the modality theory of learning. He applied his ideas on modality learning to the students in his high school foreign language classes. Reinert believed that students learned foreign language best by utilizing their strongest sensory perception. Thus, Reinert developed a word list to which each student identified an auditory, a visual or a touching descriptor for each term on the list. The data collected determined the sensory strength of individual students. With the sensory perception strength identified, Reinert was able to guide students to develop and implement learning techniques in foreign language that build upon the identified visual, auditory or touching strength of learning of each student.

Another team of researchers, Barbe and Swassing, also have based their theory of learning on perceptual modality strengths, visual, auditory and kinesthetic. Their interpretation is that the underlying concept of modality learning style is that modality is any sensory channel through which a person has received and retained knowledge. Sensation, perceptions as seeing, hearing and touching, and memory are processes that are important elements of learning. Furthermore, Barbe and Swassing explained that since these processes were the underpinnings of this learning style that the modalities have been called the keys to learning. The instrument that Barbe and Swassing developed has identified modality strengths through the very nature of the instrument which incorporates vision to identify visual strength, hearing to identify auditory strength, and touching to identify kinesthetic strength. In addition, these researchers expand the value of the identity of modality strength for they believe that optimal learning takes place when students use skills and techniques that are associated with their identified perceptual modality and when students have been exposed to learning through modality based instruction.

Many other theorist have pursued additional ideas to enhance and expand the many learning style theories that are already in the field. The learning style theorists indicated that different people learn in different ways. In all theories, one finds that visual, auditory, and/or hands-on kinesthetic experiences are underlying factors which are present as part of

the learning process. The majority of the learners have identified modality strengths which may or may not be known by the learners. During learning experiences, these students use preferential modality strategies that draw upon their individual modality strength.

This study has concentrated on modality based theory of learning with the study of a class of differentially prepared community college students enrolled in Algebra I. The study was devised to answer topical questions on learning style strengths, and learning style elements that these community colleges students stated they used throughout the semester while enrolled in Algebra I. Furthermore, this study looked for patterns in modality base strategies used in classroom and in private study by students who were visual, auditory, and/or kinesthetic learners. These comparisons were made to better understand modality based strategies which were used by successful as well as unsuccessful students. Several learning style instruments used in conjunction with the study, provided necessary data on modality strengths and modality preferences used by the learners in the participating Algebra I class.

The study was conducted to answer the following Research Question and its Corollary:

Research Question:

Can success in mathematics (defined as a grade ≥ 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students utilize their modality strengths as they study their mathematics?

Corollary:

Can non-success in mathematics (defined as a grade < 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students do not utilize their modality strengths as they study their mathematics?

Subsidiary Questions:

Since both the question and its corollary were so broad in scope, the following subsidiary questions were posed:

1. According to the Swassing-Barbe Modality Index (SBMI) what are the visual, auditory, and/or kinesthetic modality strengths of students in this study?

2. According to self-reports, what modality based strategies do students in this study use in class and are these self-reports positively correlated with SBMI data?

3. According to self-reports, what modality based strategies do students in this study use in private study and are these self-reports positively correlated with SBMI data?

4. According to self-reports of students, classified in different modality groups what are their preferences in the following learning style categories:
   a. environmental conditions, i.e., light, sound, temperature, and room design;
   b. students behaviors i.e., responsibility and motivation;
   c. social behavioral aspects i.e., studying by oneself, with peers, with competent adults;
   d. physical elements, i.e., requires food, functions best in morning or evening, and needs to be mobile? (Student were grouped by SBMI data).

5. Do academic achievement, modality strengths, and self-reported modality based strategy preferences positively correlate for unsuccessful and successful students in this study?

6. Do patterns exist in modality based strategies used by unsuccessful and successful students in this study?

The design of the study, the implementation of its procedures and the descriptive data of the research have been detailed. The data will now be presented in summary form.

Results of the Study

Subsidiary Question One

According to the Swassing-Barbe Modality Index (SBMI), what are the visual, auditory and/or kinesthetic modality strengths of students in this study?

Through the Swassing Barbe Modality Index Instrument, the modality strengths of the seventeen participating students were identified. The results disclosed that there were four visual learners, four auditory learners, four kinesthetic learners and six mixed modality learners. The fact that the distribution of modality strengths occurred as described above is purely a result of chance. This researcher had no prior knowledge or contact with students who self-selected to participate in the research study. The fortunate distribution gave this researcher a representative group from each modality category: visual, auditory, kinesthetic and mixed modalities. Because the distribution presented itself in such a balanced fashion, the researcher was then able to explore each modality strength in keeping with research proposal.

It must be noted that all the data analyzed is particular to this research project which pertains to one specific class of Algebra I students. As a result, the findings of this study may not be generalized to a greater community college Algebra I population.

Subsidiary Question Two

According to self-reports, what modality based strategies do students in this study use in class and are these self-reports positively correlated with SBMI data?

In analyzing the data on modality based strategies used by the students in the classroom, it was found that all auditory and all mixed modality learners showed a strong correlation between modality strength and use of matching modality based strategies. Auditory and mixed modality learners specifically stated that they listen to the instructor as

he explains a mathematics procedure and that they preferred the instructor to explain the problem aloud as he wrote it on the board. Additionally, the mixed modality learners who had identified visual modality strength stated that they liked to follow a step-by-step procedure written out on the blackboard. Furthermore, these same students said that they understood problems better if the instructor used diagrams as part of the explanation and solution.

The three visual learners showed a high correlation between identified visual modality strength and use of matching strategies in the classroom. Specifically, the visual learners self-reported that they liked the professor to use diagrams and charts to explain problems in algebra. They also prefer to watch the instructor write out a step-by-step solution to a problem.

The kinesthetic learners only had a moderate to a low correlation between identified modality strength and matching strategies used in the classroom. Some kinesthetic learners did draw diagrams of class demonstrations in their class notes. However, the instructor did not utilize or provide hands-on manipulatives experiences as part of the algebra course. Instruction that included manipulatives for problem solving would have given kinesthetic learners, as well as other classmates, the opportunity to enhance their understanding of algebra through hands-on activities. As the results indicate, the kinesthetic group had the lowest correlation between identified modality strength and use of matching strategies.in the classroom. Generally, students in all modality groups reported the use of visual and auditory based strategies in class during lectures and discussions.

Subsidiary Question Three

According to self-reports, what modality based strategies do students in this study use in private study and are these self-reports positively correlated with SBMI data?

In private study, all visual learners used visual based strategies to study. The visual based strategies used by the students included drawing diagrams to help understand and

solve word problems as well as studying the charts and diagrams in the textbook that illustrated a process or word problem.

The auditory students were not well correlated with the use of auditory based strategies in private study. Only one auditory student reported that he interpreted word problems best if he read them aloud to himself. The two who were moderately correlated sometimes read their class notes aloud and occasionally read difficult word problems aloud to help hear what the problem was saying. The fourth student in this group never read notes aloud in private study but once in a while did read aloud word problems to help with the understanding of the problem.

The kinesthetic learners had very mixed correlation results when modality strength was compared to use of modality base strategies Three learners were only moderately correlated while the fourth person had a low correlation. The manipulative illustrations in statement 7 on QUESTIONNAIRES # 1 and # 4, pages 145 and 148, suggested the use of coins, paper clips, and making models from paper as means to understanding problems. These students did not use these ideas or other similar manipulative operation to assist their learning. However, these kinesthetic students had not been exposed to the possible use of manipulative materials in class, nor did the text illustrate examples. Therefore, the lack of kinesthetic experiences in understanding mathematics by these students probably prevented them from using such activities to assist their understanding of algebra.

A review of results of the correlations of the six mixed modality learners indicate that two were moderately correlated while the other four were highly correlated. In private study, the highly correlated mixed modality students reported that they used visual based strategies by drawing diagrams to illustrate the word problems and that they studied the diagrams and charts in the text. These students used their auditory skills in private study by reading problems aloud while sometimes reading aloud class notes. The moderately correlated learners used visual and auditory based strategies also, but did not use these strategies regularly or as often as the highly correlated mixed modality learners.

An overall observation of results of use of modality based strategies in private study indicated that there were nine students who showed high correlation between identified modality strength and use of matching modality based strategies in private study. The eight remaining students only used matching strategies in private study sometimes or not at all.

Subsidiary Question Four

According to self-reports of students, classified in different modality groups what are their preferences in the following learning style categories:

a. environmental conditions, i.e., light,sound, temperature, and room design;

b. students behaviors i.e., responsibility, and motivation;

c. social behavioral aspects i.e., studying by oneself, with peers, with competent adults;

d. physical elements, i.e., requires food, functions best in morning or evening, and needs to be mobile? (Student were grouped by SBMI data).

First, the results of the data collected on environmental conditions, i.e., light, sound, temperature, and room design have been previously presented. After the data on environmental conditions were collected and compared, the results indicated varied preferences for each of the four elements by the seventeen subjects in the study.

As a class the students preferred moderate to bright light both in class as well as in private study. These same students indicated that some noise was tolerable in class and private study. However, during private study time background music was preferred by most of the students. As a class, these community college students preferred a warm classroom. However, some students stated that they liked to freshen the air in the study room by opening the window for a short time. There also were a couple of students who would have preferred a cool classroom with plenty of fresh air. These students did select this preference for a cool, study environment in their private study areas.

Studying in a formal, conventional environment using desks and chairs both in the classroom and in private study was the preference of all but one student.

Within each modality group, the data revealed such variation in preferences for the environmental elements of light and noise that nothing significant was reported. However, the visual, kinesthetic and mixed modality groups indicted a preference for warm study area. The auditory group was the only group which had two of the four members who preferred a cool study room. Finally, a formal room design was the preferred choice of all four modality groups.

In general, as a class the students in this study preferred bright lights, soft background noise, a warm room and a more structured formal study area both in classroom and in private study.

Second, the data collected and compared on students' behaviors i.e., responsibility and motivation have been reviewed. The results showed that the entire class acted responsibly toward being prepared for class by doing homework as thoroughly as possible. All students self-reported that they persevered over homework. Occasionally, some students admitted they were unable to complete the homework because of personal obligations or because they did not understand how to find solutions to problems.

As a result, many of these students were motivated to take the initiative to ask questions in class concerning difficult problems. Also some students chose to make appointments with the professor for individual help, use the peer tutors, or ask questions of this researcher or of the professor before class. Obtaining additional help, aided these students in understanding difficult algebra procedures or word problems. Additionally, the students stated that they set aside plenty of time to study and complete homework.

All members of each modality group acted responsibly toward their algebra studies. According to the self-reported responses, the students stated that they came to class regularly and on time and were prepared by doing homework as thoroughly as they were able. Furthermore, each modality group stated that they spent considerable time on their assigned homework problems. The visual and mixed modality groups were motivated and took the initiative to ask questions in class and to seek out additional tutorial help from the

professor, this researcher or the peers in the tutor center. The auditory and kinesthetic group had mixed preferences in seeking additional help. One of the auditory learners reported that she had a difficult time working with the peers in the tutor center. The other auditory learners asked for help as needed from the professor before class. Two of the four kinesthetic learners did not take initiative to ask questions in class. Nonetheless, these two kinesthetic students benefited because other students asked questions about difficult problems, which were answered. The other kinesthetic members took the initiative to get assistance with difficult problems at the tutor center.

As a whole class, the students acted responsibly during private study by completing home lessons and coming to class regularly. Furthermore, they were motivated to take the initiative to ask questions about difficult problems in class, to seek additional help from instructors, classmates or peer tutors in the tutorial center.

Third, data collected and compared on students' social behaviors i.e., studying by oneself or with peers, with competent adults, have been reviewed. The results showed that most of the students stated that they usually studied by themselves. Time constraints, due to full-time jobs and home obligations, limited the times and places as to when and where the students studied. Therefore, the students usually studied in the evening by themselves.

When students had difficulty with home lessons, sometimes they sought help from the professor by appointment or by coming to class early. Several students also made appointments with this researcher to seek additional help as needed. The students stated that they preferred competent adults to tutor them. Only a few students reported that they used peer help in the tutorial center. Only occasionally, did students report that they discussed difficult homework problems with each other before class.

In the visual group, only one student sought help from the peer tutor center. In the auditory group, one student occasionally studied with another person. Two of the four kinesthetic students sometimes studied at the peer tutor center. None of the mixed modality

group studied with peers. The other members in each group asked questions of the professor or this researcher before or during class.

The visual and mixed modality groups reported that they usually studied by themselves. Some of the auditory and kinesthetic students only studied by themselves, but others stated that sometimes they also studied with peers at the tutor center. All visual and kinesthetic subjects preferred to ask questions of mature, competent adults. The auditory and kinesthetic groups had members that sought help from competent adults but also from competent peers at the tutor center.

In general, the social behaviors of the students for studying in the Algebra I class were that they usually studied alone and that they used the professor or this researcher for additional assistance with difficult problems.

Fourth, the data collected on physical elements i.e., requires food, functions best in the morning or evening, and needs to be mobile has been reviewed and compared. The results showed that most students did not mind going to evening classes or studying algebra in the evening at home. In view of the fact that all students were employed at a full time job or were homemakers with child care responsibilities, attending college in the evening was the only option available for them. However, several students stated that they did use morning hours on the weekend to do homework. Several students stated that after a strenuous day at work it was difficult to stay alert for two and one-half hours in evening class.

