The Effects of Learning-Styles Information on the Achievement of Community College Developmental Math Students

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The Effects of Learning-Styles Information on the Achievement of Community College Developmental Math Students

by

Kevin A. Hoeffner

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy Department of Adult, Career, and Higher Education College of Education University of South Florida


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Keywords: College Algebra, Learning Preferences, Math Pedagogy, Retention, Junior Colleges, Preparatory Math, Remediation

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Dedication

This study of student learning styles and strategies to improve retention in remedial math classes is dedicated to the large majority of under-prepared students and the community college faculty who educate them throughout the United States. The author of this paper and other servants of community colleges in the U.S. express their deepest concern for the citizens of this country who have made a conscious decision to learn, to grow, and to improve. However, many of these students come to our colleges ill-equipped to complete their educational journey. The mission and dedication of the community college is truly an example of democracy in action.


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The Effects of Learning-Styles Information on the Achievement of Community College Developmental Math Students

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ABSTRACT

Four out of five Americans will require some postsecondary education. Therefore, a majority of population will return to a community college for retraining and personal growth (McCabe, 2003). Since the turn of this century, many studies have been conducted to examine the success and challenges of the relatively new community college system. One of the most significant challenges is the large percentage of the U.S. population requiring remedial coursework. Fifty-five percent of students entering Florida’s postsecondary system require remediation. Of this large remedial population, only 51% will complete their preparatory classes. Students who do complete classes take an average of two years to finish preparatory classes and move on to college-level work. It is hypothesized that learning styles information will empower students with knowledge about their study habits and positively effect academic achievement.

This research first examined the quantitative effect that learning styles information had on student achievement. The second qualitative phase of the study examined students’ perceptions of learning styles information. Three Introductory Algebra (MAT 0024) courses at a large suburban community college were intensively studied during one spring semester.
Due to the size of the study (N=69), results obtained in the quantitative portion were not significant enough to accept the hypotheses. Responses in focus groups showed that students generally felt that learning styles information was useful and half the class used the information to modify how they studied. Half of the students in the control group modified their study habits in response to knowing more about their learning style. Although the qualitative data was supportive of the usefulness of learning styles information in the classroom the quantitative data did not support the hypotheses that learning styles information improves achievement.
Chapter One

Introduction

In the past 30 years, many efforts have been made to improve the retention of community college students. Academic advising, orientations, facility improvements, mentoring, and continuous modifications to curriculum and pedagogy are being made continuously to ensure that the controllable variables are explored without reducing the self determination of the students. Most of these student support services have proven to be ineffective in improving student retention among large populations of students (Biggs, 1978; Derry & Murphy, 1986; Entwistle, 1960; Ford, 1981; Robyak & Downey, 1979).

In order to improve retention and academic achievement of their students, community colleges around the nation are considering the implementation of learning styles theory in the classroom. Research shows that academic achievement increases when classroom pedagogy is customized to suit the student’s individual learning styles. However, the customization of pedagogy and the institutional or departmental consensus necessary to change classroom environments to suit individual learning styles, can be a challenging, non-traditional transition for some institutions and teachers to adopt. The most popular use of learning styles information is by the individual student. Some colleges, like Florida’s Indian River State College and Manatee State College, are using learning style assessments to inform students of their unique learning style preferences. Therefore, the students are empowered with information that should positively affect achievement.
Adapting learning to a person’s unique learning style is not a new concept (Givens, 2000). The study of differences in personality dates back thousands of years. According to Rundle, one of the first written references to learning styles is Confucius’s famous saying, “I hear and I forget, I see and I remember, I do and I understand” (Rundle, 2006, p. 1). More recently, the study of learning styles based on the improvement of retaining new and difficult information began with the cognitive research of the mid 20th century (Rundle, 2006). In the 1970’s, educators began the exploration of processing strengths in learning (Marton, 1976), and Witkin and Goodenough (1981) presented a validated study that identified differences in “field independent vs. field dependent” learners.

The particular remediation challenges faced by community colleges were summarized in the Florida Legislature, Office of Program Policy Analysis and Governmental Accountability’s (OPPAGA) 2007 report. OPPAGA made six recommendations at the conclusion of this study that were based on quantitative data and interviews of administrators throughout the 28 Florida community colleges. One recommendation was to “offer students needing remediation sufficient opportunities to learn material in the settings and delivery methods that suit their individual learning styles” (OPPAGA Report, 2007, p. 10). The report also communicated the need for improved faculty training on the use of learning styles in the classrooms. According to the qualitative data, only 18% of community colleges in Florida require college preparatory teachers to be trained in how to “adjust teaching methods to address the differing learning styles of students needing remediation” (OPPAGA Report #07-31, p. 9).
Further research supporting the unique ways that people learn and the adaptation of teaching to suit learning styles and preferences is being explored in this research to consider how more self awareness may affect achievement in community college students.

**Problem Statement and Significance of the Problem**

As the United States strives to model democracy, community colleges aspire to provide education to anyone with an ambition to learn (Anderson, 1995; Anderson & Adams, 1992; Clinton, 1997; Kolb, 1984; Neilsen, 1991; Purkiss, 1995; Schroeder, 1993; Sims & Sims, 1995). According to a study published by OPPAGA in 2007, 55% of all of the students entering Florida postsecondary institutions require remediation in mathematics, reading, and/or writing; 94% of students who need remediation attend community colleges. Florida law permits that only the state’s 28 community colleges and one Florida university (Florida A&M) offer college preparatory classes. Based on the same OPPAGA study, 55% of all traditional-aged students, 18 years of age and younger, are not college-ready when entering Florida’s community colleges. The most alarming statistic is that only 52% of college preparatory students in Florida complete their remedial courses, taking an average of two years to do so (OPPAGA, 2007, pp. 1-2). This dissertation is dedicated to these students who come unprepared for college-level work and struggle to fulfill their educational goals.

The Lumina Foundation’s Achieving the Dream project published a report summarizing data from 35 U.S. community colleges from study of a cohort of students tracked from 2002 until 2008. The Lumina Foundation explained that “Developmental Math is one of the biggest barriers to student success. It is the developmental class that
most students are required to take, but are least likely to complete”. Sixty-one percent of all students from this cohort were placed into developmental math. Only 51% of this same cohort of developmental math enrollees successfully completed the course within two years. This national data is consistent with the OPPAGA 2007 study. Only 17% of developmental math students meet the qualifications to proceed into college-level math. This data shows that out of 100 U.S. community college students representing students, 61 were required to take developmental math. Of the original 100 students, only 31 students pass the developmental courses within two years. Finally, only 10 of the original 100 students actually proceed into college-level math. The vast majority of students (90%) do not make it through the front door of the most “open door” in our higher education system. (Lumina Foundation, 2006, pp. 1-2) This information is a clear indication that our educational system is not yet designed for college-level preparation and that our community colleges are unprepared for the many students who wish to pursue a post-secondary education or technical training.

Many studies have been done on the alarming retention rates of community college students. Foundational researchers Astin (1973), Bean (1980), Cope and Hannah (1975), and Mallinckrodt and Sedlacek (1987) studied demographic factors; Hannah (1969) examined personality characteristics; Allen (1986) investigated interpersonal dimensions; and Bean (1983) and Tinto (1975) constructed causal models of student attrition. Considerable work continues to be done on determinate factors that affect retention of college students. However, assessment of these students’ learning styles and the use of learning styles information as a solution have not been adequately explored in the research thus far.
Purpose and Significance of the Study

The purpose of this research is to determine whether a student’s knowledge of his/her learning style and subsequent tutorials on how to interpret and use the results of a learning styles inventory affect a student’s score on the state-mandated exit exam in developmental math. Indian River State College (IRSC, formerly Indian River Community College), has recently become the first community college to be accepted into the International Learning Styles Network. In the past few years, the College has been using learning styles information and research to improve the learning environment. IRSC is currently piloting a new and more expensive learning styles assessment. It is imperative that research is done on the value of this new inventory as it relates to student achievement. If the new Building Excellence (BE) inventory and the knowledge that students gain about themselves in the subsequent lectures and individual lessons on learning styles prove to have significant effects on the achievement of developmental algebra students, then additional investments of classroom time and institutional budget will be warranted. Another purpose of this research is to study the learning styles of the developmental math students at this community college in order to understand possible correlations between students’ grades in Introductory Algebra and the students’ psychological learning styles.

Introductory Algebra is the entry level course for many community college students. By assessing, identifying and explaining students’ learning styles, it is hypothesized that there will be a significant increase in achievement for students who customize their study habits to suit their individual learning styles. Students’ understanding of their unique learning styles has been repeatedly shown in recent
research to have positive effects on student success in entry level courses. This effect is especially true in math courses (Garcia-Otero & Teddlie, 1992; Mangino & Griggs, 2003; Nelson, Dunn, Griggs, et al., 1993; Rochford, 2004; Rochford & Mangino, 2006). If the knowledge and the use of learning styles information are proven in this research to have a significant effect on achievement, then the assessment of students’ learning styles will become a more accepted retention tool that could be used in the first few weeks of college preparatory classes.

Learning styles research is used in human resource management, sales, team development, counseling, academic applications, and many other fields. Within the academic applications of learning styles research, there are two general applications of learning styles information that affect classroom instruction and student learning. These two applications (often referred to as “using learning styles” in the classroom) are:

1. The use of learning styles information, surveys, and prescriptions by students to increase self awareness and study skills.
2. The use of learning styles information, resources, facilities, and surveys by teachers and administration to customize pedagogy and the learning environment.

This research will concentrate solely on the first application which places the responsibility on the student. Ideally, the student is expected to become more self aware and apply the new information obtained from the BE Learning Style Profile in the improvement of their study habits and classroom learning techniques.
**Research Questions**

1. What is the relationship between students’ recently-acquired knowledge of how to use their learning styles profile and their score on the exit exam in remedial math (MAT 0024)?

2. What is the relationship between students’ psychological learning styles and their score on remedial mathematics?

3. To what degree do the participants value the Building Excellence Survey, accuracy of the assessment results, and the purpose of the tutorial information?

4. What is the students’ self-evaluation of their use of the learning style information and their application of the study skills that were provided to them in class?

**Hypotheses**

Corresponding to the four previously-mentioned research questions, it was hypothesized that the data would show the following:

1. Group 1 (G1) participants will take the BE Survey, but not receive any information or treatment and will thus act as the control group for this study. Group 2 (G2) will take the BE Learning Styles Survey and receive information about their individual learning styles, and are hypothesized to score significantly higher on the final exam. Group 3 (G3) will take the BE Survey, receive the interpretation of the results, and receive individual tutorial sessions from the researcher on how to apply the information to improve study skills. It is hypothesized that the participants from G3 will score significantly higher on the Introductory Algebra final exam than the students from G1 and G2.
2. Research shows that analytic learners typically have higher success rates in math courses than global learners. In an evaluation based strictly on the psychological learning styles of the participants (global vs. analytic), it is hypothesized that analytic learners will achieve higher test scores on the final examination at the end of the course compared with global learners.

3. It is expected that students will see the value of learning styles information. It is also hypothesized that variables such as quality of the course, the time provided to the participants to discuss learning styles, and the cooperation of the students also affect the perceptions of the students.

4. It is hypothesized that motivated students will feel that knowledge and use of their BE Profile has impacted their perceived success in the course.

Definition of Terms

**College preparatory math.** The terms college preparatory math, remedial math, developmental math, and college prep math (lower case) are often used interchangeably in the research. For the purpose of this study, one course will be used to represent multiple college prep math classes available to community college students. MAT 0024 is defined by Indian River State College as a course which prepares students for Intermediate Algebra (MAT 1033, a college-level course taken prior to College Algebra). Major topics in MAT 0024 include properties of integers and rational numbers, integer exponents, simple linear equations and inequalities, operations on polynomials (including beginning techniques of factoring), introduction to graphing, and introduction to operations on rational expressions.
College preparatory Florida statutes. The State Board of Education specifies the college credit courses that are acceptable for students enrolled in each college-preparatory skill area, pursuant to Fla. Stat. § 1001.02(7)(g). To do this, it has developed and implemented a common placement test for the purpose of assessing the basic computation and communication skills of students who intend to enter a degree program at any public postsecondary educational institution. The common placement testing program is required to include the capacity to diagnose basic competencies in the areas of English, reading, and mathematics (essential to perform college-level work); and prerequisite skills that relate to progressively advanced instruction in mathematics, such as algebra and geometry. A student enrolled in a college-preparatory course may concurrently enroll only in college credit courses that do not require the skills addressed in the college-preparatory course. A student who wishes to earn an associate in arts or a baccalaureate degree, but who is required to complete a college-preparatory course, must successfully complete the required college-preparatory studies by the time the student has accumulated 12 hours of lower-division college credit degree coursework; however, a student may continue to enroll in degree-earning coursework provided the student maintains enrollment in college-preparatory coursework for each subsequent semester until those college-preparatory coursework requirements are completed, and as long as the student demonstrates satisfactory performance in degree-earning coursework. A student must pass a standardized, institutionally developed test in order to be considered as having met basic computation and communication skills requirements. Credit awarded for college-preparatory instruction may not be counted toward the number of credits required for a degree.
**Building Excellence (BE) Survey Instrument.** The BE Survey was developed by Rundle and Dunn in 1996 (see Appendix A). It has been through numerous modifications since then and has been tested rigorously for validity and reliability. The most recent version of the BE, version six, is used throughout the world in nine different languages. Although this survey was originally a paper/pencil assessment tool, the latest versions of the test are web-based, online assessments of learning styles. The BE Learning Styles Survey and Profile identifies and measures a combination of 26 characteristics that may affect, positively or negatively, how well each individual achieves and performs in educational and work-based learning environments. The survey takes approximately 20-25 minutes to complete and the *Learning and Productivity Style (LPS)* score report is provided immediately after finishing the survey. An introduction and the empirical foundation for the BE assessment is provided in Appendix A.

**Learning and Productivity Style (LPS) Report.** This report is 18-20 pages and is provided immediately after completing the survey. It includes a graphic overview, narrative descriptions of preferences, and recommended strategies to improve productivity and learning. Also included in the report is a 30-60 and 90-120 day action planner so that respondents can create concrete action plans directed at improving learning and performance in both education and workplace settings.

**State mandated exit exam.** Also known as the Florida College Basic Skills Exit Test. This State-mandated test is administered to students completing college preparatory coursework. Students must pass this exam prior to enrollment in college credit general education, English, or mathematics courses that apply to degree requirements. Students
must be recommended by the instructor to sit for the exit exam, based on the indication that all coursework has been successfully completed.

**Definitions of learning styles terminology.** Appendix A includes thorough definitions of the perceptual, psychological, environmental, physiological, emotional and sociological elements that are assessed by the BE Survey. An introduction to the BE Survey, the survey’s reliability and its empirical foundation are also included in Appendix A.

**Mixed-Methods Rationale**

The quantitative phase of this study or Phase 1 (P1) will answer the first two research questions which measure the effects on student achievement. The second qualitative phase of this study, or Phase 2 (P2), will answer the third and fourth research questions. Phase 2 will measure student opinions and the perceived value of the learning styles treatment.

According to Locke, et al., qualitative research studies in the past decade have become increasingly more desirable in academic research. “A reconsideration of assumptions about such fundamental things as the nature of reality, what constitutes knowledge and the role of human values in the process of research led scholars to challenge the adequacy of some of the established norms of inquiry” (Locke, Spirduso, & Silverman, 2000, p. 92). The basic purpose of this research is to investigate the value of using learning styles assessments in the classroom to improve the achievement of college prep math students. To investigate effectively and comprehensively the value of an assessment that measures human differences, it is widely considered good practice to use
some qualitative research methods to account for the grey areas of the research story that are not revealed by the quantitative data.

**Delimitations**

In order to increase the effects of the researcher’s learning styles treatment and the value of the data that was collected, the researcher and the supervising doctoral committee mutually decided to limit the size of the population to three classes at one large community college. Because the focus of this study is college preparatory math, the research is also limited to students who have been assessed by the college placement test or a standardized test score and found to be unprepared for college-level math. To improve the power of the research findings, the predictive nature of a participant’s learning style on achievement was delimited to only the psychological learning style of the participants. Due to the small sample size that was chosen in order to make the qualitative portion of the study manageable, it was necessary to limit the research to the correlation between only the psychological (global and analytic) learning styles and achievement.

The convenience sample that was used in this research was selected based on the willingness of a selected instructor to work intensely with the researcher on the recommended applications of the BE Survey. The college that was used in this study has spent considerable efforts in researching the best practices in learning styles. This study has been influenced by the college’s decision to use the Dunn and Dunn model, which is explained more fully in Appendix A. Subsequently, this study is limited by its focus on the BE Learning Styles Model and the college prep math population that was studied.
Limitations of the Study

The small sample chosen in this study was helpful to the researcher in improving the value of the treatment and the effect on the subjects of this study. However, limitations resulted from the small sample size, including:

1. Reduced reliability of the phase-one, quantitative data;
2. The inability to replicate this study with a similar group and obtain similar results;
3. The teacher-expectancy effect may have been a threat to the validity of this study, due to the active involvement of the instructor and researcher and their mutual concern for the research results and the improved achievement of the students.

Organization of the Remaining Chapters

Chapter Two is a literature review that includes a theoretical and practical summary of the community college system, a current description of our country’s developmental education system, the basic theoretical basis of the learning styles research, and past experimental research on the effects of learning styles information on student achievement. Chapter Two also describes the current challenges surrounding the preparation of students for college and the demands of an increasingly highly-skilled economy. Learning styles have been investigated and presented throughout this study as one possible intervention of many that can be used by the community colleges to address the significant retention problem faced by students who are unprepared for college-level math. Chapter Three is a description of the methods to be used in the study. Chapter Four summarizes the collection of quantitative and qualitative data from phase one and two of the study. Chapter Five provides an overview of the study results, applications, conclusions, implications, and recommendations for future research.
Chapter Two

Review of the Related Literature

One out of every three students does not return to college after their freshman year (Feemster, 1999). Feemster also claims that teaching students how to learn will result in improved achievement, attitude toward learning, and motivation. Therefore, learning how to learn should be one of the first developmental steps a child takes in elementary education. Even in the early years of elementary education, curriculum should include the assessment of learning strengths, weaknesses, and styles. This knowledge would improve a students’ ability to effectively study, process, and retain information.

In the past 100 years, the relatively young community college system in America has dedicated its mission to the students who need remediation and small class sizes to accomplish their educational and vocational goals. According to McCabe, “there is significant evidence that equally motivated, remedial students have more difficulty identifying with an academic environment and regulating learning strategies” (McCabe, 2003, p. 46). According to the Lumina Foundation (2006), developmental math is one of the biggest barriers to student success; it is the developmental class that most students are required to take and are least likely to complete.

The field of learning theory and adult education is constantly evolving with new research on brain-based learning, emotional intelligence, effects on neural processing speeds, and of course, the various types of learning style theories that are being explored
and practiced. Knowles, et al., explain that any definition of learning must be prefaced with the distinction between the definitions of education and learning. “Education is an activity undertaken or initiated by one of more agents that is designed to effect changes in the knowledge, skill, and attitudes of individuals, groups, or communities” (Knowles, Holton, & Swanson, 2005, p. 1). This definition emphasizes the role of the change agent, educator, trainer, or facilitator that presents, reinforces, and designs the stimuli or content that is being shared. According to Boyd and Apps, learning (in contrast to education) emphasizes the person in whom the change occurs or is expected to occur. “Learning is the act or process by which behavioral change, knowledge, skills, and attitudes are acquired” (Boyd & Apps, 1980, pp. 100-101).

**Introduction of the Chapter**

This chapter examines the research and frames the recent history of thought on the following three areas of this study: the developing community college mission, college preparatory and developmental math education, and the current learning style theory and research on pedagogical practices. It begins with setting the historical and philosophical framework and concludes with a report and analysis of research studies on learning styles.

**Community Colleges**

“The American community college movement is the most important higher education innovation of the twentieth century” (Witt, Wattenbarger, Gollattscheck, & Suppinger, 1999, p. 1). Between the years 1892 and 1920, community colleges were primarily located around the University of Chicago and were originally intended to be the first two years of the university system (Fields, 1962; Witt et al., p. 30). Private four-year
colleges that were struggling with their enrollment decided to consolidate their resources to provide the freshman and sophomore years for the university in exchange for accreditation and support from the university system. Thirty to forty years after the idea of junior colleges began in the U.S., President Truman’s Commission on Higher Education (1947) created the imperative that launched the community/junior college concept into a national educational institution (later named the National Commission on Education). It became an international model on preparing citizens for the technological age that was to come. The conclusion reached by the Commission stated, “The time has come to make education through the 14th grade available in the same way that high school is now available” (Palinchak, 1973, p. 55).

Thirty years later, the community college system was revolutionizing general education and technical skills training, and producing hundreds of thousands of graduates. However, in the 1980’s, community colleges were still faced with the dilemma that more and more youth emerged from high school unprepared for college or for work (Gardner et al. 1983).

The “open door” of the community college has long been a hallmark for its democratic purpose in society (Palinchak, 1973). The diversity of the unprepared, less conventional community college students makes the challenge of retention and the need for remediation critical to its success (Bulalowski & Townsend, 1995). Forty years ago, when the community colleges were defining their missions, they could have collectively decided to take the easier path of separating technical schools from college preparatory junior colleges. However, the Jeffersonian approach that they took toward developing
well-rounded working citizens has proven to be both challenging and rewarding work (Rosenfeld, 2005).