Many students indicated a preference for some refreshment as coffee or soda during class break. Additionally, other students expressed that they took a break away from studies at home by getting some food or drink. A few students stated that they did not eat or drink during study time. It appeared that having refreshments during study time at class or at home was a very personal and individual choice of each student.

Many students expressed a preference for being mobile during study time such as needing a mid-class break or taking a diversion away from studying in private time.

During the class time break, usually all students got out of their chairs and walked around either in the classroom or in the corridors. At home, these students stated that they studied for an hour and took a break before returning to complete lessons. Some students took a break by getting a coffee or soda, while other students stretched, or took a short walk. Some students studied only for one hour each evening over several days, until homework was completed.

Some members of each modality group expressed that evening hours for class and studying were difficult. All students in the auditory group stated that evening class and study time were acceptable. Since all modality groups had so much variance in preferences for refreshments during study, that there is no significant result to report. However, the choice of and desire for refreshments during study time appears to be a very individual preference. All modality groups had some variance within the group for preference for mobility. However, more members of the kinesthetic group than the other groups indicted the need for mobility by taking a break from studying by moving, stretching or walking.

In summation, all these students acted responsibly toward class work and home lessons. Evening hours were difficult for some students, but they did come to class and often studied at night. A few morning persons did use Saturday and/or Sunday mornings to do private study. Furthermore, it appeared to be a very personal and individual choice for students to have refreshments while studying. Additionally, these students were mobile in class and during study time They stated that they needed to take a break during class, move about after a long period of intense classroom work and often took a break from long, concentrated study efforts.

Subsidiary Question Five

Do academic achievement, modality strengths, and self-reported modality based strategy preferences positively correlate for unsuccessful and successful students in this study?

The data collected and compared on students' academic achievements of quizzes and hourly examinations in Algebra I throughout the semester showed grades as successful (≥ 70) or unsuccessful (< 70). These grades fluctuated for some students throughout the semester. Of the seventeen subjects, fifteen students were successfully, two students were unsuccessful in Algebra I. One unsuccessful student with a failing grade, < 70, after seven quizzes and three exams in the Algebra I class was a SBMI auditory learner. The second unsuccessful student was a SBMI kinesthetic learner. This study contains insufficient data for unsuccessful students in the modality groups to report any significant finding.

All visual learners were successful. Also, the SBMI identified visual learners were positively matched with the use of visual based strategies in the classroom and in private study. Thus, these results have been interpreted to mean that there was a high correlation between the success of these students and the fact that these SBMI identified visual subjects used visual strategies in learning algebra.

Limitations on this interpretation and the following results exist in that many other factors may have influenced the success of the students such as motivation, perseverance, and responsibility to study home lessons and complete course requirements all of which have been previously discussed in results of Subsidiary Question Four.

A review of the data on the auditory learners, indicated that three of the four learners were successful in obtaining a QPA ≥ 70. These three successful auditory students were well matched with use of auditory based learning strategies both in class and in private study. However, the data collected on the only auditory learner who was unsuccessful indicated that even though the student was using auditory based strategies in class, the student did not use auditory based learning strategies during private study time.

For the three successful auditory students, the use of auditory based strategies used in class and in private study seemed to influence the students' success in learning Algebra I.

The mixed modality learners were all successful. This group, whose mixed modalities were identified as visual and auditory were well matched in use of visual and auditory learning strategies in class. A few students did not use visual and/or auditory strategies as often in studying at home as they reported they did in class. However, all six mixed modality students were successful and did use mixed modalities in learning Algebra I that matched their modality strengths. Furthermore the one student who was a mixed visual, auditory, and kinesthetic modality learner also used some kinesthetic strategies in private study time.

The kinesthetic students had a low correlation for use of kinesthetic modality based strategies. These students did not use manipulative materials or have concrete experiences demonstrated as part of their learning in Algebra I class. Two of the kinesthetic students did report that they did occasionally use manipulative materials during private study. These kinesthetic students were only moderately correlated with use of kinesthetic based strategies in learning algebra. Despite these facts, three of the four kinesthetic students were successful. A fourth kinesthetic student who was unsuccessful as the semester continued, finally dropped out of the course two weeks before the end of the semester. The fact that these three kinesthetic students were successful may be attributed to the fact that they were also using auditory and visual based strategies as the data reported earlier in CHAPTER IV, Subsidiary Questions Two and Three.

Many adult learners have developed a combination of many modality learning strategies because of their great number of years of work and life experiences in solving problems and attempting new tasks. In class and in private study these three kinesthetic students apparently used visual and auditory strategies, which were not identified by SBMI as their modality strengths, to reach success in Algebra I.

Subsidiary Question Six

Do patterns exist in modality based strategies used by unsuccessful and successful students in this study?

The data collected and compared on modality based strategies used by each of the SBMI identified modality groups were reviewed specifically to find patterns of learning used by students of each modality group. Also, the individual profiles of the two unsuccessful students were grouped together, and the individual learning style profiles of the fifteen successful students were grouped and filed by SBMI modality strength. Both the unsuccessful and successful were examined to find the prevalent modality based strategies that were used by students in each group.

There were only two students in the research study group who were unsuccessful. One student was an auditory learner; the other was a kinesthetic learner. Any patterns of modality based strategies that they used or did not use as part of the learning process of algebra were very individual to the particular student. The learning strategies that were used by these students will be discussed to give some insight into possible factors that were apparent or were lacking when the study habits of unsuccessful students were compared to successful students of same modality group.

Review of the data collected of the unsuccessful auditory student showed only a moderate match between use of auditory based learning strategies and modality strength by SBMI. However, this student was persistent and did complete the Algebra I course. When this student's profile was examined, specifically in private study, it showed that she only sometimes read her notes prior to studying and attempting homework. She also had difficulty doing word problems and did not attempt to read them aloud. In class, she listened during the instructor's explanation but was not easily able to follow the display of solutions written out board without a thorough step-by-step discussion. This same student also was annoyed in class when students interrupted the flow of instructor's solution by asking questions about a step in the procedure. This particular student was also confused

by diagrams that the professor used to accompany solutions to word problems. Furthermore, a review of this student's use of modality based strategies showed that she did not use auditory based strategies that successful members of the auditory group used. As noted previously, the successful visual, auditory, mixed modality, and kinesthetic students in the research study used many modality based strategies, some of which did not match their SBMI modality strength. Because this auditory student was not regularly using matching modality based strategies and/or visual based strategies in class and study, it appears that this lack of use may have brought about her academic failure. Her underdeveloped study skills and her lack of use of auditory based strategies apparently played a role in her lack of success in algebra.

The other unsuccessful student was a kinesthetic learner who showed a moderate match between kinesthetic modality strength and use of kinesthetic based strategies in learning algebra. This student did not complete the course, dropping out before the final exam. However, this student did answer the four QUESTIONNAIRES and reported that she sometimes used a few manipulatives, but that she also used auditory and visual based strategies as part of her learning of algebra. In class, she followed the professor as he explained and as he did step-by-step solutions to problems. She also was able to follow the diagrams that the professor used in understanding and in solving word problems. However, she did not regularly use these strategies in doing her homework lessons. Furthermore, as the semester progressed, there were extenuating personal circumstances that interfered with this student's prompt arrival to class, as well as preparation for class. Near the end of the semester, this student was absent from class and did not take the final.

The analysis of this data on unsuccessful students is particular for the specific students. Since there were only two unsuccessful students who represented only the auditory and kinesthetic modality groups, this research lacks sufficient data to make any further comments concerning patterns of modality based strategies that unsuccessful students in specific modality groups used.

The individual profiles of the successful visual students were grouped and examined. These students used visually based strategies to varying degrees. The most significant strategies used in class by visual students were watching step-by step solutions written out on the board and observing the use of diagrams that the professor presented as part of problem understanding and solution. Furthermore, these students used these two strategies of step-by-step solution and diagramming problems while doing home work. As mentioned previously, these visual students also incorporated auditory based strategies in their learning algebra. Specifically, in class they listened intently to the professor as he explained solutions to word problems, concepts and techniques in algebra. In private study, these students often read aloud word problems in order to comprehend the content and questions to be answered from the problems.

The auditory learners focused their attention in class on listening carefully and intently to the professor while he explained the problems as he wrote the solution. Usually these students listened to the professor and then copied notes from the board. During private study, these students read word problems aloud to themselves as a routine part of understanding. They also read aloud their notes. These auditory students also used additional modality based strategies in their studying of algebra. These students combined visual based strategies with auditory based strategies to understand concepts of algebra in class as well as at home. Visual learning techniques such as drawing and using the number line as well as diagraming word problems were used frequently by these auditory learners.

The kinesthetic learners were successful despite the fact that kinesthetic based strategies were not a regular, integral part of their learning algebra. The kinesthetic student used their visual and auditory skills to implement many visual and auditory based strategies that helped them learn algebra. These kinesthetic learners listened intently to the professor explain step-by-step problems. They learned from and developed the use of diagrams for problem solving from the professor in class. During private study of home assignments, these kinesthetic students used schematic drawings as part of visual strategy for solving word

problem. Additionally, reading word problems aloud was a strategy that the kinesthetic students implemented in private study of algebra. As a result of using many, diverse modality strategies, the kinesthetic students were able to achieve success in Algebra I.

The six students who were mixed modality used both visual and auditory based strategies to reach successful achievement in algebra. These mixed modality students were extremely attentive in class to the professor. They watched the step-by-step solutions written on the board and listened intently to the explanation as the professor wrote out the problem procedure or solutions. These students stated that word problem were easier to understand if diagrams were used as part of the solution. During private study, these mixed modality learners used visual and auditory based strategies to understand and do homework lessons. These students frequently read aloud word problems as well as drew diagrams as part of the solution to homework problems. Occasionally, these students studied charts and diagrams in the text as well as read over class notes to prepare themselves to do homework problems. The only student, who has mixed modality of auditory, visual, and kinesthetic, used a few manipulative strategies in homework. From reading additional library algebra textbooks, this student used some hands-on discovery strategies which helped her to understand word problems concerning volume and distance. The mixed modality students were successful in algebra, having used both visual and auditory based strategies that matched their SBMI modality strength.

Research Question

Can success in mathematics (defined as a grade $\geq$ 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students utilize their modality strengths as they study their mathematics?

Corollary

Can non-success in mathematics (defined as a grade $<$ 70 on quizzes and hourly examinations in developmental Algebra I class) be attributed to the fact that students do not utilize their modality strengths as they study their mathematics?

There were successful students in each modality group. In review of the self-reports of modality learning strategies used both in the classroom and in private study, it is apparent that the successful students in all four modality groups used both the visual and auditory based strategies in class and private study. These students not only used matched modality strategies, but also broaden their learning style by incorporating additional modality strategies. The visual, auditory, and mixed modality students had a positive correlation between use of modality based strategies and modality strength. As this Algebra I class was presented as a lecture style, there were ample opportunities in the classroom to use visual and auditory strategies which matched the instructors written and oral lecturing. The successful kinesthetic students also used visual and auditory based strategies which were strategies that they had developed beyond their modality strength. Results indicate that the successful students did utilize their modality strength to be successful in the Algebra I class.

There were unsuccessful students in only the auditory and kinesthetic groups. In both cases each student only received a moderate correlation between use of modality based strategies and modality strength. The auditory student did listen to the professor in class, but did get annoyed by students who asked questions of the instructor and interrupted the flow of the instructors explanation. This students also was confused by diagrams that the professor used to illustrate problems. In private study this student did not regularly use auditory based strategies suggested in the QUESTIONNAIRES. Because this student was not regularly using matching modality based strategies and /or visual based strategies in class or study, it appears that this lack of use may have brought about academic failure. The second unsuccessful student was a kinesthetic learner, and had a moderate correlation between use of modality based strategies and modality strength. However, this student did use additional strategies besides matched modality strategies. This was illustrated by a

high score in watching step-by-step solutions to problems and in understanding problems when diagrams were used in class by the instructor. In private study, this student did not regularly use these strategies in homework lessons. Results indicate that the unsuccessful students did not utilize their modality strength and were not successful in Algebra I class.

To make this study meaningful to the participants, each student was sent a copy of their own individual profile, Appendix I, pages 161-180. It is hoped that these reports will be reviewed by the students and the data on the individual profile will prove interesting and significant to the individual student. Also, a copy of the table, "Observable Characteristics Indicative of Modality Strength" (Barbe & Swassing, 1979, pp. 44-45), Appendix J, page 179, and the table "Modality Based Learning Strategies", Appendix K, page 181 have been included in the mailing. The Barbe and Swassing table gives each student additional pertinent information on modality characteristics of each modality strength which may prove helpful to them in understanding their modality learning style. "Modality Based Learning Strategies" is a table that lists study strategies used by successful students in each modality that may serve to assist and broaden study strategies of students.

Generalizability of the Study

This study was limited to the extent that the sample was not representative of all differentially prepared mathematics students at the community college. The number of subjects was too small to have produced results that could be generalized to anything other than the specific Algebra I class that was monitored. The results provided patterns of modality based learning strategies of the successful students grouped by modality strength had stated they used. These results were only useful to the class of Algebra I students who participated in the study. Learning style profiles of students identified the students modality strengths by the Swassing Barbe Modality Index which is a validated statistical

instrument. The modality based strategies used in class and in private study were identified by self-reports to the QUESTIONNAIRES developed by the researcher for this study. The QUESTIONNAIRES also provided data specific for each student on many other elements of learning often associated with learning style. These QUESTIONNAIRES were limited in and of themselves in that the focus of some statements were narrow and too specific.

The focus of this study was limited in size and in specific population of the nontraditional, differentially prepared students. Based upon these facts, it is unadvisable for his researcher to make generalization to other populations.

Implications of the Study

This study has provided data on modality learning styles of differentially prepared nontraditional students while they were enrolled in Algebra I. Additionally, data had been collected on self reported modality based strategies that these students used in classroom and in private study. Patterns of modality based strategies used by successful and unsuccessful students have been pursued in each modality. The results reported may have some bearing on teaching developmental mathematics at the community college and on understanding students' learning styles and learning strategies associated with them. The following are some ideas that might be helpful to successful teaching and learning of developmental mathematics for population of differentially prepared, nontraditional students in community college.

To Community Colleges

The following are recommendation: (1) pretest students for proper academic mathematics placement, and also for identification of modality learning strength;

(2) provide varied learning environments, such as mathematics laboratories equipped with audio/visual aids and manipulative materials that provide mathematics experiences based on visual, auditory and kinesthetic modalities to improve the effectiveness of teaching outcomes; (3) provide instructors, peer tutors and tutors of both sexes and in different age groups not only who will meet the academic needs but also who will be sensitive to the emotional needs of nontraditional, differentially prepared students; (4) provide staff development that enriches auditory, visual, and kinesthetic modality based teaching techniques among the college faculty; (5) provide student workshops to develop learning habits and study skills that develop and enrich awareness of students' modality strengths as well as modality based strategies to broaden the many skills associated with learning.

To Instructors of Developmental Mathematics

The following are recommendations: (1) provide visual, auditory, and kinesthetic learning experiences in class; (2) provide video tapes of specific mathematical procedures for review or for make up class; (3) provide opportunities to explore and to make use of all visual, auditory, and kinesthetic equipment in the mathematics laboratory; (4) provide a mathematics laboratory with a competent adult trained in modality based instruction and with resources to support modality based learning experiences for students of development mathematics.

Future Research

There are several ideas for research projects that have been stimulated by this learning style research study and are possible extensions to augment this project. An initial assessment study can be expanded to include the entire student body of developmental

mathematics at the community college. The larger sample would provide data that would ensure a broader base from which to draw conclusions about importance of personal modality strength knowledge and modality based instruction and to make recommendations for other changes in community college mathematics teaching.

The first phase of the study could be designed so as to identify the modality strengths of all developmental mathematics students. Then with some students of each modality in a control classroom with tradition lecture style teaching and with other students in a modality-rich teaching environment, parallel assessment of academic achievement could be monitored. The study could look at the use of modality based strategies of students in both test and control environments. Also, the study could investigate the use of modality based strategies that students use in private study. From the data collected correlations could be made between variations in modality based instruction and use of modality based study strategies and students' academic achievements.

Another study could be devised in which students tape record lecture for listening review in private study time. Also video tapes of the particular mathematical concepts could be made available for review of mathematical procedures and solutions to word problems. Then a study could be conducted to find the impact of the augmented auditory and visual/auditory modality learning experiences provided for a test group but not a control group.

Another research project could be a comparative study of modality learning style instruments for validity on community college students for example: Canfield, L S I, Learning Style Inventory; Dunn, P E P S (Productivity Environment Preference Survey); Marsh, QUESTIONNAIRES; National Association of Secondary School Principles, L S I; Barbe and Swassing, S B M I.

An impact of environment study could be established in which students studied in college classrooms that met students' consensus of classroom environmental preferences such as light, sound, temperature, and moveable furniture vs. control classroom without regard for classroom environmental preferences of students. This study would look at academic achievement in relation to students' attitudes, motivation, rate of learning and interest in mathematics under both sets of conditions.

Concluding Statement

The intent of this dissertation was to bring attention to the learning styles of differentially prepared community college students while enrolled in developmental mathematics. Therefore, this study focused on identification of modality strength of these students and their use of modality based strategies in learning Algebra I.

The Barbe and Swassing philosophy of learning is based upon the fact that learning lies within the modality strength of the students. The key is to identify the student's modality strength and then to have the student use modality based learning strategies that capitalize upon modality strength. Students must be made aware of learning and study practices that build upon their modality strength. The Modality Based Learning Strategies table in Appendix K provides learning techniques in each modality that build upon modality strength.

Enriched classroom instruction allows students to use modality strength to construct their own meaning to mathematical procedures and practices. In the classroom, the instructor can use methods that incorporate visual and auditory aids and provide kinesthetic experiences so that instruction reaches every learner. These teaching practices not only are sensitive to the issue that every student learns differently but also provides learning

experiences in which students are active participants. Developing and adopting methods that meet the modality strength of the learner provide an outline for a formula to create efficient and successful ways to achieve the goals of education. Thus, modality based instruction can be effective since it is oriented toward modality strength of the learner.

Modality is a physiological characteristic with which an individual is endowed. Modality strength is determined chiefly by hereditary factors and it undergoes little change between childhood and adulthood (Barbe & Swassing, 1979). As adults, we usually know our own weak areas of learning which we have learned through years of trial, error, and frustration. As adults, we usually avoid these difficult areas and methods of learning and direct our activities instead to our areas of strength. By utilizing our preferred, comfortable methods of learning to tackle new projects or overcome deficiencies, not only are the tasks easier to learn, but the learning experiences are enjoyable. These learning experiences are both positive and successful because we are dealing from a position of strength.

The diverse backgrounds that nontraditional students bring to community college classroom are not only a product of previous educational background and life experiences, but also a result of processes of learning that nontraditional persons have acquired and used. Therefore, to understand the learning processes employed by these students is an important fact to consider when establishing courses at the community college. An awareness of modality strengths in learning and modality teaching practices that address diverse modality strengths of students can be incorporated into classroom teaching. Students have developed their own learning style and research has shown that individuals learn differently. However, nontraditional, differentially prepared students have learned not only to rely on their modality strength but also they have incorporated other modality based strategies learned through their life's experiences. As a result, diverse teaching practices that reach visual, auditory, and/or kinesthetic learners must be an important

consideration by the faculty at the community colleges. This fact should be addressed by the colleges. A sharper focus on teaching practices to meet all learning styles is an important endeavor of the college instructors for successful teaching/learning of developmental mathematics.

Modality based instruction is an approach to teaching which capitalizes on students' learning strengths. This theoretical teaching construct seems compatible with the constructivists' philosophy espoused by the National Council of Teachers of Mathematics and the National Research Council. The vast amount of modality-based research that has been conducted over the past two decades is in no way conclusive but, findings seem to suggest that modality researchers are contributing to the epistemological understandings of constructivists educators.

With the National Council of Teachers of Mathematics and the National Research Council calling for reform in mathematics that will have students constructing their own personal understandings and actively participating in their learning, more studies on the impact of modality based instruction may be warranted.

The National Research Council urges educators from elementary schools through post secondary school to engage students actively in the process of learning. This suggests that teachers should teach to the modality strengths of their students. This Council makes an appeal to the colleges in EVERYBODY COUNTS A Report to the Nation on the Future of Mathematics Education which states that,

> Real change requires action by everyone involved in mathematics education. Change in the institutions of education must come about as result of debate within the institutions. ...To Colleges and University Faculty:
> Make introductory courses attractive and effective; Recognize that mathematics classes need computer labs; Restore integrity to the undergraduate program; *Lecture less; try other teaching methods; (Italics added)* Link scholarship to teaching. (National Research Council, 1989, pp. 93-94)

When environments and interactions are arranged so that students can use their modality preferences to 'act on" the mathematics they are trying to understand, teachers at all levels should feel confident that they are producing individuals who feel mathematically capable and personally empowered to handle the quantitative demands of the twenty-first century.

APPENDIX A

PERMISSION LETTERS

Springfield, MA 01108
Fall, 1990

Dean of Academic Affairs
Community College in Massachusetts

Dear Dean:

I am a doctoral candidate in mathematics education at the University of Massachusetts. Through my association with Dr. X during the past two years, I became aware of the department of academic affairs' interest in stress management for nontraditional students. Much of my research interests have dealt with mathematics anxiety and nontraditional students who are underprepared for college level mathematics.

Additionally, Dr. X made me aware of the Title III Project that was in progress with Dr. Z in the mathematics department. The questionnaires used to gather information on students enrolled in the developmental mathematics series will provide much data that can be studied to gain knowledge of the students in the developmental mathematics program.

Therefore, I would like permission to look into data results further. I would like to have access to students' permanent records. To broaden my study, I would like to administer the Swassing/Barbe Modality Index Test .
I would like to interview some of the students to investigate learning style preferences. Additionally, I would like to observe the developmental mathematics classrooms to gather on site information on modality based strategies that students used in the classroom.

However, I wish to assure you of the anonymity in regard to population and setting. Students will only be identified as developmental mathematics students who are nontraditional, male or female learners at an urban community college in Massachusetts.

I thank you for your consideration on these requests.

Sincerely,

Joan C. Marsh

Joan C. Marsh

Springfield, MA.01108
October, 1990

Dr. Raymond H, Swassing
Department of Educational Research
Ohio State University
Columbus, Ohio, 43210

Dear Dr. Swassing;

I am a graduate student in the School of Education at the University of Massachusetts. Currently, I am writing my dissertation proposal titled: Developmental Mathematics Achievement of Differentially Prepared, Nontraditional Students At A Community College: A Study of Modality (Learning Styles) Preferences.

I plan to use the Swassing/Barbe Modality Index, SBMI, to reveal the modality strengths of my subjects. I would like your permission to use the SBMI test in my research.

Enclosed is a permission statement that I would like you to sign and return in the addressed envelope provided. Thank you for your cooperation.

Sincerely,

Joan C. Marsh

Joan C. Marsh

encl.(2)

Permission Statement

Date October 21, 1990

I K. H. Swassing give my permission to use the Swassing /Barbe Modality Index , SBMI, to Joan C. Marsh, a doctoral candidate in education at the University of Massachusetts, in her research study.

APPENDIX B

WRITTEN CONSENT FORM

Written Consent Form
Developmental Mathematics Achievement of
Differentially Prepared, Nontraditional Students,
at a Community College:
A Study of Modality (Learning Styles) Preferences

To Participants in This Study:

I am Joan C. Marsh, a graduate student, at the University of Massachusetts in Amherst. The subject of my doctoral research is, "Modality Learning Styles and Mathematics Achievement of Differentially Prepared, Nontraditional, Community College Students". I plan to collect and review data from Questionnaires which you will be taking. Also, I plan to interview you as students of developmental mathematics throughout the semester, to investigate your mathematics learning experiences here at this community college. You are one of many student participants.

As part of this study, you, as students at this community college, are being asked to participate in a series of questionnaires and interviews which will focus on your mathematics learning style preferences in the classroom and in your private study time. Also a Modality Index of perceptual learning styles will be administered to you to further identify the strengths of your most efficient learning styles. Each interview, questionnaire or Index will take approximately 15 to 20 minutes.

Furthermore, I will attend your mathematics lectures and audio-tutorial laboratory to make classroom observations and journal entries of students' activities, modality based strategies used by students, and mathematics instruction.

My goal is to review the data gathered from the questionnaires, the interviews and Modality Index to look for patterns in learning styles that are used by visual, auditory and/or kinesthetic students who are successful and unsuccessful in mathematics. I plan to write a descriptive profile of learning style preferences of each participant. I may also wish to use some of the data and results of this study for journal articles, workshop presentations or for instructional purposes in my teaching. I may wish to write a book based on this dissertation.

All notations, data results, journal notes will be transcribed by myself. I plan to code all names to maintain anonymity. In all written materials that I use, I will not use your name, nor the name of your college and its city location. Furthermore, you may withdraw at any time from this study. If I were to use any materials in a manner not consistent with what is stated above, I would seek your additional written consent.

In signing this form, you are also assuring me that you will make no financial claims for the use of materials you contributed toward this study.

I,....., have read the above statements and agree to participate under the conditions stated above.

Signature of participant.....

Signature of researcher.....Date.....