Today, the mission of community colleges continues to develop and improve (Witt et al., 1999). Community college students who have earned at least one year of college credit can earn 5-11% more than the high school graduate (Grubb, 1999; Kane & Rouse, 1995; Pascarella, 1999). According to the last U.S. Census in 2000, 84% of Americans over the age of 25 earned a high school diploma. The mean income of a high school graduate working full-time in 1999 was $30,500 and the average income of a person who had obtained an Associates Degree was $38,200. The average income increases to $52,200 if the employee has obtained a bachelor’s degree (Day & Newburger, 2002, Figure 1, p. 2). Rochford and Mangino (2006) tout the monetary value of higher education, but the enrollment of low-income students in community colleges has decreased from 24% to 21%. And, less than 63% of community college freshman return to college for a second year (National Center for Public Policy and Higher Education, 2004). Although the community college is continuously making improvements to quality, it is still faced with significant problems in the areas of remediation and college preparation (OPPAGA, 2006).

In the past decade, community colleges have rededicated themselves to learning. Recent developments include the addition of baccalaureate degrees. The colleges are now responding to the needs of the information-driven service industry by offering Bachelors of Applied Science Degrees in Business, Education, Nursing, and many other technical and professional degrees. This represents a major shift in the technical and college preparatory programs that have been offered in the past, and yet the accessibility
of the degrees and remedial work is still paramount in the mission and development of community colleges.

O’Banion and Milliron wrote about the movement from customer relationship management to learning relationship management. Universities and colleges have adopted many trends from business theory, and these have contributed to the development of today’s modern educational system. “The word learning has emerged to frame a whole new set of constructs: learning organizations, learning communities, learning audits, learning outcomes, learning-based funding, e-learning, and learning colleges” (O’Banion & Milliron, 2001, p. 19). Many conferences, journal articles, accreditation self studies, grants, and mission statements have been focusing on the definition and practice of learning.

The question for the upcoming decade is: will colleges and universities adopt learningstyle theory and learning-centered education into their changing cultures? The fact that learning is central to the purpose of the community college system should increase the odds that the learning revolution would last longer than other fads of the past (O’Banion & Milliron, 2001). O’Banion and Milliron provided the following list of questions that community college educators should be asking in the conversations about learning:

- What kinds of learning do we value the most?
- How do we measure the kinds of learning we agree to produce?
- What kind of learning do we value highly that we feel cannot be measured?
- Why can’t it be measured?
• What are the primary learning styles of our students, and which of these can we best accommodate?
• How can we provide more learning experience options for our students to respond to their diverse learning styles?
• How do we distinguish between learner-centered education and learning-centered education?
• How can we use technology to better help our students expand their learning?
• Is there a more useful way to document learning than grades and course credit?
• Is there a more effective way than workload formulas to utilize the skills and talents of faculty in facilitating the learning process?
• How do secretaries, custodians, technicians, and other non-faculty staff contribute to learning?
• How do we really know that our students have learned? (O’Banion & Milliron, 2001, p. 21)

Developmental and Adult Education

According to the National Statistics on Education, student enrollment in Fall 2004 in all post-secondary institutions of higher education that received Title IV funding was 17,710,798 (IES National Center for Education Statistics, 2005-06, retrieved from http://nces.ed.gov/programs/digest/). Of this sample, 6,655,812 students attended 2-year undergraduate colleges (NCES website). In Florida, during the 2005-06 year, 793,517 students attended a community college. Based on the data which states that 78% of the students entering the community college require remediation, approximately 580,000
community college students in Florida required remedial classes in 2005-06 (OPPAGA Report 06-40, p. 2).

The number of high school graduates attending college has risen over the past twenty years from 49% to 63% (McCabe, 2003). According to OPPAGA (2006), the need for the remediation of high school graduates in Florida who enrolled in post-secondary education has remained relatively constant; around 45% (see Figure 1).

![Remediation Rates](image)

**Figure 1. The Percentage of Recent Florida High School Graduates Who Need College Remediation 1997-2004.** (Florida Department of Education)

Another piece of data which reflects the community colleges’ challenge of continuous improvement is that more than 60% of college students fail to complete a degree in five years, and only half will remain in college after the first year of coursework (McGrath, 2001). According to OPPAGA, 78% of Florida community college students require remediation in mathematics, reading, and/or writing, as shown in Figure 2. The same report lists the cost of preparing these Florida students for college-level work at $118.3 million dollars in 2004-2005 (OPPAGA Report, 2006, p. 3).
The need to improve student preparation for college-level work is vital to the growth and function of the community. “Eighty percent of new jobs will require some postsecondary education, yet only 42% of today’s students leave high school with the necessary skills to begin college-level work” (McCabe, 2003, p. 13). Although the State of Florida has made many significant improvements to education in the past 10 years, the need for college-level remediation has remained constant. Indian River State College is just one of many colleges that are becoming aware of the value of showing students how to adapt their studies to their unique learning styles.

Aside from the academic competencies, developmental students are generally as motivated and demonstrate similar non-cognitive characteristics compared with the entering, college-ready freshman class (Saxon & Boylan, 1998). A majority of the problems faced by community college students which affect their continued enrollment include the typical challenges of finances, child care, health, transportation, family life, and general indecision about their academic future. In addition to these problems,
remedial students “have more difficulty identifying with an academic environment and regulating learning strategies…Remedial students tend to lack higher-order thinking skills needed to survive in an academic setting, and they need careful assessment, intensive counseling, and other structured learning assistance services” (McCabe, 2003, p. 46).

The term developmental education refers to the college’s mission as it relates to the full personal development of the student. The organizational structure and administrative support of developmental education is critical to the success of a remedial program. Roueche and Roueche (1999) outline the following list as the basic measures that should be taken by administrators to strengthen an institution’s commitment to developmental education:

1. Mandatory placement testing for all entering students
2. Mandatory placement into developmental education courses based on assessment results
3. Limited selection of academic courses that can be taken by developmental students
4. Systematic evaluation of remedial programs
5. Monetary commitment to support teaching and faculty development
6. Increased support and structure offered to at-risk students
7. Expanded pre-enrollment activities
8. Strong support of good advising systems
9. Required orientation
10. Institutional support for college-wide attendance policies
Limited course-schedules for students who work
Comprehensive financial aid program
Recruiting and hiring the best faculty
Innovative experiments in curriculum design
Increased student services
Completion of remedial courses as an institutional priority. (as cited in McCabe, 2003, p.49)

In the past decade, most comprehensive community colleges have dedicated themselves to developmental education and have created departments that serve the specific needs of students who require extra assistance and remediation.

Although the terms developmental and adult education are sometimes mistakenly used synonymously, they are very different, yet related professional fields of education. The larger umbrella of adult education and Adult Learning Theory refers to the education and learning of all adults in and outside of academia, including the students in need of developmental assistance. The uniqueness of the learner, the learning process, and the context in which learning takes place all make up the foundation of adult education (Merriam, 2001).

**Learning Style Theories**

In the past 30 years, a person’s learning style has been defined similarly by several different learning theorists. Smith (1982) defined the concept of learning style as “a person’s preferred mode of learning.” James and Blank explain that a learning style is the “complex manner in which, and conditions under which, learners most efficiently and most effectively perceive, process, store and recall what they are attempting to learn”
Swanson quotes Reichmann's reference to learning style as "a particular set of behaviors and attitudes related to the learning context" and also presents Keefe's definition of learning style as "the cognitive, affective, and physiological factors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Swanson, 1995, p. 2). These (1979) postulated that a learning style is a biological and developmental set of personal characteristics that make identical instructional environments, methods, and resources effective for some learners and ineffective for others. Dunn and Dunn (1992, 1993) simplified a useful definition which will be repeatedly referred to in this study. “A learning style is the way in which individuals begin to concentrate on, process, internalize, and retain new and difficult academic information” (Dunn & Dunn, 1992, 1993; Dunn, Dunn & Perrin, 1994). There are as many definitions of learning style as there are surveys and inventories used to categorize a person’s unique methods of processing, communicating, and retaining information. It is important to note that learning-style preferences differ vastly. The stronger the learning style preference, the more important it is to provide compatible pedagogy (Braio, Dunn, Beasley, Quinn, & Buchanan, 1997).

One common misperception among educators is that learning style represents only the perceptual differences in how a person learns. Research done in the 1980’s by Barbe and Milone (1981) and Dunn (1988) brought national and international attention to the value of modifying curriculum and pedagogy to the perceptual differences of students. However, in the past 30 years of research, the learning styles community has developed more complex and comprehensive models that take into effect other elements
of a person’s unique learning style. For example, Keefe (1987) described three
dimensions of personal preferences or styles in learning, as was stated in the dissertation
by E. Paul (2001):

- **Cognitive styles** – information processing to include the way one encodes,
  processes, stores, retrieves, and decodes information;
- **Affective styles** – personality dimensions to include attention span, motivation,
  interests, and emotions; and
- **Physiological styles** – to include gender behavior, health-related behavior, and
  physical environmental conditions.

Gregorc’s (1982) learning theory of adaptive instruction focused on the perceptual
learning styles (i.e. auditory, tactile/kinesthetic, and visual.). Kolb’s cognitive learning
theories are also well known and respected in the body of literature (Manochehri, 2001).
Some theorists, like Gregorc, place the responsibility of customizing the learning
environment on the teacher. Other researchers believe students must be responsible for
modifications to improve learning. Regardless of who assumes responsibility, if the
methods and environment in which a student learns best are identified and customized,
most theorists claim that the student will not only learn more, but enjoy the learning
experience more (Bostrom, Olfman, & Sein, 1990).

The BE Survey created by Dunn and Dunn (1996-2000) and used in this study
examines and explains 26 different learning style characteristics or preferences. These
characteristics are a part of six unique elements of a person’s learning styles profile.
The elements described by Dunn and Dunn are:
• **Perceptual** – One’s predisposition for learning and retaining new knowledge skillfully.

• **Psychological** – One’s preferences for processing new information, making decisions, and solving problems.

• **Environmental** – The stress-related elements in the immediate surroundings that affect one’s ability to concentrate and focus on tasks for extended periods.

• **Physiological** – The conditions that affect one’s ability to remain energized and alert while completing school assignments and working details.

• **Emotional** – The preferences that influence how effectively and how quickly one completes challenging and complex tasks.

• **Sociological** – Preferred ways of learning and interacting with others. (See Appendix A)

Although there is significant research stated in this review of the literature, which supports the use of learning styles in the improvement of teacher pedagogy and study habits of students, a few researchers have contested the value of teaching to a student’s learning style (Desai, 1996; Hajizainuddin, 1999; Lindsay, 2006). McKeachie argues that categorizing students into specific learning style boxes can have unintended negative consequences. In the following quote, he states his most serious concern related to using learning styles in teaching.