APPENDIX C

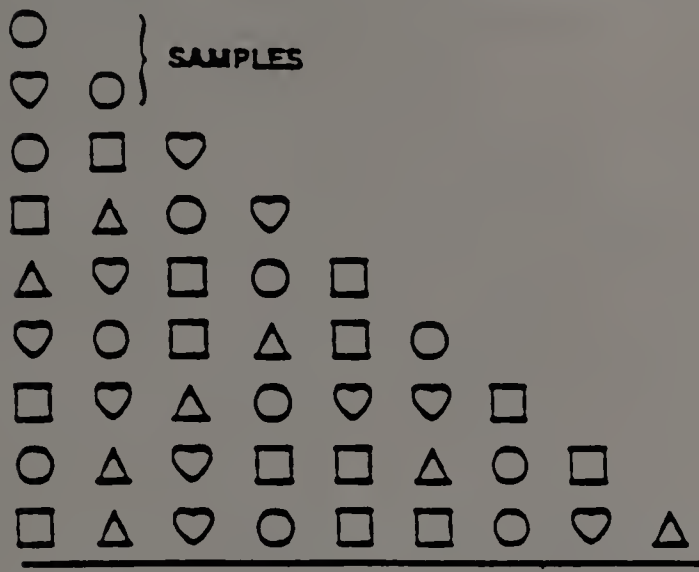
SWASSING & BARBE MODALITY INDEX FORM

SWASSING—BARBE MODALITY INDEX RECORD SHEET

Date: _____

Name: _____ Examiner: _____

Birthdate: _____ Sex: F____ M____ Grade: _____ Dominant Hand: L____ R____



VISUAL TEST:
Show set of shapes; follow timing guidelines as outlined in directions. Remove card at end of time limit or when child indicates she/he is finished if before allotted time. Child assembles sequence just seen. Mark answer sheet. Stop test when child has made errors on two consecutive sets.

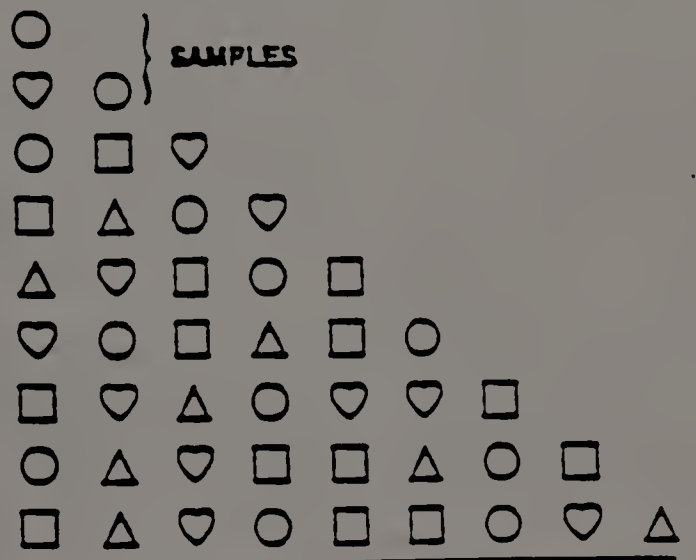
TOTAL VISUAL CORRECT: _____

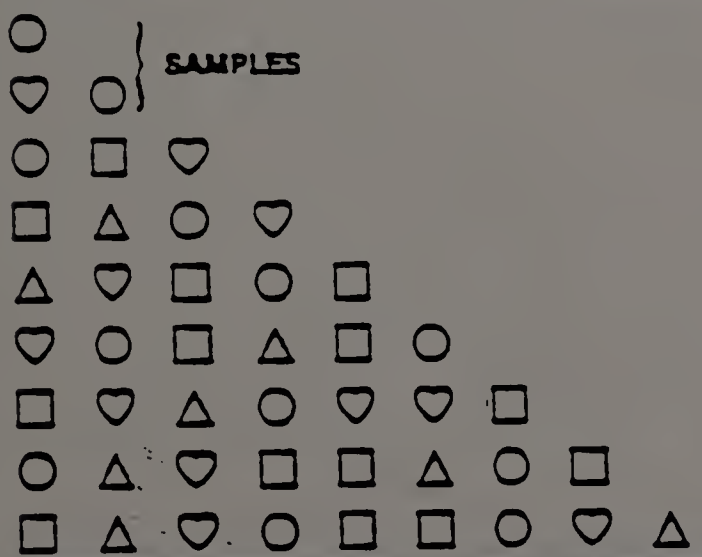
Before proceeding, ask child how she/he arrived at answer _____

AUDITORY TEST:
Read aloud the names of shapes in sequence at rate of one per second. Child assembles sequence of shapes just heard. Mark answer sheet. Stop test when child has made errors on two consecutive sets.

TOTAL AUDITORY CORRECT: _____

Before proceeding, ask child how she/he arrived at answer _____





KINESTHETIC TEST:
Holding shield so child cannot see shapes, put set in front of child; place child's dominant hand on first shape on left; child may use both hands. Do not speak during test. If child accidentally skips a shape, place her/his hand on missed shape. Follow timing guidelines as outlined in directions; remove set and shield. Child assembles sequence. Mark answer sheet. Stop when child has made errors on two consecutive sets.

TOTAL KINESTHETIC CORRECT: _____

Ask child how she/he arrived at answer _____

VISUAL CORRECT: _____

AUDITORY CORRECT: _____

KINESTHETIC CORRECT: _____

TOTAL CORRECT: _____

PERCENTAGE VISUAL: _____%

PERCENTAGE AUDITORY: _____%

PERCENTAGE KINESTHETIC: _____%

APPENDIX D

QUESTIONNAIRES

QUESTIONNAIRE A

NAME _____ code _____.

ADDRESS _____.

_____ State _____ zip _____.

PHONE _____.

BIRTHDATE _____ MALE _____ FEMALE _____.

FILL IN THE BLANKS AND CIRCLE APPROPRIATE ANSWERS

SINGLE .MARRIED .CHILDREN? No Yes NUMBER _____.

BILINGUAL? No Yes LANGUAGE _____.

IN WHAT COUNTRY WERE YOU EDUCATED PRIOR TO HIGH SCHOOL?

_____.

WHAT YEAR WERE YOU IN SCHOOL PRIOR TO THIS COLLEGE? 19 _____.

WHAT TYPE OF SCHOOL? VOCATIONAL HIGH SCHOOL _____.

.MILITARY SERVICE JOB CORPS GED OTHER ? _____.

PRESENTLY EMPLOYED? NO YES FULL TIME PART TIME _____.

TYPE OF WORK? HOMEMAKER Yes No _____.

PLANNED MAJOR AT THIS COLLEGE _____.

FACTORS INFLUENCING YOU TO ENROLL AT THIS COMMUNITY COLLEGE

_____

_____

DIRECTIONS FOR QUESTIONNAIRES

This questionnaire gives you the opportunity to describe your preferences of how you learn best. There are no right or wrong answers. You are to read each of the fourteen statements and CIRCLE the response according to how well it describes your reaction or feelings.

QUESTIONNAIRE # 1 code_____.

1. I prefer to study in a room with subdued, overhead lighting.
never once in a while sometimes many times every time

2. I study in a quiet room with the door shut.
never once in a while sometimes many times every time

3. I read my class notes aloud to understand them better.
never once in a while sometimes many times every time

4. I feel more comfortable studying in a warm room.
never once in a while sometimes many times every time

5. I draw diagrams to help solve math problems
never once in a while sometimes many times every time

6. I munch on cookies and/or candy while studying.
never once in a while sometimes many times every time

7. I use coins, paper clips etc. to help me understand a math problem.
never once in a while sometimes many times every time

8. I do my homework in the early part of the evening.
never once in a while sometimes many times every time

9. I prefer to do my homework by myself.
never once in a while sometimes many times every time

10. I find I sit at a desk for long time before I get up to move about.
never once in a while sometimes many times every time

11. At home, I study on the floor reading and /or writing my lessons.
never once in a while sometimes many times every time

12. I can find many excuses for not doing my homework.
never once in a while sometimes many times every time

13. I study my homework with a partner.
never once in a while sometimes many times every time

14. I set aside plenty of time to get all my homework done.
never once in a while sometimes many times every time

QUESTIONNAIRE #2 code ____.

1. The brightness of the lights in the classroom bothers me.
never once in a while sometimes many times every time

2. I like the classroom to be quiet.
never once in a while sometimes many times every time

3. I like teacher to explain problem aloud as he writes it on the board
never once in a while sometimes many times every time

4. I think and work better in a warm classroom.
never once in a while sometimes many times every time

5. I understand problems better when he uses diagrams & charts.
never once in a while sometimes many times every time

6. I enjoy drinking soda or coffee during class.
never once in a while sometimes many times every time

7. I learn an idea better if I pick up a model, handle or work with it.
never once in a while sometimes many times every time

8. I learn better if my classes are in the morning.
never once in a while sometimes many times every time

9. I prefer to work out the homework problems by myself.
never once in a while sometimes many times every time

10. I need to go for a walk at class break time.
never once in a while sometimes many times every time

11. I like to work at large tables in the classroom.
never once in a while sometimes many times every time

12. I come prepared for class with my homework completed.
never once in a while sometimes many times every time

13. I like instructor to do solutions to problems with much detail.
never once in a while sometimes many times every time

14. I go to class early to get help from the instructor.
never once in a while sometimes many times every time

QUESTIONNAIRE #3 code ___.

1. I cannot be attentive in class if the lights are dull.
never once in a while sometimes many times every time

2. During tests, the least sound distracts me from my work.
never once in a while sometimes many times every time

3. In class,I listen to professor as he explains math idea or procedure.
never once in a while sometimes many times every time

4. I can learn better if the classroom is cool.
never once in a while sometimes many times every time

5. I watch step-by-step solutions to problems when written on board
never once in a while sometimes many times every time

6. I eat candy or chew gum in class.
never once in a while sometimes many times every time

7. In class, I find I recreate demonstrations as drawings in my notes.
never once in a while sometimes many times every time

8. I find it difficult to learn in my classes at night.
never once in a while sometimes many times every time

9. I understand problem solving better when I work with a partner.
never once in a while sometimes many times every time

10. When forming team, I walk to group at another place in the room
never once in a while sometimes many times every time

11. I prefer to have desks in class lined up in rows.
never once in a while sometimes many times every time

12. I hand in my homework on time.
never once in a while sometimes many times every time

13. I team up with a mature adult in class for problem solving.
never once in a while sometimes many times every time

14. I ask teacher questions in class if I need additional explanation.
never once in a while sometimes many times every time

QUESTIONNAIRE # 4 code ____.

1. I need a direct, bright light near me when I study.
never once in a while sometimes many times every time

2. I like the radio playing softly in the background while studying.
never once in a while sometimes many times every time

3. I interpret word problems best if I read them out loud to myself.
never once in a while sometimes many times every time

4. I like to open window for fresh air and to keep cool while I study
never once in a while sometimes many times every time

5. Studying charts & graphs in text helps me to understand problem
never once in a while sometimes many times every time

6. I enjoy drinking soda, coffee, or some beverage while I study.
never once in a while sometimes many times every time

7. I fold paper or tear up into pieces to help solve problems.
never once in a while sometimes many times every time

8. I prefer to do my homework first thing in the morning.
never once in a while sometimes many times every time

9. I study with a classmate.
never once in a while sometimes many times every time

10. I take a lot of breaks from my desk during study time.
never once in a while sometimes many times every time

11. I do my homework sitting on a firm chair at a desk.
never once in a while sometimes many times every time

12. I make sure that I try to do all my math homework.
never once in a while sometimes many times every time

13. I use the tutorial service for help with difficult problems
never once in a while sometimes many times every time

14. I make an appointment to see instructor for help with homework
never once in a while sometimes many times every time

Key for QUESTIONNAIRES code ___.

1. LIGHT 1. _____2._____3._____4._____.

2. SOUND 1. _____2._____3._____4._____.

3. AUDIO 1. _____2._____3._____4._____.

4. TEMPERATURE 1. _____2._____3._____4._____.

5. VISUAL 1. _____2._____3._____4._____.

6. FOOD 1. _____2._____3._____4._____.

7. KINESTHETIC 1. _____2._____3._____4._____.

8. TIME 1. _____2._____3._____4._____.

9. PEER 1. _____2._____3._____4._____.

10. MOBILITY 1. _____2._____3._____4._____.

11. ROOM DESIGN 1. _____2._____3._____4._____.

12. RESPONSIBILITY 1. _____2._____3._____4._____.

13. ADULT AUTHORITY 1. _____2._____3._____4._____.

14. SELF MOTIVATION 1. _____2._____3._____4._____.

APPENDIX E

INTERVIEW QUESTIONS

INTERVIEW QUESTIONS #1 code ____.

1. Are you nervous about this algebra class?

   Explain

2. Are you confused during class lesson presentations?

   Explain

3. Do you have difficulty doing the homework?

   Explain

INTERVIEW QUESTIONS #2 code___.

1. What kind of classroom presentations do you find most helpful?

   Explain

2. What do you do during study time to help you understand the new material?

   Explain

3. Do you take advantage of the tutorial service?

   Explain

INTERVIEW QUESTIONS #3 code ___.

1.What characteristics of your instructor do you find most helpful?

Explain

2. What characteristics of your instructor do you find least helpful?

Explain

3.What practices have you added to your study time to improve your understanding of algebra?

Explain

4. How confident do you feel about your understanding of algebra as a basis to continue into the next course in the mathematics series?

Explain

DEPARTURE INTERVIEW

Name _____.

Date _____.

Did you find participation in this research interesting?

Explain

Would you like to have a profile of your modality learning strengths and preferences?

I want to thank you for your participation in my research project. I hope that the profile you requested will benefit your future college studies.

Good luck in your final exams.