Some teachers may draw the implication that they must match their teaching to the student’s particular style, and some students who have been labeled as having a particular style feel that they can only learn from a certain kind of teaching…Some teachers become devotees of one or another learning style system. However, the “styles” or “types” identified by learning style inventories are not little boxes, neatly separated from one another; rather, they represent dimensions along which learners may differ. (McKeachie, 1995, p. 6)
With the exception of valid concerns like these, many researchers support that learning styles have significant effects on academic achievement. According to a meta-analytic validation study of 42 learning style research studies with 3,181 participants, “students whose learning styles are accommodated would be expected to achieve 75% of a standard deviation higher than students who have not had their learning styles accommodated. A weighted effect size among the 36 valid studies was .353” (Dunn, Griggs, Olson, Gorman, & Beasley, 1995). Similar award-winning research affirms that instruction matched to a student’s learning style improves academic performance of adult learners (see Appendix B for a list of award-winning research studies on this topic).

Prior to the most recent learning style theories and research, Piaget, Bandura, and Skinner were studying the cognitive and behavioral effects on learning prior to researchers such as Dunn and Dunn. Skinner (1938) posited that there are two types of behavior: respondent and operant. “Respondent behavior refers to reflexes or automatic responses that are elicited by stimuli.” Operant behaviors are responses emitted without a stimulus (Engler, 1991, p. 216). Respondent behaviors can be shaped and affected by learning. Operant behaviors are instead freely made, without the restrictions of innate reflex.

Piaget (1986-1980) a Swiss philosopher, natural scientist and developmental psychologist was well known for his research on children and his theory of cognitive development. He outlined the development of new cognitive stages in life and created sequential stages of learning and development which have impacted curriculum and pedagogy in classrooms throughout the world. According to Piaget, the developmental learning process starts with random action and interpretation of the abstract and ends with
a complex construction of new knowledge from many forms of relationships and input. This higher level of knowledge Piaget called gestalt.

Educators are just beginning to discover the many applications of learning style theory, and in general, how we learn is still being studied, measured and categorized not only in the educational area, but in, for example, biological studies on how the brain responds under different environmental influences and stimuli (which this dissertation does not attempt to explore).

Learning Style Practice and Research

The quantity and quality of research that is being done in the area of learning styles continues to increase with the reports of successful improvements to academic achievement. At the heart of the research examined here is a comparison of traditional methods of instruction versus a modified pedagogy that is suited to various learning styles of the diverse student population. The community college system has attempted many support methods which have been moderately successful in the retention of students in the past few decades (Derry & Murphy, 1986; Ford, 1981; Tinto, 1985). According to the studies, community college students who were presented with pedagogy suited to their unique learning style significantly improved achievement when compared with students who were presented with instruction incongruent with their learning style (Clark-Thayer, 1987; Dunn, Deckinger, Withers, & Katzenstein, 1990; Ingham, 2003; Lenehan, Dunn, Ingham, Murray, & Signer, 1994; Mangino & Griggs, 2003; Miller, 1998; Rochford, 2003). According to Rochford and Mangino, these results occurred because learning-style behaviors vary according to:


Rochford (2003) has provided a few excellent studies recently on the value of using learning styles information to improve both classroom pedagogy and the study habits of students. Her most recent learning styles study with Mangino (2006) was a brief overview of research conducted on 176 participants from two urban community colleges. There were six research hypotheses presented in the study, which could be narrowed down to one basic research question: Is there a significant difference between the learning styles of remedial students and education majors? A t-test of independent means demonstrated significant differences (some at the $p<.05$ level and other differences at the $p<.001$ level) between the education majors and remedial students:

(a) for the learning style elements of noise, motivation, intake, time of day, tactual learning, and kinesthetic activities; and (b) for GPAs, age, ACT scores. These findings suggested that the remedial learners desired a quieter learning environment and late afternoon or evening learning. In contrast, the education majors revealed a need to snack and preferred activities that involve the manipulation of materials and whole body movement. (Rochford, 2006).

Although the Rochford (2003) research presents a wide variety of tests of differences in remedial students and education majors, it does not present evidence of how this knowledge was used to benefit student learning. Understanding student differences is invaluable. However, categorizing students without an academic plan or subsequent recommendations on how to study and for pedagogical changes in the classroom is useless knowledge. In one of the stronger critiques of learning styles by Dembo and Howard, the authors state that instructors generally need to be more sensitive
to the individual differences of their students and admit that instructors “may be more successful if they try different teaching methods with different students” (Dembo & Howard, 2007, p. 2). However, they warn that categorizing any group of students incorrectly according to their learning styles can be harmful to a student's learning process.

Nelson et al. (1993) was one of the most respected studies on learning styles interventions at a community college. The two-year study of 1,089 participants posed four research questions during a two-phase methodology. The first two research questions provided a major impetus to this study:

1. During Phase One, do experimental-group participants who were assessed on their learning styles and received an interpretation of their strengths at the beginning of the fall semester differ from control-group participants at the end of the semester on retention and academic achievement?

2. During Phase Two of the spring semester, do students who were (a) assessed on their learning styles and received an interpretation of their strengths versus (b) those assessed for their learning styles, received an interpretation of their strengths, and were provided with instructional sessions on applying these strengths to studying and completing assignments versus those who (c) received no treatment differ at the end of the semester on retention and academic achievement?

Within the Nelson et al. study, the authors briefly referenced eight other studies between 1978-1990 which demonstrated improved achievement of students when learning styles strategies were used in the classroom and when assessed learning styles were accommodated by the instructor. Nelson et al. also stated, “The present study
extends the research in this area because it is the only study with a college population that addresses the impact of educating students to varying extents regarding their learning styles on retention and achievement” (Nelson, et al., 1993, p. 365).

The hypotheses shared between the Nelson et al. study and this research on the effects of learning styles and student achievement are very similar in nature. Comparisons can be easily drawn between this study and the second phase of the Nelson et al. research. In the first phase of the Nelson et al. research, academic achievement and retention were both analyzed using a t-test and 2x2 chi square independent sample analysis. Phase 1 of the study only measured the effect of taking the PEPS Learning Styles Test and a brief instructor explanation of the results. In P1, the students were not provided any information about learning styles or how to use the results of the test. Tables 1 and 2 show the results of phase one of this research.

<table>
<thead>
<tr>
<th>Group</th>
<th>Observed</th>
<th>(Expected)</th>
<th>Observed</th>
<th>(Expected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retained</td>
<td>373</td>
<td>389.8</td>
<td>504</td>
<td>487.2</td>
</tr>
<tr>
<td>Dropout</td>
<td>111</td>
<td>94.2</td>
<td>101</td>
<td>117.8</td>
</tr>
</tbody>
</table>

Note. $x^2 = 6.67754, p = .01$
In Table 1, at an alpha level of .01, the effect of the PEPS test on Grade Point Averages (GPAs) at the end of the class was considered insignificant. In Table 2, the chi square value was found to be significant at the .01 level. The frequency of students retained in the experimental cohort was greater than the frequency expected, as opposed to the observed frequency in the control cohort, which was less than. Phase one of the Nelson et al. study determined that giving the PEPS test and providing the results had no effect on the achievement of the students. However, the retention rate of the students in the Experimental Cohort (83.3% retained) was significantly higher than the Control Cohort (77% retained) (Nelson et al., 1993).

In phase two of the Nelson et al. study, two groups of students were studied over two semesters, under three different levels of exposure to learning styles information. Many research tools were used to analyze the data. The three levels of exposure were (a) students tested using the PEPS test for learning styles strengths with an explanation of the results compared with (b) students assessed by the PEPS who received an interpretation and who were provided with three instructional sessions on how to apply the information to studying and completing assignments, versus (c) students who received no treatment at all. In phase two, a Tukey-Kramer Modification to the HSD test indicated that students from the experimental group, who received further exposure to learning styles information, achieved a higher mean spring grade-point average than those in either the spring control group or the first experimental treatment group who had only taken the test. “This finding was especially important, for whereas the change in mean GPA from fall to spring was negligible for the control Group, there was a more positive change for the Experimental Group I, which received only the very limited exposure, and a
dramatically marked change for the Experimental Group II student who were taught to study congruently with their individual learning styles. In fact, the .69 difference in mean GPA from fall to spring reflected an increase approximately 16 times greater than that of the control probationary students” (Nelson et al., 1993, p. 368).

Retention rates were also studied in the second phase of the study. Nelson et al. witnessed significantly higher retention rates in the students who had received more learning styles information after taking the PEPS test. The chi-square value was significant at the .0001 level, indicating a retention rate that was much different than those that were expected by chance. The retention effects were noticeably applicable in both populations studied: probationary students who were retained at a rate of 97.82% in the Experimental Group II, as compared to 78.33% and 81.48% in the spring Control Group and Experimental Group I respectively. Non-probationary students were retained at a 100% rate in the Experimental Group II, compared with 94.34% and 94.40% in the Control and Experimental I Groups respectively (Nelson et al., 1993, p. 368).

Nelson et al. hypothesized that “It may be that providing students with a readily applicable, individualized methodology for studying that optimized the management of their study time outside the classroom lead to significantly higher academic achievement” (Nelson et al., 1993, p. 368). It is the aim of this research to find a similar conclusion applicable in a smaller sample size using the newly-developed BE Survey. The BE Survey online test was developed by Susan Rundle and Rita Dunn to eventually replace the PEPS instrument. This dissertation extends the earlier research done by Nelson et al. (1993), Clark-Thayer (1987), Cook (1989), and Dunn, Dunn, and Price (1982) by using the newest instrument available, the BE Survey.
Summary of the Review of Related Literature

This chapter has reviewed the collection of literature on the themes of this research: the community college, college preparatory math students, and the theory and practice of learning styles. This chapter was written for the purpose of framing the history of this research and defining the motivation and thought process of the researcher.

The section on the development of the community colleges was intended for the audience who was unfamiliar with the purpose and value of the community college system. Its democratic beginnings, the growing need for vocational training and college preparation, and the challenges of its future in our changing economic and social world, were addressed.

The remediation challenges faced by colleges and universities were explored. The root causes for the problems relating to large numbers of students unprepared for college-level work when they enter community colleges and universities, were discussed. The recent best practices in developmental education were summarized.

In the section titled Learning Styles Theory, the recent growth in research on the unique learning style of individuals was examined. The many theorists such as Dunn and Dunn, Smith, James and Blank, Swanson, Keefe, Engler, Bandura, Skinner, and Piaget were all referenced for their contributions to this developing body of knowledge. The various definitions of Learning Theory were listed in this section, and the theoretical constructs for this research were outlined.