APPENDIX F

DUNN & DUNN & PRICE, 1975

DUNN & DUNN & PRICE 1975

STIMULI

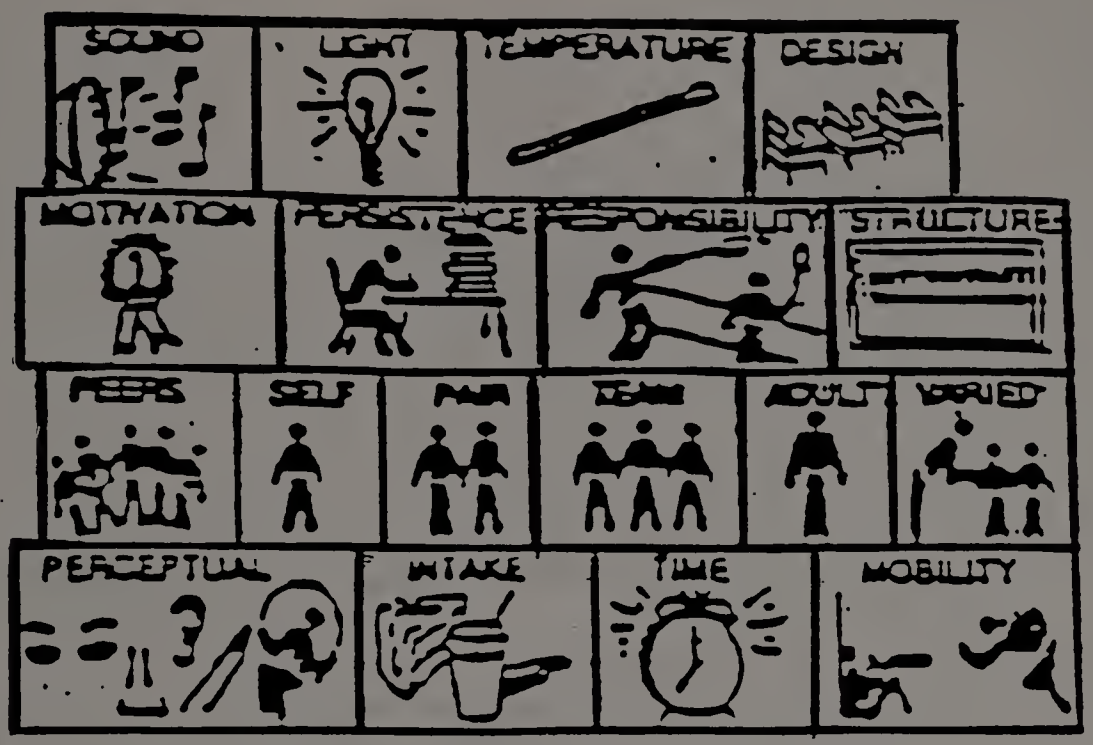
LEARNING STYLE ELEMENTS

ENVIRONMENTAL

EMOTIONAL

SOCIOLOGICAL

PHYSICAL



ENVIRONMENTAL STIMULI

1. SOUND-QUIET OR SOUND PREFERRED
2. LIGHT- BRIGHT OR LOW
3. TEMPERATURE- COOL OR WARM
4. DESIGN- INFORMAL OR FORMAL

EMOTIONAL STIMULI

5. SELF-MOTIVATED
6. ADULT-MOTIVATED
7. TEACHER-MOTIVATED
8. UNMOTIVATED
9. PERSISTANT-NOT PERSISTANT
10. RESPONSIBLE-NOT RESPONSIBLE
11. STRUCTURE NEED OR NOT NEED

SOCIOLOGICAL STIMULI

12. PREFERS LEARNING ALONE
13. PEER-ORIENTED LEARNER
14. PREFERS LEARNING WITH ADULTS
15. PREFERS LARNING IN SEVERAL WAYS

PHYSICAL STIMULI

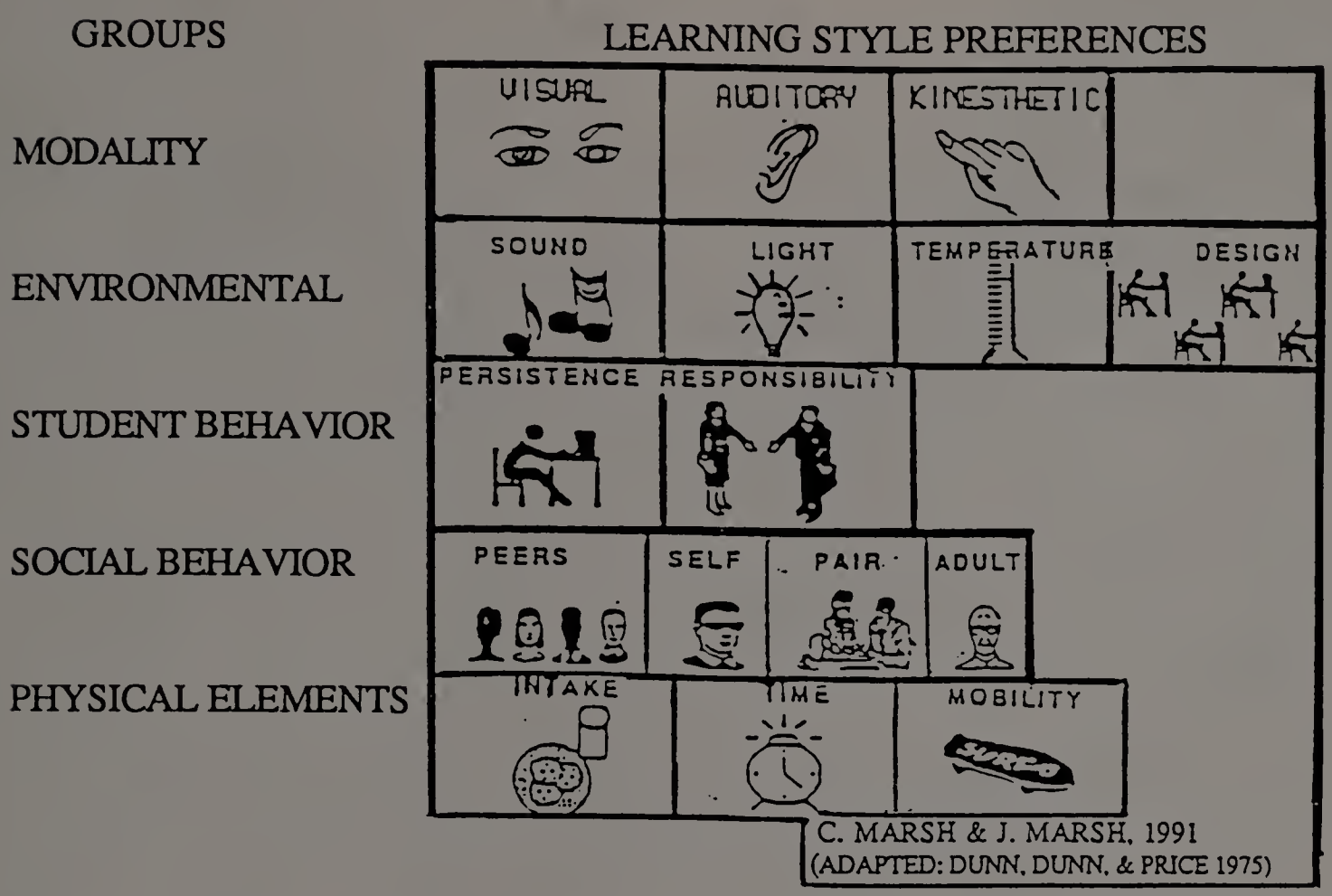
16. HAS AUDITORY PREFERENCES
17. HAS VISUAL PREFERENCES
18. HAS TACTILE/KINESTHETIC PREFERENCES
19. FOOD REQUIRES- NOT REQUIRES
20. FUNCTIONS BEST IN MORNING
21. FUNCTIONS BEST IN LATE MORNING
22. FUNCTIOONS BEST IN AFTERNOON
23. FUNCTIONS BEST IN EVENING
24. MOBILITY NEED OR NOT NEED

DUNN AND DUNN (1978)

APPENDIX G

MARSH & MARSH LEARNING STYLE PREFERENCES, 1991

MARSH & MARSH LEARNING STYLE PREFERENCES



SUMMARY OF GROUPS OF LEARNING STYLE PREFERENCES

LEARNING STYLE CATEGORIES	QUESTIONNAIRE STATEMENTS	ELEMENTS
MODALITY	3	AUDITORY
	5	VISUAL
	7	KINESTHETIC
ENVIRONMENTAL	1	LIGHT
	2	SOUND
	4	TEMPERATURE
	11	ROOM DESIGN
STUDENT BEHAVIOR	12	RESPONSIBILITY
	14	SELF MOTIVATION
SOCIAL BEHAVIOR	9	STUDY BY SELF / PEER
	13	STUDY WITH ADULT
PHYSICAL ELEMENTS	6	FOOD
	8	TIME OF DAY
	10	MOBILITY

APPENDIX H

COMPARISON OF MAJOR LEARNING STYLES

COMPARISON OF MAJOR LEARNING STYLES

THEORIST	ELEMENTS OF MODEL					
DUNN & DUNN	ENVIRON-MENTAL	EMOTIONAL	SOCIOLOGICAL	PHYSICAL	PSYCHOLOGICAL	
N.A.S.S.P.	ENVIRON-MENTAL	EMOTIONAL	SOCIOLOGICAL	PHYSICAL	PSYCHOLOGICAL COGNITIVE	STUDY SKILLS
HILL				QUALITATIVE/ THEORETICAL SYMBOLS	MODALITIES OF REFERENCE	CULTURAL
LETTERI					COGNITIVE STYLE	
RAMIREZ					BI-COGNITIVE STYLE	BI-CULTURAL
RENNERT BARBE & SWASSING				PERCEPTUAL MODALITIES		
SCHMECK					COGNITIVE PROCESSING	STUDY METHODS RETENTION
HUNT	NEED FOR STRUCTURE	NEED FOR AUTHORITY DEPENDENT/INDEPENDENT				
KOLB					CONCRETE EXPERIENCE VS. ABSTRACT CONCEPTUALIZATION ACTIVE EXPERIMENTATION VS. REFLECTIVE OBSERVATION	
GREGORC					PERCEPTION/ ORDERING	
McCARTHY					INNOVATIVE/ANALYTIC/ COMMON SENSE/DYNAMIC HEMISPHERICITY	

(DEBELLO, 1985)

APPENDIX I

INDIVIDUAL PROFILES

INDIVIDUAL PROFILE SUMMARY

NAME _____ **CODE** S 2 **DATE** JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC _____ MIXED X
OBSERVING _____ LISTENING _____ USING HANDS-ON ACTIVITIES _____
VISUAL X
AUDITORY X
KINESTHETIC _____

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70% _____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC			●
ENVIRONMENT			
1. LIGHT	●		
2. SOUND		●	
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION			●
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD	●		
8. TIME (NIGHT)		●	
10. MOBILITY		●	

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 60%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 80%
WATCH STEP-BY-STEP SOLUTION WRITTEN ON BOARD 80%	STUDIES CHARTS AND GRAPHS IN TEXT 80%

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom	In Private Study
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS 80%	READS CLASS NOTES ALOUD DURING STUDY TIME 60%
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES 100%	READS WORD PROBLEMS ALOUD FOR BETTER INTERPRETATION 80%

INDIVIDUAL PROFILE SUMMARY

NAME_____ CODE S 3 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC ___X___ MIXED _____
OBSERVING_____ LISTENING _____ USING HANDS-ON ACTIVITIES __X__ VISUAL _____ AUDITORY _____ KINESTHETIC___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% ___ UNSUCCESSFUL QPA < 70% __X__

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND		●	
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD		●	
8. TIME (NIGHT)			●
10. MOBILITY			●

SPECIFIC KINESTHETIC MODALITY BASED STRATEGIES

In the Classroom	In Private Study
LEARNS FROM PICKING UP AND HANDLING A MODEL 40%	USES MANIPULATIVE PIECES *I.E.* COINS OR CLIPS TO UNDERSTAND PROBLEMS 40%
RECREATES DEMONSTRATIONS AS DRAWING IN CLASS NOTES 60%	FOLDS OR TEARS PAPER TO MAKE MANIPULATIVE PIECES 60%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 4 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC ___X___ MIXED _____
OBSERVING _____ LISTENING _____ USING HANDS-ON ACTIVITIES __X__ VISUAL _____ AUDITORY _____ KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% __X__ UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND		●	
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER		●	
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD			●
8. TIME (NIGHT)			●
10. MOBILITY			●

SPECIFIC KINESTHETIC MODALITY BASED STRATEGIES

In the Classroom	In Private Study
LEARNS FROM PICKING UP AND HANDLING A MODEL 40%	USES MANIPULATIVE PIECES *I.E.* COINS OR CLIPS TO UNDERSTAND PROBLEMS 40%
RECREATES DEMONSTRATIONS AS DRAWING IN CLASS NOTES 20%	FOLDS OR TEARS PAPER TO MAKE MANIPULATIVE PIECES 60%

INDIVIDUAL PROFILE SUMMARY

NAME_____ CODE S 6 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY X KINESTHETIC _____ MIXED _____
OBSERVING_____ LISTENING X USING HANDS-ON ACTIVITIES ___
VISUAL _____
AUDITORY ____
KINESTHETIC___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70%____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC			●
ENVIRONMENT			
1. LIGHT		●	
2. SOUND			●
4. TEMPERATURE	●		
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER		●	
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD	●		
8. TIME (NIGHT)			●
10. MOBILITY		●	

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom		In Private Study	
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS.	100%	READS CLASS NOTES ALOUD DURING STUDY TIME	60%
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES	100%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING	60%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 7 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL X AUDITORY _____ KINESTHETIC _____ MIXED _____
OBSERVING X LISTENING _____ USING HANDS-ON ACTIVITIES ____ VISUAL _____
AUDITORY _____
KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND	●		
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD	●		
8. TIME (NIGHT)			●
10. MOBILITY		●	

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 100%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 80%
WATCHES STEP-BY-STEP SOLUTION WRITTEN ON BOARD 100%	STUDIES CHARTS AND GRAPHS IN TEXT 80%

INDIVIDUAL PROFILE SUMMARY

NAME_____ CODE S 8 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY ___X___ KINESTHETIC _____ MIXED _____
OBSERVING_____ LISTENING ___X___ USING HANDS-ON ACTIVITIES ___ VISUAL _____ AUDITORY _____ KINESTHETIC___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% ___ UNSUCCESSFUL QPA < 70% X

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY		●	
5. VISUAL		●	
7. KINESTHETIC	●		
ENVIRONMENT			
1. LIGHT		●	
2. SOUND	●		
4. TEMPERATURE			●
11. ROOM DESIGN		●	
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION	●		
SOCIAL BEHAVIORS			
9. PEER		●	
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD	●		
8. TIME (NIGHT)			●
10. MOBILITY		●	

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom		In Private Study	
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS	40%	READS CLASS NOTES ALOUD DURING STUDY TIME	40%
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES	80%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING	60%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 9 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY __X__ KINESTHETIC _____ MIXED _____
OBSERVING _____ LISTENING __X__ USING HANDS-ON ACTIVITIES ___ VISUAL _____ AUDITORY ____ KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% __X__ UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY		●	
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND			●
4. TEMPERATURE	●		
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD			●
8. TIME (NIGHT)			●
10. MOBILITY			●

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom	In Private Study
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS 60%	READS CLASS NOTES ALOUD DURING STUDY TIME 20%
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES 100%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING 60%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 10 DATE JANUARY 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC _____ MIXED X

OBSERVING _____ LISTENING _____ USING HANDS-ON ACTIVITIES ____ VISUAL X

AUDITORY X

KINESTHETIC ____

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT		●	
2. SOUND		●	
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD			●
8. TIME (NIGHT)		●	
10. MOBILITY		●	

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 80%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 80%
WATCHES STEP-BY-STEP SOLUTION WRITTEN ON BOARD 100%	STUDIES CHARTS AND GRAPHS IN TEXT 40%

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom	In Private Study
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS 100%	READS CLASS NOTES ALOUD DURING STUDY TIME 40%
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES 100%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING 60%

INDIVIDUAL PROFILE SUMMARY

NAME_____ **CODE** S 12 **DATE** JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL __X__ AUDITORY _____ KINESTHETIC _____ MIXED _____
OBSERVING __X__ ISTENING _____ USING HANDS-ON ACTIVITIES ____ VISUAL _____ AUDITORY _____ KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% _X_ UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT	●		
2. SOUND			●
4. TEMPERATURE		●	
11. ROOM DESIGN		●	
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD			●
8. TIME (NIGHT)			●
10. MOBILITY			●

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 40%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 100%
WATCHES STEP-BY-STEP SOLUTION WRITTEN ON BOARD 80%	STUDIES CHARTS AND GRAPHS IN TEXT 60%

INDIVIDUAL PROFILE SUMMARY

NAME _____ **CODE** S 13 **DATE** JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC _____ MIXED X

OBSERVING _____ LISTENING _____ USING HANDS-ON ACTIVITIES ____ VISUAL X AUDITORY X KINESTHETIC X

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50 60	HIGH RANGE 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND			●
4. TEMPERATURE			●
11. ROOM DESIGN		●	
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD		●	
8. TIME (NIGHT)		●	
10. MOBILITY		●	

IN THE CLASSROOM **IN PRIVATE STUDY**

SPECIFIC VISUAL MODALITY BASED STRATEGIES

BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 80%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 80%
WATCH STEP-BY-STEP SOLUTION WRITTEN ON BOARD 100%	STUDIES CHARTS AND GRAPHS IN TEXT 40%

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES 100%	READS CLASS NOTES ALOUD DURING STUDY TIME 80%
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS 100%	READS WORD PROBLEMS ALOUD FOR BETTER .UNDERSTANDING 60%

SPECIFIC KINESTHETIC MODALITY BASED STRATEGIES

LEARNS FROM PICKING UP AND HANDLING A MODEL 40%	USES MANIPULATIVE PIECES *I.E.* COINS OR CLIPS TO UNDERSTAND PROBLEMS 60%
RECREATES DEMONSTRATION AS DRAWING IN CLASS NOTES 60%	FOLDS OR TEARS PAPER TO MAKE MANIPULATIVE PIECES 40%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 14 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC ___X___ MIXED _____
OBSERVING _____ LISTENING _____ USING HANDS-ON ACTIVITIES __X__ VISUAL _____ AUDITORY ___ KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% __X__ UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL		●	
7. KINESTHETIC	●		
ENVIRONMENT			
1. LIGHT	●		
2. SOUND			●
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY		●	
14. SELF MOTIVATION	●		
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD			●
8. TIME (NIGHT)		●	
10. MOBILITY	●		

SPECIFIC KINESTHETIC MODALITY BASED STRATEGIES

In the Classroom	In Private Study
LEARNS FROM PICKING UP AND HANDLING A MODEL 40%	USES MANIPULATIVE PIECES *I.E.* COINS OR CLIPS TO UNDERSTAND PROBLEMS 20%
RECREATES DEMONSTRATIONS AS DRAWIING IN CLASS NOTES 40%	FOLDS OR TEARS PAPER TO MAKE MANIPULATIVE PIECES 40%

INDIVIDUAL PROFILE SUMMARY

NAME_____ **CODE** S 17 **DATE** JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC __X__ MIXED _____
OBSERVING_____ LISTENING _____ USING HANDS-ON ACTIVITIES _X_
VISUAL _____
AUDITORY _____
KINESTHETIC___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% _X_ UNSUCCESSFUL QPA < 70%____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT		●	
2. SOUND			●
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER		●	
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD			●
8. TIME (NIGHT)			●
10. MOBILITY			●

SPECIFIC KINESTHETIC MODALITY BASED STRATEGIES

In the Classroom	In Private Study
LEARNS FROM PICKING UP AND HANDLING A MODEL 60%	USES MANIPULATIVE PIECES *I.E.* COINS OR CLIPS TO UNDERSTAND PROBLEMS 40%
RECREATES DEMONSTRATIONS AS DRAWING IN CLASS NOTES 40%	FOLDS OR TEARS PAPER TO MAKE MANIPULATIVE PIECES 60%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 20 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY ___X___ KINESTHETIC _____ MIXED _____
OBSERVING _____ LISTENING ___X___ USING HANDS-ON ACTIVITIES ___ VISUAL _____ AUDITORY _____ KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND		●	
4. TEMPERATURE		●	
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION			●
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD	●		
8. TIME (NIGHT)			●
10. MOBILITY		●	

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom		In Private Study	
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES	100%	READS CLASS NOTES ALOUD DURING STUDY TIME	80%
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS	100%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING	80%

INDIVIDUAL PROFILE SUMMARY

NAME_____ CODE S 21 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC _____ MIXED ___X___
OBSERVING_____ LISTENING _____ USING HANDS-ON ACTIVITIES ____ VISUAL ___X___ AUDITORy_X_ KINESTHETIC___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70%____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND		●	
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD		●	
8. TIME (NIGHT)			●
10. MOBILITY		●	

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 100%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 80%
WATCHES STEP-BY-STEP SOLUTION WRITTEN ON BOARD 100%	STUDIES CHARTS AND GRAPHS IN TEXT 80%

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom	In Private Study
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES 100%	READS CLASS NOTES ALOUD DURING STUDY TIME 40%
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS 100%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING 80%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 22 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC _____ MIXED ___X___
OBSERVING _____ LISTENING _____ USING HANDS-ON ACTIVITIES ___
VISUAL ___X___
AUDITORY ___X___
KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC	●		
ENVIRONMENT			
1. LIGHT			●
2. SOUND		●	
4. TEMPERATURE		●	
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER	●		
13. ADULT AUTHORITY		●	
PHYSICAL ELEMENTS			
6. FOOD		●	
8. TIME (NIGHT)			●
10. MOBILITY	●		

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 60%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 60%
WATCH STEP-BY-STEP SOLUTION WRITTEN ON BOARD 100%	STUDIES CHARTS AND GRAPHS IN TEXT 80%

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom	In Private Study
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS 100%	READS CLASS NOTES ALOUD DURING STUDY TIME 60%
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROBLEMS 100%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING 60%

INDIVIDUAL PROFILE SUMMARY

NAME _____ CODE S 23 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL _____ AUDITORY _____ KINESTHETIC _____ MIXED ___X___
OBSERVING _____ LISTENING _____ USING HANDS-ON ACTIVITIES ____ VISUAL ___X___ AUDITORY ___X___ KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% _X_ UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT		●	
2. SOUND		●	
4. TEMPERATURE		●	
11. ROOM DESIGN	●		
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER		●	
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD		●	
8. TIME (NIGHT)		●	
10. MOBILITY	●		

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 60%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 60%
WATCH STEP-BY-STEP SOLUTION WRITTEN ON BOARD 100%	STUDIES CHARTS AND GRAPHS IN TEXT 80%

SPECIFIC AUDITORY MODALITY BASED STRATEGIES

In the Classroom	In Private Study
PREFERS PROFESSOR TO EXPLAIN WHILE SOLVING PROBLEMS 60%	READS CLASS NOTES ALOUD DURING STUDY TIME 80%
LISTENS TO INSTRUCTOR AS HE EXPLAINS MATH PROCEDURES 80%	READS WORD PROBLEMS ALOUD FOR BETTER UNDERSTANDING 60%

INDIVIDUAL PROFILE SUMMARY

NAME_____ CODE S 25 DATE JANUARY, 1991

SWASSING-BARBE MODALITY INDEX

VISUAL X AUDITORY _____ KINESTHETIC _____ MIXED _____
OBSERVING X LISTENING _____ USING HANDS-ON ACTIVITIES ____ VISUAL _____ AUDITORY _____ KINESTHETIC ___

ACADEMIC ACHIEVEMENT

SUCCESSFUL QPA ≥ 70% X UNSUCCESSFUL QPA < 70% ____

QUESTIONNAIRES:

LEARNING STYLE ELEMENTS	TOTAL POINTS SCORED LOW RANGE 20 30 40	MID RANGE 50	HIGH RANGE 60 70 80
MODALITY PREFERENCE			
3. AUDITORY			●
5. VISUAL			●
7. KINESTHETIC		●	
ENVIRONMENT			
1. LIGHT			●
2. SOUND		●	
4. TEMPERATURE			●
11. ROOM DESIGN			●
STUDENT BEHAVIORS			
12. RESPONSIBILITY			●
14. SELF MOTIVATION		●	
SOCIAL BEHAVIORS			
9. PEER		●	
13. ADULT AUTHORITY			●
PHYSICAL ELEMENTS			
6. FOOD		●	
8. TIME (NIGHT)			●
10. MOBILITY			●

SPECIFIC VISUAL MODALITY BASED STRATEGIES

In the Classroom	In Private Study
BETTER UNDERSTANDING IF PROFESSOR USES DIAGRAMS 80%	DRAWS DIAGRAMS TO SOLVE PROBLEMS 80%
WATCH STEP-BY-STEP SOLUTION WRITTEN ON BOARD 80%	STUDIES CHARTS AND GRAPHS IN TEXT 60%