The most valuable research which was reviewed, the study by Nelson et al. (1993) on students at a Texas community college, helped to guide the methodology of this research study. The instrument, population and hypotheses could easily be compared and
contrasted with this study. Nelson et al. hypothesized “that providing students with a readily applicable, individualized methodology for studying, optimized the management of their study time outside the classroom and may lead to significantly higher academic achievement” (p. 368). This model of research, with slight variations in sample size and the type of research methods employed, serves as an excellent framework for this dissertation.
Chapter Three

Method

This research was conducted on three sections of Introductory Algebra (MAT 0024) at a large suburban community college in Florida during the spring semester of 2008. The total sample population was comprised of three classes ranging from 26-28 students for a total original sample size of 83 students. While it was decided that a smaller sample size would provide a more concentrated treatment group and a more realistic environment in which to conduct the qualitative portion of this study, the potential threats to the power of the quantitative portion of this study were considered as a necessary delimitation.

Problem Statement and Significance of the Problem

Community colleges aspire to provide education to anyone with an ambition to learn (Anderson, 1995; Anderson & Adams, 1992; Clinton, 1997; Kolb, 1984; Neilsen, 1991; Purkiss, 1995; Schroeder, 1993; Sims & Sims, 1995). According to a study published by OPPAGA (2007), 55% of all of the students entering Florida postsecondary institutions require remediation in mathematics, reading, and/or writing; and 94% of these students attend community colleges (p. 2). Florida law permits that only the state’s 28 community colleges and one Florida university (Florida A&M) offer college preparatory classes. Based on the same OPPAGA study, 55% of all traditional-aged students, 18 years of age and younger, are not college-ready when entering Florida’s community colleges (p. 2). The most alarming statistic is that only 52% of college
preparatory students in Florida complete their remedial courses; taking an average of two years to do so (OPPAGA, p. 1). This study is dedicated to the fragile majority of students who come unprepared for college-level work and will struggle to fulfill their educational goals.

From a 2002 cohort of students that were tracked until 2008, the Lumina Foundation’s (2006) Achieving the Dream project published a report that summarizes data from 35 community colleges throughout the nation. The Lumina Foundation explained that “Developmental Math is one of the biggest barriers to student success. It is the developmental class that most students are required to take, but are least likely to complete” (p. 1). Sixty-one percent of all students from this cohort of 35 community colleges throughout the nation were placed into developmental math (p. 1). Only 51% of this same cohort of developmental math enrollees successfully completed the course within two years (p. 1). This national data is consistent with the OPPAGA study. Only 17% of developmental math students will meet the qualifications to proceed into college-level math (Lumina Foundation, p. 2). Out of 100 community college students representing students throughout the nation, 61 were required to take developmental math (p. 1), but only 31 will pass the developmental courses within two years (p. 2), and only 10 of the original 100 students will actually proceed into college-level math (p. 2). The vast majority of students (90%) do not make it through the front door of the most “open door” in our higher education system (p. 2). This fact is a clear indication that our educational system is not yet designed for college-level preparation and that our community colleges are still unprepared to adequately remediate the many students who wish to pursue a post-secondary education or technical training.
Many studies have been done on the alarming retention rates of community college students. Foundational researchers, Astin (1973), Bean (1980), Cope and Hannah (1975), and Mallinckrodt and Sedlacek (1987), studied demographic factors; Hannah (1969) examined personality characteristics; Allen (1986) investigated interpersonal dimensions, and Bean (1983) and Tinto (1975) constructed causal models of student attrition. Considerable work continues to be done on determinate factors that effect retention of college students. However, the assessment of these students’ learning styles and the use of learning styles information as a solution have not been adequately explored in the research thus far.

**Purpose and Significance of the Study**

The purpose of this research is to investigate whether a student’s knowledge of his/her learning style and subsequent tutorials on how to interpret and use the results of a learning styles inventory will have an affect on a student’s score on the state-mandated exit exam in developmental math. Indian River State College (IRSC, formerly Indian River Community College) has recently become the first community college to be accepted into the International Learning Styles Network. In the past few years, the College has been using learning styles information and research to improve the learning environment. IRSC is currently piloting a new and more expensive learning styles assessment. It is imperative that research is done on the value of this new inventory as it relates to student achievement. If the new Building Excellence (BE) inventory and the knowledge that students gain about themselves in the subsequent lectures and individual lessons on learning styles prove to have significant effects on the achievement of developmental algebra students, then additional investments of classroom time and
institutional budget will be warranted. Another purpose of this research is to study the learning styles of the developmental math students at this community college in order to understand possible correlations between students’ grades in Introductory Algebra with the students’ psychological learning styles.

Introductory Algebra is the entry level course for many community college students. By assessing, identifying and explaining students’ learning styles, it is hypothesized that there will be a significant increase in achievement for students who customize their study habits to suit their individual learning styles. Students’ understanding of their unique learning styles has been repeatedly shown in recent research to have a significant effect on student success in entry level courses. This effect is especially true in math courses (Garcia-Otero & Teddlie, 1992; Mangino & Griggs, 2003; Nelson, Dunn, Griggs, et al., 1993; Rochford, 2004; Rochford & Mangino, 2006). If the knowledge and the use of learning styles information are proven in this research to have a significant effect on achievement, then the assessment of students’ learning styles will become a more accepted retention tool that could be used in the first few weeks of college preparatory classes.

Learning styles research is used in human resource management, sales, team development, counseling, academic applications, and many other fields. Within the academic applications of learning styles research, there are two general applications of learning styles information that affect classroom instruction and student learning. These two applications (often referred to as “using learning styles” in the classroom) are:

1. The use of learning styles information, surveys, and prescriptions by students to increase self awareness and study skills, and
2. The use of learning styles information, resources, facilities, and surveys by teachers and administration to customize pedagogy and the learning environment. This research will concentrate solely on the first application that places the responsibility on the student. Idealistically, the student is expected to become more self aware and apply the new information obtained from the BE Learning Style Profile in the improvement of their study habits and classroom learning techniques.

This research sought to evaluate both quantitative and qualitative data from three MAT 0024 courses. The first, quantitative phase of this study (P1) answered the first two research questions by analyzing final exam test data. Subsequently, P1 drew potential correlations between achievement and the participants’ psychological learning style profile. The qualitative phase of this study (P2), surveyed the students’ opinion of how valuable the learning styles information was, and how they used the information to improve their study habits.

This section will review the research questions and design. It will also provide a demographic description of the participants and how their rights as research subjects were protected. The validity and reliability of the learning style instrument that was chosen will also be summarized. Finally, this section will include an outline of the research procedures used and the types of data collection and analysis that were employed to answer the research questions.

**Research Design**

A large sample of college preparatory students was initially considered when preparing for this study. After further discussion with my doctoral committee, the value of a smaller, mixed-methodology consisting of both quantitative and qualitative research
was agreed to be the most suitable for the purposes of this research. The quantitative phase of this study or P1 will answer the first two research questions that measure the effects on student achievement. The second qualitative phase of this study, or P2, will answer the third and fourth research questions and will measure student opinions and the perceived value of the learning styles treatment.

According to Locke, Spirduso, and Silverman (2000), qualitative research studies in the past decade have become increasingly more desirable in academic research. “A reconsideration of the assumptions about such fundamental things as the nature of reality, what constitutes knowledge, and the role of human values in the process of research led scholars to challenge the adequacy of some of the established norms of inquiry” (p. 92). The basic purpose of this research is to investigate the value of using learning styles assessments in the classroom to improve the achievement of college prep math students. To investigate the value of an assessment that measures human differences effectively and comprehensively, it is widely considered good practice to use some qualitative research methods to account for the grey areas of the research story that are not told by the quantitative data.

**Research Questions**

This study is focused on the development of the following four research questions. Questions 1 and 2 are referred to as P1 and questions 3 and 4 are referred to as P2.

1. What is the relationship between students’ recently-acquired knowledge of how to use their learning-styles profile and their score on the exit exam in remedial math (MAT 0024)?
2. What is the relationship between students’ psychological learning styles and their score on remedial mathematics?

3. To what degree do the participants value the BE Survey, accuracy of the assessment results, and the purpose of the tutorial information?

4. What is the students’ self evaluation of their use of the learning-style information and their application of the study skills that were provided to them in class?

**Hypotheses**

Corresponding to the four previously-mentioned research questions, it was hypothesized that the data would show the following:

1. Group 1 (G1) participants served as the control group, took the BE Survey, but did not receive any information or treatment. Group 2 (G2) took the BE Survey and received information about their individual learning styles, and are hypothesized to score significantly higher on the final exam. Group 3 (G3) took the BE Survey, received the interpretation of their results, and received individual tutorial sessions from the researcher on how to apply the information to improve study skills. It was hypothesized that the participants from G3 would score significantly higher on the Introductory Algebra final exam than the students from either G1 or G2.

2. Research shows that analytic learners typically have higher success rates in math courses than global learners. In an evaluation based strictly on the psychological learning styles of the participants (global vs. analytic), it was hypothesized that analytic learners would achieve higher test scores on the final examination at the end of the course than global learners.
3. It is expected that students will see the value of learning styles information. It is also hypothesized that variables such as the quality of the course, the time provided to the participants to discuss learning styles, and the cooperation of the students would also affect the perceptions of the students.

4. It is hypothesized that students will feel that knowledge of their Learning Styles Profile has impacted their perceived success in the course.

Participants

The college preparatory math population chosen for this study was selected by the researcher because this group represents one of the greatest retention challenges in the community college system. The participants were selected using a convenience sample of Introduction to College Algebra students, from a large suburban community college in Florida and were taught by the same instructor during the spring 2008 semester. The college at which this study was conducted currently enrolls over 40,000 students with more than 9,000 of them in full-time status. The MAT 0024 students are placed into a remedial math course to prepare them for College-Level Algebra. Placement is determined by a standardized computer placement test (CPT) that is used throughout the 28 community colleges in Florida.

Introduction to College Algebra is designed to prepare students for their first college-level math course, Intermediate Algebra (MAT 1033). The objective of MAT 0024 is to introduce students to polynomials, methods of solving equations and inequalities, rational expressions, radicals, and graphing. The instructor uses Martin-Gay’s (2004) *Beginning algebra* (4th ed.) as the text for the course and required three
tests, not including the final exam, which the students must pass in order to complete the course. Eighty percent of the final grade is based on the tests and the final exam.

The students were assured that their participation in the study would be voluntary. They were also told, during the introduction of the class, how important this research is and that the results would be published for others to benefit from. Students were provided with a copy of the participant letter (see Appendix C) that is in compliance with the University of South Florida’s Internal Review Board and the Research Review Board at the college where the study was being held. The letter that was given to the students asked for their participation and instructed them to complete the student profile form if they wished to volunteer to participate in the study. The information provided in the letter and the student’s voluntary completion of the student profile form met the IRB requirements for informed consent.

The same group of students were used in both P1 (Quantitative Phase) and P2 (Qualitative Phase) of the experimental section of this study. Twenty-five participants from G3 received the full treatment during P1 and were surveyed in P2. Students were asked the eight questions on the Student Opinion Survey during P2 of the study (see Appendix D) and observations and insights were recorded during the administration of the survey. Questions 6-8 were open-ended questions aimed at obtaining written opinion and eliciting oral opinion as well. A recording device was used during each of the small group survey sessions. Participants were asked for permission to record the responses or any elaboration they may offer to questions 6-8.

Although the small sample negatively affected the power and generalizability of this study, the smaller sample size was necessary to make P2 more valuable and
manageable. Table 3 provides a reference of projected data points provided in the proposal stage of this study that were expected to be collected from each participating group.

Table 3  
*Numbers of Data Points for Phase 1 and Participants for Phase 2*

<table>
<thead>
<tr>
<th>Participant Group</th>
<th>P1: Spring 2008</th>
<th>P2: Spring 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(G1)</td>
<td>(G2)</td>
</tr>
<tr>
<td># of Participants</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

*Note. P1- n = approx. 75. P2- n = approx. 25*

**Instrumentation**

The achievement of MAT 0024 students were measured by comparing final exam scores of the control group versus the two treatment groups. The BE Survey was used in phase one to provide participants with their individual learning styles profiles. In addition to the BE Survey, the state-mandated standardized final exam for MAT 0024 and the qualitative survey created by the researcher were also used as measurement instruments.

The BE Survey was modeled after the Productivity Environmental Preference Survey (PEPS) that was developed by Dunn, Dunn, and Price in 1982. Although the PEPS was used for the past 6 years at the college where this study was conducted, it was determined by the Learning Styles Committee at the college that the paper-pencil PEPS was less user-friendly than the computerized BE assessment.

The BE was developed by Susan Rundle (President of Performance Concepts International and Director of Adult Learning, St. John’s University’s Center for the Study...
of Teaching and Learning Styles) and Rita Dunn (Professor, St. John’s University, Jamaica, New York) (1996-2000). This instrument was recently adopted by the College, because of its well-documented reliability, validity, and ease of use.

“The BE Survey allows individuals to acquire a comprehensive picture of their unique learning and productivity strengths and preferences. Persons are easily able to compare and to contrast their differences and sameness from a learning- and productivity-style perspective based on the report provided” (Rundle, 2006, Appendix A). The twenty-six variables are categorized into six learning style elements referenced and assessed in the BE instrument. They are listed below:

- **Perceptual Elements** – The preferences that influence the degree to which an individual retains new and complex information for later recall. These elements are described as: Auditory, Visual, and Tactile/Kinesthetic.

- **Psychological Elements** – One’s inclination for processing new and complex information, making decisions, and solving problems. These elements are described as: Analytic, Global, Reflective, and Impulsive.

- **Environmental Elements** – The stress-related elements in the physical environment (immediate surroundings) that affect one’s ability to concentrate and remain motivated over time. These elements are described as: Light, Sound, Temperature, and Seating.

- **Physiological Elements** – Elements that affect your ability to remain energized and stay alert when learning and influence concentration, decision making and quality of work. These elements are categorized as: Early Morning, Late Morning/Early Afternoon, Late Afternoon, Evening, Intake, and Mobility.
• **Emotional Elements** – Elements that influence the way in which an individual begins and completes tasks and assignments productively. These elements are described as: Motivation, Conformity, Task Persistence, and Structure.

• **Sociological Elements** – Elements of the social environment that affect efficiency, and one’s preference for either routine or a variety of methods for completing tasks and assignments. These elements are: Team Interaction, Authority, and Variety. (Appendix A)

**Building Excellence Learning Styles Inventory**

According to Rundle (2006), “a Principle Component Factor Analysis that employed Kaiser normalization and Varimax rotation, in combination with reliability analysis, was used during the development of the BE Survey to verify the construct validity of the six parts and their respective scales (p. 16).” A diverse population of 7,304 participants was used to determine the statistical reliability and validity of the assessment. Due to the differences in culture and language in the international sample, a random sample of the total population was used to determine the reliability of the BE. As shown in Table 4, the BE Survey measures many facets of a person’s learning style with a high level of reliability.
<table>
<thead>
<tr>
<th>Learning Style Measured</th>
<th>Reliability of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceptual</td>
<td></td>
</tr>
<tr>
<td>Auditory</td>
<td>0.91</td>
</tr>
<tr>
<td>Visual Picture</td>
<td>0.92</td>
</tr>
<tr>
<td>Visual Text</td>
<td>0.68</td>
</tr>
<tr>
<td>Tactile and/or Kinesthetic</td>
<td>0.87</td>
</tr>
<tr>
<td>Verbal Kinesthetic</td>
<td>0.72</td>
</tr>
<tr>
<td>Psychological</td>
<td></td>
</tr>
<tr>
<td>Analytic/Global</td>
<td>0.73</td>
</tr>
<tr>
<td>Reflective/Impulsive</td>
<td>0.84</td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
</tr>
<tr>
<td>Sound</td>
<td>0.83</td>
</tr>
<tr>
<td>Light</td>
<td>0.89</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.85</td>
</tr>
<tr>
<td>Setting</td>
<td>0.91</td>
</tr>
<tr>
<td>Psychological</td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td>0.94</td>
</tr>
<tr>
<td>Early Morning</td>
<td>0.91</td>
</tr>
<tr>
<td>Late Morning / Early Afternoon</td>
<td>0.80</td>
</tr>
<tr>
<td>Late Afternoon</td>
<td>0.91</td>
</tr>
<tr>
<td>Evening</td>
<td>0.90</td>
</tr>
<tr>
<td>Mobility</td>
<td>0.83</td>
</tr>
<tr>
<td>Emotional</td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>0.81</td>
</tr>
<tr>
<td>Task-Persistence</td>
<td>0.87</td>
</tr>
<tr>
<td>Conforming</td>
<td>0.86</td>
</tr>
<tr>
<td>Structure</td>
<td>0.85</td>
</tr>
<tr>
<td>Sociological</td>
<td></td>
</tr>
<tr>
<td>Alone/Pairs</td>
<td>0.86</td>
</tr>
<tr>
<td>Small Groups</td>
<td>0.91</td>
</tr>
<tr>
<td>Team</td>
<td>0.85</td>
</tr>
<tr>
<td>Authority</td>
<td>0.75</td>
</tr>
<tr>
<td>Variety</td>
<td>0.87</td>
</tr>
</tbody>
</table>

*Note.* Building Excellence Survey Elements ($N = 1,195$)
The BE Survey is produced by the same company that created the PEPS learning styles assessment which has been widely used at the college being studied for the past several years. The BE Survey is currently being piloted by a small Learning Styles Committee of faculty who have reported this test to be easier to read, understand, and complete. One of the challenges reported by the pilot group is getting students to complete the online form at home and then return the printed profile to the instructor. Bonus points and other methods of positive reinforcement are being used in the classes at this college to motivate the students to complete the forms on their own time and return the profile for extra credit. To avoid problems with the completion of the survey, the researcher obtained class time from the instructor to complete the survey so that extra credit and other incentives would not be necessary to encourage participation in the study.

The state-mandated exit exam, also known as the Florida College Basic Skills Exit Test, was administered as a measurement of achievement at the end of the MAT 0024 course. All students completing college preparatory coursework must pass this exam prior to enrollment in college credit general education, English, or mathematics courses that apply to degree requirements. Students must be recommended by the instructor to sit for the exit exam, based on the indication that all coursework has been successfully completed. This exam was developed by the State of Florida to measure competency in College Preparatory Math, and is administered in class by the college instructor.

The assessment instruments used in this study included a qualitative survey developed by the researcher, the BE Survey used to determine the learning style of the
students, and the state-mandated math exam used to measure the math achievement of the participants.

The qualitative survey used was developed and validated with input and review by colleagues and faculty from the college where the study was held. The questions were kept simple and were presented to the students for the purpose of obtaining opinions regarding the use of the learning styles assessment and the use of learning styles information in modifying study habits.

**Procedures and Treatment**

A large sample of college preparatory students was initially considered when preparing for this study. After further discussion with my dissertation committee, the value of a smaller, mixed-methodology consisting of both quantitative and qualitative research was agreed to be more suitable for the purposes of this research. The quantitative phase of this study or P1 answered the first two research questions that measured the effects on student achievement. The second qualitative phase of this study or P2 answered the third and fourth research questions which measured student opinion and perceived value of the learning styles treatment.

The control group was informed of the purpose of this study, completed the student profile survey, and took the BE survey. The control group did not receive the results of the BE survey until the conclusion of the class. The control group class, taught by the same instructor in the spring of 2008, was similar in size and proportionately diverse compared to the treatment groups. On the first few days of the study, the treatment groups were given the same information and surveys as the control group and were also given the results to the learning styles survey to use in modifying their study habits.
habits. The full treatment groups were provided time with the researcher to analyze fully the results of the survey and discuss its implementation in their studies.

A list of research activities in which participants in each group (G1, G2, G3), including general time guidelines, that were voluntarily imposed on the instructor and students of the experimental group are listed below. The instructor was fully aware of the guidelines and the details of the research and agreed to all of the terms prior to the beginning of the study (Appendix E):

1. **Day One:** Description of the study (15 min. each group)
2. **Day One:** Filled out Consent Form & Student Profile (15 min. each group)
3. **Day Two:** Completed the Learning Styles Survey in a Computer Lab outside of the classroom. Recorded the students’ initial response to the test. (45-60 min. each group)
4. **Day Two:** Printed and handed out the results of the survey to only G2 and G3 with no explanation of the results. (10 minutes)
5. **Day 3-12:** Met with each participant in G3 during scheduled class time, to review the student’s Learning and Productivity Style (LPS) Report and discussed how to use the information in the report to improve their study habits (30 minutes for each student totaling 12 hours and 30 minutes)
6. **Final Day of Class:** Met with five separate small groups of participants from G3 to complete a brief questionnaire (see Appendix D) outside of the classroom on the value of the learning styles information and briefly discussed and recorded their opinions from questions 6-8 on the value and use of the learning styles information they have acquired.
During the first week of the spring semester, the instructor was asked to read the *Letter to Students* (see Appendix C).” The researcher and the instructor distributed consent forms, for those students who chose to participate in this study. On this same day, students were asked to complete a *Student Profile Survey* (see Appendix F) to identify the age, gender, ethnicity, contact information and previous math knowledge of the participants. Those students who choose to participate and complete the *Student Profile Survey* were immediately assigned a personal I.D. code which was used on all research forms, surveys, and reports utilized in this study.