APPENDIX J

OBSERVABLE CHARACTERISTICS INDICATIVE OF MODALITY STRENGTH

OBSERVABLE CHARACTERISTICS INDICATIVE OF MODALITY STRENGTH

	Visual	Auditory	Kinesthetic
Learning Style	Learns by seeing; watching demonstrations	Learns through verbal instructions from others or self	Learns by doing; direct involvement
Reading	Likes description; sometimes stops reading to stare into space and imagine scene; intense concentration	Enjoys dialogue, plays; avoids lengthy description, unaware of illustrations; moves lips or subvocalizes	Prefers stories where action occurs early; fidgets when reading, handles books; not an avid reader
Spelling	Recognizes words by sight; relies on configuration of words	Uses a phonics approach; has auditory word attack skills	Often is a poor speller; writes words to determine if they "feel" right
Handwriting	Tends to be good, particularly when young; spacing and size are good; appearance is important	Has more difficulty learning in initial stages; tends to write lightly; says strokes when writing	Good initially, deteriorates when space becomes smaller; pushes harder on writing instrument
Memory	Remembers faces, forgets names; writes things down, takes notes	Remembers names, forgets faces; remembers by auditory repetition	Remembers best what was done, not what was seen or talked about
Imagery	Vivid imagination; thinks in pictures, visualizes in detail	Subvocalizes, thinks in sounds; details less important	Imagery not important; images that do occur are accompanied by movement
Distractibility	Generally unaware of sounds; distracted by visual disorder or movement	Easily distracted by sounds	Not attentive to visual, auditory presentation so seems distractible
Problem Solving	Deliberate; plans in advance; organizes thoughts by writing them; lists problems	Talks problems out, tries solutions verbally, subvocally; talks self through problem	Attacks problems physically; impulsive; often selects solution involving greatest activity
Response to Periods of Inactivity	Stares; doodles; finds something to watch	Hums; talks to self or to others	Fidgets; finds reasons to move; holds up hand
Response to New Situations	Looks around; examines structure	Talks about situation, pros and cons, what to do	Tries things out; touches, feels; manipulates
Emotionality	Somewhat repressed; stares when angry; cries easily, beams when happy; facial expression is a good index of emotion	Shouts with joy or anger; blows up verbally but soon calms down; expresses emotion verbally and through changes in tone, volume, pitch of voice	Jumps for joy; hugs, tugs, and pulls when happy; stamps, jumps, and pounds when angry, stumps off; general body tone is a good index of emotion
Communication	Quiet; does not talk at length; becomes impatient when extensive listening is required; may use words clumsily; describes without embellishment; uses words such as *see, look*, etc.	Enjoys listening but cannot wait to talk; descriptions are long but repetitive; likes hearing self and others talk; uses words such as *listen, hear*, etc.	Gestures when speaking; does not listen well; stands close when speaking or listening; quickly loses interest in detailed verbal discourse; uses words such as *get, take*, etc.
General Appearance	Neat, meticulous, likes order; may choose not to vary appearance	Matching clothes not so important, can explain choices of clothes	Neat but soon becomes wrinkled through activity
Response to the Arts	Not particularly responsive to music; prefers the visual arts; tends not to voice appreciation of art of any kind, but can be deeply affected by visual displays; focuses on details and components rather than the work as a whole	Favors music; finds less appeal in visual art, but is readily able to discuss it; misses significant detail, but appreciates the work as a whole; is able to develop verbal association for all art forms; spends more time talking about pieces than looking at them	Responds to music by physical movement; prefers sculpture; touches statues and paintings; at exhibits stops only at those in which he or she can become physically involved; comments very little on any art form

(BARBE & SWASSING, 1979)

APPENDIX K

MODALITY BASED LEARNING STRATEGIES

Modality Based Learning Strategies

Visual	Auditory	Kinesthetic
RECOPY CLASS NOTES	READ NOTES ALOUD BEFORE HOMEWORK	USE NUMBER LINE & MOVEABLE PIECES TO SOLVE PROBLEMS
USE NUMBER LINE TO SOLVE PROBLEMS	READ WORD PROBLEMS ALOUD	USE OBJECTS LIKE CLIPS, COINS TO DO INTEGER PROBLEMS
DRAW DIAGRAMS IN PROBLEM SOLVING	TALK OVER WORD PROBLEMS WITH OTHERS	DRAW DIAGRAMS THAT REPRESENT HANDS-ON ACTIVITIES
COPY BLACKBOARD NOTES WITH ALL DRAWINGS	LISTEN IN CLASS THEN TAKE NOTES	HAVE INSTRUCTOR USE DEMONSTRATION MODELS/DIAGRAMS
GET COPY OF VISUAL AIDS FROM TEACHER	ASK QUESTIONS IN CLASS. TALK ABOUT PROBLEMS IN CLASS	ASK FOR CONCRETE EXAMPLES/TASKS TO AID UNDERSTANDING
ASK TO HAVE CHARTS & GRAPHS AS PART OF PROBLEM SOLVING	TAPE RECORD CLASS LESSONS	SHOW AND DISCUSS MANIPULATIVE ACTIVITIES THAT HELP TO SOLVE PROBLEMS

BIBLIOGRAPHY

Adickes, Sandra. (1980). A Re-entry Curriculum Guide For the Adult Learner. Pro Report of Three Year Study, 76-79, PROJECT CHANCE, funded by Improvement of Post Secondary Education: Report BBB16492, published by the Office of Education (D.H.E.W.), Women's Educational Equity Act Program. Washington, D.C.

Appleman, Jay. (1989, March). Strategies for Teaching Remedial Mathematics to Learning Disabled Students. Paper presented at annual meeting of Mathematics Association of Two Year Colleges, Franklin, MA.

Axford, Roger. (1969). Adult Education: The Open Door. Scranton, PA: International Textbook Co.

Barbe, W. & Swassing, R. (1979). Teaching Through Modality Strengths: Concepts and Practices. Columbus, OH: Zaner-Bloser.

Barbe, W. B., & Milone, N. N. Jr. (1980). What We Know about Modality Strengths. Journal of Educational Leadership, February, 75-79.

Berenson, Sarah B. (1990). Levels of thinking and Success in College Developmental Algebra. Focus-on-Learning-Problems-in-Mathematics, 11(2), 3-14.

Betz, Nancy E. (1978). Prevalence Distribution, and Correlates of Mathematics Anxiety in College Students. Journal of Counseling Psychology, 25(5), 441-448.

Bohr, Dorothy H., & Bray, Dorothy. (1980). HELP: A Pilot Program for Community College High-Risk Students. Educational Abstracts, ED16635.

Bruno, Anthony. (1982). Designing learning activities for the tactile learner. In Student Learning Styles and Brain Behavior. Reston, VA: National Association of Secondary School Principals.

Buerk, Dorothy. (1985). The Voices of Women Making Meaning in Mathematics. Journal of Education, 167(3), 60-70.

Burns, Richard. (1988). Basic Arithmetic Laboratory Manual: MacIntosh Lab Springfield, MA: Springfield Technical Community College.

Cafferty, E. (1981). An Analysis of Student Performance Based Upon the Degree of Match Between the Educational Cognitive Style of the Teacher and the Educational Style of the Student. (Doctoral dissertation at University of Nebraska, Lincoln). Dissertation Abstracts International, 41, 2908 A.

Canfield, Albert A. (1980). Canfield Learning Styles Inventory (LSI). Los Angeles, CA: Western Psychological Services.

Celis, William, III. (1991). New ideas abound at first school in nation to be run by a business. Springfield Union-News, November 16, p. 18.

Claxton, Charles S. & Ralston, Yvonne. (1978). Learning Styles: Their Impact on Teaching and Administration. ERIC Clearinghouse, Washington, D C: American Association for Higher Education.

Cleveland, Kathleen. (1990). Teaching to Every Learner. Lawrenceville, GA: The Connecting Link Press.

Coldway, Dana O. (1974). Comparison of Small Group Contingency Management with the Personalized System of Instruction and the Lecture Method. Bethesda, MD. (ERIC Document Reproduction Service No. ED 096 987).

Conti, Gary L. (1985). Assessing teaching styles in adult education: How and Why. Lifelong Learning, An Omnibus of Practice and Research, 8(8), 7-11, 28.

Copeland, Richard. (1979). How Children Learn Mathematics. (Teaching Implications of Piaget's Research), Third edition. New York: MacMillan Publishing Co., Inc.

Corn, Juliana, Ed et al. (1989). Teaching Remedial Mathematics to Students with Learning Disabilities. Bayside, NY: Queensboro Community College.

Creative Publications. (1978). Diadactics and Mathematics, The Art and Science of Learning and Teaching Mathematics. Sunnyvale, CA: Creative Publications.

Creative Publications. (1989-1990). Creative Publications Catalogue. Palo Alto, CA: Creative Publications, Inc.

Crepin, Dorothy. (1981). A Developmental Mathematics Program for Community College Students. Educational Abstracts, ED 21007.

Cross, K. Patricia. (1976). Accent on Learning. San Francisco: Jossey-Bass.

Cuisenaire. (1989-1990). Cuisenaire: Materials for Learning Mathematics and Science. New Rochelle, NY: Cuisenaire Co. of America.

Cullen, Mary. (1980). An Investigation into the Cognitive Styles of Community College and the Effects of Instructional Treatment on their Mathematics Achievement. Unpublished doctoral dissertation. University of Massachusetts at Amherst.

Cullen, Mary. (1989). Mathematics Curriculum Guide. Gardner, MA: Mount Wachusett Community College.

Cupkie, L. Frederick. (1980). The effects of similarity of instructor preferred teaching style and student preferred learning style on student achievement in selected courses in a metropolitan community college. (Doctoral dissertation at University of Missouri, Kansas City). Dissertation Abstracts International, 41, 988A-1003A.

Czalejan, M. (1989). Bi-Lingual Developmental Courses at the Community College. Springfield, MA: Springfield Technical Community College.

DeBello, Thomas C. (1989, March). Comparison of Eleven Major Learning Styles. Lecture at annual meeting of the Association of Supervisors of Curriculum Development, Orlando, FL.

Dessart, D. J. (1981). Curriculum. Mathematics Education Research: Implications for the 80's. Alexandria, VA: Association of Supervisors of Curriculum Development.

Devault, M. V. (1981). Computers. Mathematics Education Research: Implications for the 80's. Alexandria, VA: Association of Supervisors of Curriculum Development.

Domino, George. (1970). Interactive Effects of Achievement Orientation and Teaching Style on Achievement. Act Research Report, 39, 1-9.

Dossey, John A. (1989). Transforming Mathematics Education. Educational Leadership, 47(3), 22-24.

Driscoll, Mark. (1986). Research Within Reach: Secondary School Mathematics. Reston, VA: National Council of Teachers of Mathematics.

Dunn, R., Dunn, K. & Price, G. E. (1978). Learning Styles Inventory. Lawrence, KS: Price Systems.

Dunn, R., Dunn, K. & Price, G. E. (1989). Productivity Environmental Preference Survey. Lawrence, KS: Price Systems.

Dunn, R. & Griggs, S. (1988). Learning Styles: Quiet Revolution in American Secondary Schools. Reston, VA: National Association of Secondary School Principals.

Dunn, R. S. & Bruno, A. (1982). Learning Through the Tactual/Kinesthetic Senses. Momentum, 13(4), 40-42.

Dunn, R. S., Beaudry, J. S., & Klavas A. (1989). Survey of Research on Learning Styles. Educational Leadership, 46, March, 50-58.

Dunn, R., & Dunn, K. (1977a). Identifying Individual Learning Styles and Instructional Methods and/or Resources to which Handicapped Early Childhood Youngsters Respond. Early Childhood Education. Wayne, NJ: Avery Publishing.

Dunn, R., & Dunn, K. (1977b). Sensing, Hearing, Moving, Touching and Learning Packages. Teacher, May-June, 48-51.

Dunn, R., & Dunn, K. (1979a). Teaching Students Through Their Individual Learning Styles. Reston, VA: Reston Publishing.

Dunn, R., & Dunn, K. (1979b). Learning Styles/Teaching Styles: Should They, Can They.Be Matched?. Educational Leadership, January, 238-244.

Dunn, R., & Dunn, K. (1988). A Review of Articles and Books on Learning and Teaching Styles. Jamaica, NY: St. John's University.

Dunn, Rita S. (1983). Teaching Students Through Their Perceptual Strengths or Preferences. Journal of Reading, 12, 304-309.

Elliott, Portia C. (1983). Question: Is Math Anxiety a Figment of the Imagination? Answer: Never! (A Neurological Glimpse at Mathematics Anxiety). International Journal of Mathematics Education and Science Technology, 14(6), 777-785.

Elliott, Portia C. (1986). Right (or Left) Brain Cognition, Wrong Metaphor for Creative Behavior: It is Prefrontal Lobe Volition that Makes the (Human/Humane) Difference in the Release of Creative Potential. The Journal of Creative Behavior, 20(3), 202-214.

Elliott, Portia C. (1987). Mathematics matters: matters of consequence or doing something consequential? International Journal of Mathematics Education and Science Technology, 18(1), 127-138.

Farr, Beatrice J. (1971). Individual Differences in Learning: Predicting One's More Effective Learning Modality. (Doctoral dissertation, The Catholic University of America, 1971). Dissertation Abstracts International, 32, 1332A.

Fennema, Elizabeth. (1976). Preferential Learning Style Inventory. Journal Supplement Abstract Service. Catalog of Selected Documents in Psychology.

Fernald, G. M. (1943). Remedial techniques in basic school subjects. New York: McGraw-Hill.

Friedman, M., & Stomper, C. (1988). Effective College Instruction in Basic Mathematics. Journal for Research in Mathematics, 19(2), 169-174.

Friedman, Mordechai. (1986). A Model for Teaching College Remedial Mathematics. Mathematics and Computer Education, 20(1), 45-51.

Gillingham, A. & Stillman, B. (1988). Remedial Training for Children with Specific Disability in Reading, Spelling and Penmanship (7th ed.). Cambridge, MA: Educators Publishing Service, Inc.