During the second week of classes, the *Building Excellence Learning Styles Assessment* was scheduled in a computer lab and taken by all of the students who agreed to participate from the MAT 0024 class. Students used the personal I.D. as a confidential means of identification. The participants from G2 and G3 had the opportunity to print out the BE Summary report immediately after taking the assessment or receive it at the next class meeting. Participants from G1 did not receive the results of the BE Summary report until the end of the course.

In the third week of class, students from G2 and G3, who had not received the results from their Learning Styles test after the initial administration, were given the BE Summary Reports during class (see Appendix G for a sample of the BE Summary Report.) Group 2 received only a brief explanation of the Summary Report. Group 3 was divided into five sub-groups according to similar-typed learning styles, and each sub-group met in another classroom while the math instructor continued with the regularly scheduled class. A 20- minute discussion with each group was conducted on how to interpret the BE Summary Report and how to best use the information in the report to
modify study habits to suite individual learning styles. Students were asked to read sections of the report out loud, were asked questions about their learning style, and were encouraged to share study strategies with one another. Separate meetings with the subgroups from G3 were held on three different occasions throughout the semester. At these three meetings, both myself and the students were able to learn more about learning styles and share personal information about their individual study habits.

During the final week of class, G3 was surveyed for opinions regarding the value of the study and all three groups took the common state-mandated exit examination required to complete this College Preparatory Class MAT 0024. Opinions were collected from the subgroups of G3 by written survey and tape recorded discussion. The hypothesis that learning styles information would have an effect on achievement was measured by the analysis of variance between the scores of the control group and scores of the treatment groups on the final exit examination.

**Data Collection**

The types of data that was collected includes: the learning styles of the students, the demographic information provided in the student profile survey, test scores from the final exam, and the qualitative data collected in the final focus groups.

Data was collected using three methods. Learning styles data from the students was collected using the BE Survey, and the online tools provided by the Dunn and Dunn Research Company were useful and easy to use when compiling and reporting the learning styles of the students. An Excel spreadsheet was used to store, manipulate, and analyze the data on the researcher’s secured computer. Student profile data was collected using a paper survey created by the researcher to report demographic information and
previous math skills about the population. This information was also stored in Excel on the researcher’s computer. Students were given an identification number to allow communication of the data without having to include the names of the students.

The qualitative data in Part 2 of the study was collected using a survey designed to acquire specific opinions from the students. Group 3 was organized into four small groups based on common learning styles. During the final week of class, the G3 students were divided into 5 separate subgroups, and each subgroup was surveyed for approximately 20 minutes. Each group sat in a small circle of desks within an empty classroom that was located next to their MAT 0024 class. Surveys were distributed to the group and an explanation of this final portion of the study was provided to each group. The questions from the student survey were read to each group and responses and conversations that occurred when the students provided their opinions were recorded on tape. Students were also asked to write brief responses on the written survey. The student opinions were all written down, stored in an Excel spreadsheet and then reported in this study.

**Data Analysis**

A two factor ANOVA was used to statistically analyze the effect of the learning styles treatment on the achievement of the remedial math students comparatively in each of the three sections taught by the same instructor. A t-test was used to compare the achievement of global and analytic learners and to evaluate the hypothesis that achievement in math may be linked to the psychological learning style of the student. Finally, an analysis of the types of student opinions provided in the focus groups was
used to evaluate the value of the learning styles instrument and the intervention provided to the students.

**Summary of Methods**

In summary, a mixed methodology was employed to answer four research questions to evaluate four hypotheses. Three groups were studied and provided varying levels of treatment. G1, the control group, was given a learning styles survey and did not receive the results until the end of the class. G2 was given a learning styles survey and provided the results after taking the test with a very limited explanation. G3 was given a learning styles survey, provided the results, and instructed on how to use the results to improve their study habits.

A two-factor ANOVA and t-test were used to analyze the quantitative test scores and learning styles data collected. Research questions three and four evaluated qualitative student opinion about the value of the learning styles instrument and the intervention provided.
Chapter Four

Results

This chapter is a collection of the quantitative and qualitative data that resulted from the study that has been outlined in the previous chapters. The research was conducted on three groups of college preparatory math students. The study is divided into two phases of a mixed research methodology. The mixed research methodology was recommended by my doctoral committee and was useful in balancing the qualitative findings. The size of the sample was purposefully kept small in order to implement a full treatment of learning styles tutoring for one college class and to keep the qualitative reporting feasible for the researcher. This chapter begins with a recapitulation of the research methods and design of the study and sequentially moves through the four research questions that were proposed earlier. Quantitative statistical analysis was used to answer research questions one and two. The results from a survey and focus groups produced qualitative data that was used to answer research questions three and four. Finally, descriptive statistics were used to show the diversity and similarities of learning styles in the three groups that were studied and to describe the demographic profiles of the study participants.

Recapitulation

Phase 1 (P1) answers the first and second quantitative research questions that measure the treatments’ effect on the students’ math achievement. Phase 2 (P2) answers the third and fourth qualitative research questions aimed at measuring and describing
student opinion and the perceived value of the learning styles treatment. In Chapter Three, the research advantages of a mixed methodology were described. Qualitative research was employed to learn more about the opinions of the math students as “users” of this innovative assessment tool and application of learning styles information in the classroom.

Phase 1 was initiated in three fall semester classes of College Algebra (MAT 0024) taught by the same instructor at a branch campus of a large suburban community college in Florida. The classes met every Tuesday and Thursday during the morning for 90 minutes per class. Informed consent forms, a description of the study, review of the concept of a learning style, and student profiles were completed in all three classes on the first day of class (Tuesday).

The students who completed the informed consent forms were asked to report to a learning lab on the second week of class to take an online learning-style assessment called the BE Survey. On the second day of class (Thursday), the instructor of the course reminded the class of their responsibility to report to the lab for their assessment. On the third day of class, all three classes reported to a computer lab to complete the BE Survey.

The computer lab was set up to accommodate 25 students taking the BE Survey on the internet at the same time. In two of the larger classes it was necessary for a few students to wait until a computer became available. The survey was completed by most students within a 20-30 minute time frame. A few students required an additional ten minutes to complete the BE survey. Instructions, including user identification and pass codes, were placed on the white board prior to the beginning of each class. Brief instructions on how to log-in to the survey were given to each class. The researcher
explained to the participants that: They should take their time, breaks will be provided throughout the survey, and they should answer honestly for the most accurate results. A few participants had simple questions that were answered individually after they raised their hand.

Group 1 (G1) was told that they would receive the results from their survey at the end of the course. Group 2 (G2) and Group 3 (G3) were told that they could print the BE profile results that day or receive the results on their next visit to their Algebra class. The printing process was complicated by too few printers being available at the end of the testing period, so most of the participants chose to receive their results at the next scheduled Algebra class.

There were a total of 83 participants in all three groups, all of whom completed the informed consent forms and completed student profiles. However, eight students did not remain in the class after the first day and subsequently did not take the BE Survey. A total of 75 students \((n = 75)\) participated in the study and took the BE Survey. Six additional participants dropped out of the course mid-semester and were subsequently removed from the study. G1, the control group, had 29 participants but did not receive the results until the end of the course. G2, the mid-level treatment group, had 17 participants who received the BE profile and a basic explanation of the results after taking the survey. G3, the full-treatment group, had 29 participants who received three tutoring sessions in the first few weeks of class on how to interpret and use the BE Survey results. In addition to the BE Surveys taken by all three groups in the second week of class, preliminary data was also collected in the first two weeks of the class using a student profile survey. The student profile survey collected data on the age,
ethnicity, gender, and the students’ past academic experience in Math and college preparatory courses. Table 5 below depicts the research method that was used in all three groups.

Table 5

<table>
<thead>
<tr>
<th>Participant Groups</th>
<th>N</th>
<th>Took BE Survey</th>
<th>Received Results Immediately</th>
<th>Received Info Seminars</th>
<th>Surveyed in Focus Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>29</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G2</td>
<td>17</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G3</td>
<td>29</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Quantitative Findings

Phase 1, the quantitative portion of this study, was represented by the data collected from the answers to the first two research questions. These two questions and the data collected will be addressed in the subsections below.

Research question 1. What is the relationship between students’ recently-acquired knowledge of how to use their learning-styles profile and their score on the exit exam in remedial math (MAT 0024)? Phase 1 started with 83 participants in three groups who were divided into the control group, G1; a partial-treatment group, G2; and a full treatment group, G3. Table 6 below shows the distribution of original participants, including those few that did not take the BE Survey or complete the course.
Although 83 students filled out informed consent forms on the first day of the study, 75 students took the BE Survey on the third day of class. Six students were removed from the study and withdrew from the course. These students decided to withdraw within a couple of weeks after completing the BE Survey in the first week of class. After these 6 additional students were removed from the study, a total of 69 students were left in the three groups who completed an informed consent form and student profile sheet, took the BE Survey, and participated in the study until the conclusion of the course. Table 7 represents the summary data from the students who remained in the study. This table shows the size of the population as well as the average score of each class on the final exam. The highest average score from Table 7 shows little variation from 80% - 83%. The highest scoring class was G2 at an 83.59% average grade.
Table 7
Summary Table Without Students Who Do Not Have Grades

<table>
<thead>
<tr>
<th>Groups</th>
<th>Count</th>
<th>Sum of Final Exam Grades</th>
<th>Average</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29</td>
<td>2404</td>
<td>82.89655</td>
<td>101.2389</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>1421</td>
<td>83.58824</td>
<td>86.7573</td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>1838</td>
<td>79.91304</td>
<td>87.083</td>
</tr>
</tbody>
</table>

Research Question 1 examined the relationship was between the participants’ understanding of their own learning style and their achievement on the state-mandated MAT 0024 exit examination. A two-factor ANOVA was used to statistically analyze the effect of the learning styles treatment on the achievement of the remedial math students in each of the three sections taught by the same instructor.

Based on the between groups ANOVA statistical analysis shown below in Table 8, there was no significant difference between the final exam scores taken from participants at the conclusion of the class.