Good, Thomas L., Grouws &, D. A. (1981). Mathematics Education Research: Implications for the 80's. Alexandria, VA: Association of Supervisors of Curriculum Development.

Gourgey, Annette. (1985). The Relationship of Misconceptions about Mathematics and Mathematical Self-Concept to Mathematics Anxiety and Statistical Performance. Resources in Education, 20(7).

Greenwood, Jay, & Anderson, Robert. (1983). Some Thoughts on Teaching and Learning Mathematics. Arithmetic Teacher, 31(3), 42-49.

Gregorc, Anthony. (1979a). Learning Styles their Nature and Effects, Student Learning Styles: Diagnosing and Prescribing Programs. Copyright Reston, VA: National Association Secondary School Principals.

Gregorc, Anthony. (1979b). Learning/Teaching Styles: Potent Force Behind Them. Educational Leadership, 36, 234-236.

Gregorc, Anthony. (1981). An Adult Guide to Style. Maynard, MA: Gabriel Systems.

Groeneveld, L. (1989). Advising Students for Mathematics Courses: Prerequisites and Requirements. Memorandum. Springfield, MA: Springfield Technical Community College.

Groeneveld, L. (1990). Grant Proposal. Survey Questionnaire Results Support for Computer Assisted Instruction. Springfield, MA: Springfield Technical Community College.

Guinta, Steven F. (1984). Administrative Considerations Concerning Learning Styles, Its Relationship To Teaching Style, and The Influence Of Instructors/Student Congruence In High Schoolers' Achievement and Educators' Perceived Stress. (Doctoral dissertation, St. John's University, 1984). Dissertation Abstract International, 45, 1A-545A.

Hackett, Gail. (1985). Role of Mathematics Self Efficacy in the Choice of Mathematics Related Majors of College Women and Men: A Path Analysis. Journal of Counseling Psychology, 31(1), 47-56.

Halloran, Phillip. (1977). The Calculator as the Ultimate Low Stress Algorithmic Device. New England Mathematics Journal, IX(2), 10-15.

Heitmeyer, Jeanne R. (1985). The Relationship Between Match/Mismatch of Cognitive Learning Styles of Fashion Merchandising Majors, Cognitive Learning styles of Instructional Settings and Level of Student Achievement at Florida State University. (Doctoral dissertation, Florida State University, 1985). Dissertation Abstracts International, 46, 539A-1110A.

Hendell, Darwin D. (1980). Experiential and Affective Correlates of Mathematics Anxiety in Adult Women. Psychology of Women Quarterly, 5(2), 219-230.

Hill J. S. (1976). Cognitive Style Interest Inventory. Bloomfield Hills, MD: Oakland Community College

Hill J. S. et al. (1971). Personalizing Educational Programs Utilizing Cognitive Style Mapping. Bloomfield Hills, MD: Oakland Community College.

Hodges, H. (1985). An analysis of the relationships among preferences for a formal/informal design, one element of learning style, academic achievement and attitudes of seventh and eighth grade students in remedial mathematics in a New York City junior high school. (Doctoral dissertation, St. John's University, 1971). Dissertation Abstract International, 45, 2791A.

Hogben, Lancelot. (1968). Mathematics for the Millions (4th ed.).New York: W. W. Norton Co.

Johnston, William B., & Packer, Arnold E. (eds.). (1987). Workforce 2000: Work and Workers for the Twenty-First Century. Indianapolis, IN: Hudson Institute.

Joyce, Bruce, & Weil, M. (1979). Models of Teaching (2nd ed.). Englewood Cliffs, NJ: Prentiss-Hall, Inc.

Joyce, B. (1985). Models for Teaching Thinking. Educational Leadership, 42(8), 4-7.

Keefe, J. W., Monk, J. S., Letteri, C., Languia, M., & Dunn, R. (1986). Learning Style Profile. Reston, VA: National Association of Secondary School Principals.

Keefe, James W. (1987). Learning Style, theory & practice. Reston, VA: National Association of Secondary School Principals.

Kephart, N. C. (1960). The Slow Learner In The Classroom. Columbus, OH: Merrill.

Kirk, S. A., & Kirk, W. D. (1971). Psycholinguistic learning disabilities:diagnosis and remediation. Urbana: University of Illinois.

Kirk, S. A., McCarthy, J., & Kirk, W. D. (1961). Illinois Test of Psycholinguistic Abilities (Experimental Edition). Urbana: University of Illinois.

Kolb, David. (1976). Learning Style Inventory. Boston, MA: McBer and Co.

Kolb, David. (1979). Disciplinary Inquiry Norms and Student Learning styles: Diverse Pathways for Growth. In Chickering A. (Ed.). The Future American College. San Francisco, CA: Jossey-Bass .

Kostka, Marion P., & Penmanship, Christina. (1986). Reducing Math Anxiety in Non-Traditional Age Female Students. Journal of College Students Personnel, 27(6), 530-534.

Kramer, R. (1976). Maria Montessori. New York: Putnam.

Lane, H. (1976). The Wild Boy of Aveyron. Cambridge, MA: Harvard University.

Lerner, Helene. (1985). STRESS BREAKERS. Minneapolis, MN: CompCare Publ.

Letteri, C. A. (1980). Cognitive Profile: Basic Determinant of Academic Achievement. Journal of Educational Research, 73, 195-199.

Martini, M. (1986). An Analysis of the Relationships Between and Among Computer Assisted Instruction, Learning Styles Perceptual Preferences, Attitudes and the Science Achievement of Seventh Grade Students in a Suburban New York School District. (Doctoral dissertation, St John's University, 1986). Dissertation Abstracts International, 47, 877A.

Massachusetts Board of Regents Annual Report. (Fall, 1987). Boston.

Massachusetts Board of Regional Community Colleges Policy. (1973). Adopted: November 9; Amended: November 12, 1976: Boston.

McCarthy, Bernice. (1981). The 4MAT System: Teaching to Learning Styles with Right/Left Mode Techniques. Arlington Heights, IL: Mark Anderson and Associates.

McDonald, James. (1989). History of Mathematics Department. Unpublished Report. Springfield, MA: Springfield Technical Community College.

McIntyre, Janice L. (1981, April). Nontraditional Strategies For Nontraditional Students. Paper presented at the annual meeting of International Reading Association, New Orleans.

McKinnon, Joe W. (1976). The College Student and Formal Operations. In Rinner et al (Ed.), Research, Teaching and the Piaget Model (pp. 110-120). Norman, OK: University of Oklahoma Press.

Messick, S. and Associates. (1976). Individuality in Learning. San Francisco: Jossey-Bass.

Mills, R. E. (1970). The Teaching Of Word Recognition. Ft. Lauderdale, FL: The Mills School.

Molnar, A. R. (1978-1979). The Next Great Crisis in American Education: Computer Literacy. Journal of Educational Technology Systems, 7, 275-283.

Montessori, Maria. (1912). The Montessori Method. New York: Stokes

Myers, I. B. & Briggs, K. C. (1967). The Myers-Briggs Type Indicator. Princeton: Educational Testing Service.

Myers, Isabell B. (1976). Introduction to Type. Gainesville, FL: Center for Application of Psychological Type.

Napolitano, R. A. (1986). An experimental investigation of relationships among achievement, attitude scores, and traditionally, marginally and underprepared college students enrolled in an introductory psychology course when they are matched and mismatched with their learning style preferences for the element of structure. (Doctoral dissertation, St. John's University, 1986). Dissertation Abstracts International, 47A, 435.

National Council of Supervisors of Mathematics. (1989). Essential Mathematics for the Twenty First Century. Houston, TX: National Council of Supervisors of Mathematics.

National Council of Teachers of Mathematics. (1980). An Agenda for Action: Recommendations for School Mathematics of the 1980's. Reston, Va: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1989). Curriculum and Evaluation Standards for School Mathematics. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1991). Professional Standards For Teaching Mathematics. Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (1989). Everybody Counts: A Report on the Future of Mathematics Education. Washington, DC: National Academy Press.

Nolting, Paul. (1987). Winning at Math. Pompano Beach, FL: Academic Success Press.

Nowick, Paula. (1988). No Sweat Math. Unpublished Survey. Springfield, MA: Springfield Technical Community College.

Nowick, Paula. (1989a). Overcoming Academic Stress. Student Program. Springfield, MA: Springfield Technical Community College.

Nowick, Paula. (1989b). Creatively Coping with Stress. (Videotapes). East Longmeadow, Ma: Stress Relief Institute.

Orton, S. T. (1937). Reading, Writing, and Speech Problems in Children. New York: Norton Publishing Co.

Pilsarski, Sue. (1989). Activities in Mathematics Tutorial Laboratory. Unpublished Report. Gardner, MA: Mount Wachusett Community College.

Rank, Janice. (1979, April). One That Works! An Integrated Program of Basic Skills. Paper presented at the 12th Annual Meeting of the Western College Reading Association, Honolulu, Hawaii.

Reinert, Harry. (1976). One Picture Worth a Thousand Words? Not Necessarily!. Modern Language Journal, LX(4), 160-168.

Reyes, Laurie, A. (1984). Affective Variables and Mathematics Education. Elementary School Journal, 84(5), 558-581.

Richardson, Elliott. (1972). Hearings Before the Subcommittee on Labor and Public Welfare, March, (pp. 21-375). Washington, D C: U.S. Government Printing Office.

Romberg, Thomas & Carpenter, Thomas P. (1985). Research on teaching and learning mathematics: two disciplines of scientific inquiry. In M.C.Wittrock (Ed.), Handbook of Research on Teaching. (3rd ed., pp. 850-874). New York: MacMillan.

Rose, Barbara. (1989). Brown Bag Lunch: Interested in Going to College?. Gardner, MA: Mount Wachusett Community College.

Roueche, John E. (1976). Creating an Environment for Learning. Community College and Junior College Journal, March, 48-50.

Roueche, John E., & Roueche, Susan D. (1977). Developmental Education: A Primer For Program Development and Evaluation. Atlanta: Southern Regional Education Board.

Sells, Lucy W. (1981). High School Mathematics as the Critical Filter in the Job Market. Resource in Education, 16(10).

Seymour, Dale. (1985). Mathematics With Pizzazz. Palo Alto, CA: Dale Seymour Publications.

Smith, Jean Burr. (1983). Data Collection and Description Statistics for Effective Program Evaluation. Unpublished Report. Middletown, CT: Middlesex Community College.

Smith, Jean Burr. (1988, April). Re-Entry Math: The Math You Need to Get Started Again. Paper presented at Conference of New England Community College Mathematics Instructors Council. Franklin, MA.

Sobel, Max A., & Maletsky, Evan M. (1975). Teaching Mathematics: Source Book of Aids, Activities and Strategies. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Spires, R. D. (1983). The effects of Teacher in-service about learning styles on students' mathematics and reading achievement. (Doctoral dissertation, Bowling Green State University, KY, 1983). Dissertation Abstracts International, 46, DA 852, 4144.

Steen, L. Arthur. (1989a). Teaching Mathematics for Tomorrow's World. Educational Leadership, 47(1), 18-22.

Steen, L. Arthur. (1989b). Everybody Counts. Washington, DC: National Academy Press.

Stocker, Marilyn. (1989, January). Adult Students on Campuses: Colleges Adjusting Curricula and Teaching Methods. Paper presented at meeting of Association of American Colleges, Washington, DC.

Strauss, A. A. and Lehtinen,L. E. (1947). Psychopathology and Education of the Brain-injured Child. New York: Grune and Stratton.

Taveggia, Thomas C. (1977). Goodbye Teacher, Goodbye Classroom, Hello Learning: A Remedial Appraisal of Teaching-Learning Linkages at a College Level. Journal of Personalized Instruction, June, 119-121.

Taylor, Clark. (Ed.). (1982). Diverse Student Preparation: Benefits and Issues. New Directions for Experiential Learning. San Francisco: Jossey- Bass Inc.

Thompson, Carla, & Fiske, Joyce. (1984) . CLIMB: A two Year College Approach to Technology in Mathematics. Journal of Computers in Mathematics and Science Teaching, 3(2), 13-15.

Tobias, Sheila. (1978). Overcoming Math Anxiety. Boston: Houghton- Mifflin.

Vlock, L. (Filmmaker), & Smith, J. (Mathematics Instructor). (1986). Math Anxiety: We beat it, so can you! (Film). Newton, MA: Education Development Center, Inc.

Watkins, Beverly. (1989). With More Adult Students on Campuses, Some Colleges are Adjusting Their Curricula and Teaching Methods. The Chronicle of Higher Learning, 35(19), A 27-28.

Williams, W. Virginia. (1988). Answers to Questions About Math Anxiety. School Science and Mathematics, 88(2), 95-104.

Witkin, Herman. (1976). Cognitive Style in Academic Performance and in Teacher-Student Relations. In S. Messick at al (Eds.), Individuality in Learning. San Francisco: Jossey-Bass Inc.

Yawin, Robert. (1981). Remedial and Developmental Mathematics Program at S.T.C.C. Mathematics Center. Springfield, MA: Springfield Technical Community College. ERIC Document Reproduction Service, ED 213 456.

Yawin, Robert. (1989). Arithmetic for College Students. Boston: Brown Publishers.