Table 8
ANOVA to Measure the Difference in Final Exam Scores Between G1, G2, G3

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>Df</th>
<th>MS</th>
<th>F</th>
<th>P-value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>166.0043</td>
<td>2</td>
<td>83.00215</td>
<td>0.892404</td>
<td>0.414554</td>
<td>3.135918</td>
</tr>
<tr>
<td>Within Groups</td>
<td>6138.633</td>
<td>66</td>
<td>93.0096</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6304.638</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. N = 69, f = 0.892, p = 0.415
Research question 2. What is the relationship between students’ psychological learning styles and their score on remedial mathematics? This question was aimed at affirming past research that concluded that analytic learners, who learn best through sequenced instructions, are more likely to excel in a traditional math course than global learners. It was decided by the research committee that the term psychological learning style would be limited to global and analytic styles of learning. The part of this research question that was left a bit ambiguous was the comparison of global learners to analytic and integrated learners or the comparison of global learners to analytic learners. Since a person’s psychological learning style measured by the BE Survey Profile is reported on a continuum that ranges from strong to moderate to integrated, a comparison was made between the strong and moderate global learners with the strong and moderate analytic learners. Integrated learners or those students who chose “It Depends” on the survey were not included in the comparison. Further consideration of the “It Depends” group in future research is referenced in Chapter 5 of this study. Although the data represented used both t-test comparisons, the intension of the research was to compare the global learners with the analytic learners in order to get a true contrast in the achievement of these distinctly different psychological styles.

A standard t-test was used to measure the variable effect of a student’s learning style on achievement in math. Table 8 compared analytic learners’ achievement with global and integrated learners from the remainder of the population and table 9 compared the moderate analytic learners with the moderate global/integrated learners.
Table 9
*Two-Sample T-Test (assuming unequal variances) to Measure the Difference in Final Exam Scores Between Analytic vs. Global and Integrated Learners*

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Analytic</th>
<th>Global and Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Score</td>
<td>83.75</td>
<td>81.88</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>57</td>
</tr>
</tbody>
</table>

*Note.* N = 69, df = 18, t = 0.6896, p = 0.4992

In Table 10, a t-test was used to compare the achievement of the moderate analytic and moderate global learners. The relatively large number of integrated learners was left out of this test to see if there was a noticeable difference in these two variations to research question #2. The second t-test was an even smaller sample size of N = 20 and thus had even lower power.

In Table 10, the results from a t-test did not show any significant difference in achievement between the mean exam scores of the two psychological learning styles, analytic and global, in this relatively small population. The results listed in both Table 9 and Table 10 did not provide data to either accept or reject the hypothesis associated with research question #2.

Table 10
*Two-Sample T-Test (assuming unequal variances) to Measure the Difference in Final Exam Scores Between Analytic and Global Learners*

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Analytic</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Score</td>
<td>83.75</td>
<td>85</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>8</td>
</tr>
</tbody>
</table>

*Note.* N = 20, df = 14, t = 0.3163, P (T <= t) one-tail = 0.3782, P(T <= t) two-tail = 0.7564
Qualitative Findings

Part 2 of the study sought to explore the opinions of students and answer the qualitative research questions three and four. Question 3 evaluated the students’ opinions of the BE Survey and the Research Intervention; and question 4 evaluated the students’ opinion of their own practical use of the learning styles information. The population for the qualitative study consisted of 19 of the 29 students included in the full treatment group (G3) who were conveniently available at the final class held prior to the final exam. These 19 subjects were divided into 5 small focus groups.

The brief focus group sessions facilitated with each group served as closure to the previous meetings with these same small groups within G3 earlier in the semester. The focus groups also served as an opportunity to learn more about student opinions related to the instrument and treatment. Surveys were distributed to these focus groups. The questions on the surveys were asked out loud to the subjects, and any verbal responses were recorded on a digital voice recorder with the students awareness and consent.

The survey instrument had 8 questions that were aimed at answering Research Question 3 and 4. The survey instrument was validated by the researcher with review and recommendations from faculty at the college where the study was conducted. The first two questions on the survey positively confirmed that all 19 participants in this phase of the study had taken the BE Survey, received the full learning styles profile, and had been given an in-depth explanation of their learning style.

After the participants confirmed receiving the learning styles intervention, six additional survey questions were asked. Student Survey Questions #3, #4, #6, and #8 were aimed at establishing whether the participant perceived that the B.E. Survey and
Profile were accurate and useful. Survey Question #8 allowed participants to comment openly on their opinions. Survey Questions #5 and #7 were used to better understand if and how the participants used the knowledge they had learned about themselves to modify the method in which they studied (see Appendix D).

A mixture of open and closed questions was employed to obtain clear yet rich data for this study. The researcher used probing oral questions to obtain student opinions during and after the implementation of the survey. Questions #3, #4, and #5 were closed questions looking for specific factual opinions from the participants. Questions #6, #7, and #8 were open questions used to elicit more elaboration on their opinions about the assessment, the study, and the use of the information.

Research question 3. The 19 participants in G3 were asked two closed- and two open-ended questions that were aimed at determining the participants’ opinion of the value of the BE Survey and tutorial information. Table 11 shows that participants generally supported the hypothesis that learning styles information, presented in the BE Profile, would be perceived as accurate and useful information. Random comments from other participants, the instructor, and conversations in the focus groups also generally supported this hypothesis.

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3   Was information accurate?</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>#4   Was information useful?</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 11
Answers to Survey Questions #3 and #4

65
In addition to the closed-ended questions, the participants were asked two open-ended questions to obtain opinions on the value of the instrument and information presented in the seminars. Fifteen participants responded favorably to the use of learning styles information and occasionally elaborated on how the learning styles information improved their study habits. Some of the direct quotes taken from questions #6 and #8 are listed below.

1. “It helped me with what I needed to cope with in and out of a classroom.”
2. “I learned about myself and the best way to study for tests.”
3. “Helped me to understand how I learn best.”
4. “The learning styles profile helped me by showing me the way I learned, so that I could study more efficiently.”
5. “I learned my style and I took advantage of it. Knowing how I learned helped me out, to understand how I learn/study.”
6. “In the way I learned and knowing how I learned.”
7. “Because where I can study and how I study well.”
8. “Confirmed temperature of environment and time of day I work best.”
9. “In some cases the profile was a reminder as to what circumstances enable more effective studying.”
10. “I accommodated my environment to fit my learning style.”
11. “I have a better understanding now of how I study best.”
12. “Knowing in what light or time of day is best for me to study is helpful.”
The 12 responses to questions #6 and #8 provided all positive feedback on the usefulness of the learning style information provided in the class. Some of the responses were more specific in the type of information that was valuable. Even after some oral prompting, it was a challenge to get the subjects to provide opinions. Some possible variables may have been the students diminishing interest in the course on the final day of class. The same students who seemed engaged during the seminars held earlier in the semester were observed as being ambivalent and tired. Questions to get the group more involved were asked and personal reflections were discussed. However, the group remained focused on completing the focus group by offering brief responses.

**Research question 4.** To answer the final qualitative research question related to the practical use of the learning styles information, the following two questions were asked of the participants:

#5 Did you modify the way that you study at home or in class after learning more about your learning style?

#7 If you answered “yes” to #5, please elaborate on what types of changes you made to your study habits.

Although students generally found the information presented interesting and useful, only half of the population admitted to changing their study habits as a result of the information presented in the profile and learning style seminars (see table 12).

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5 Did you modify your study habits?</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

**Table 12**

_Survey Question #5_
It was noted from the accounts of the participants that a few students had received similar information before or had already made modifications to their study habits based on their own self assessment of their learning style preferences. This fact may have altered the data. In some cases this assessment served as a reminder to students to act on what they already knew about their own perceptual, psychological or environmental preferences. The following quotes in the list below were taken from the answers to question #7:

- “I now study in the late afternoon and play low techno music while I study.”
- “My learning style stated that I absorb information better by studying mid-day as apposed to any other time of the day.”
- “I used more visual studying styles in a cooler environment with not so much light.”
- “To look at every single piece of detail in an all around global picture.”
- “I studied more in the evening after dinner.”
- “I study a lot more. I tried different ways to study.”
- “Did my work at the best times.”
- “Yes, when I tried to study under less private circumstances. I was reminded that I would need to revert to a quiet and private environment.”
- “I have made myself do work in quiet environments.”
- “The survey said that I think best when I am moving. I started walking around when I am studying for tests and quizzes.”
- “Me being Kinesthetic, I now exercise when I study and it works a lot better.”
The 11 direct quotes listed above reflect the most valuable data in this study. These students described in their own words how the information provided was useful to them and how they modified their study habits to improve their achievement in MAT 0024. Since the entire class represented only 29 students, these 11 students represent 38% of the students in this class. If this similar result could be projected out to the other classes in the college, this would mean that 38% of the students may perceive the learning styles information to be beneficial in modifying study habits.

However, one must ask if this percentage was the group that needed the assistance. As was stated earlier in the introduction of this study, 55% of students entering Florida’s postsecondary system will require remediation (OPPAGA, 2007). Of this large remedial population, only 51% will complete their preparatory classes (Lumina Foundation, 2006). The population that never made it to the second week of class and those who had no opinion at all in this study are likely a large part of the population who are depicted in this study’s problem statement.

**Description of the Population and the Researcher**

On the first day of the study after the participants signed the informed consent form, they also completed a student profile sheet so the demographics of the population could be reported and those with previously obtained Math skills could be determined. In addition to the student profile data, the BE online survey produced a summary of the learning styles within the entire population studied. This section reports the descriptive data on the 83 students included in the study and provides an objective description of the researcher.
The learning styles data was collected from the total population that took the BE Survey at the beginning of the class. It should be understood that 69 of the 83 original students remained in the classes until the end of the study. This represents a 17% reduction in the original size of the population that took the BE Survey in the first week of the class.

The descriptive statistics collected from the student profile showed a population that is racially diverse, primarily young (16-20 years.), and equally balanced in its gender. Seventy percent of the population had taken 3-4 math courses in high school and the other 30% reported taking less than 3 math courses in high school. Seventy-eight percent reported taking previous college preparatory courses, and 17% percent of the population had already taken MAT 0024 and were repeating the course. Each of the three classes studied were randomly diverse in age, race, and gender.

To interpret the learning styles data shown in Table 13 effectively, it is important to focus attention on the moderate and strong columns to learn where the true preferences in class are categorized. There was a large population (30%-50% of the results reported in each learning style element) who responded “it depends” and thus did not show a strong or weak learning style preference. If the moderate and strong preferences were combined as an indicator of preference for a certain learning style element, then 74% of the total population preferred learning through visual pictures and 70% of the population preferred learning by repeating or hearing themselves talk about the information to be learned. The auditory group was by far the smallest of the perceptual preferences with only 41% of the population preferring to listen to the information presented. If one is to believe that students learn better when presented with information in their preferred
In the psychological category, 50% of the students were analytic learners and only 19% were global learners. Analytic learners prefer information presented in a systematic and sequential way. Global learners prefer to understand the whole picture and then take the rest of the details as pieces of the whole picture. The hypothesis not supported in this study was that analytic learners would achieve higher grades on the final exam compared with global learners. Within the remaining categories of learning styles assessed in this study, 40%-60% of the 77 students stated the environmental, physiological, emotional, and sociological effects on learning depended on their specific situation. The “it depends” group was the largest subsection of the total population not included in this study.

According to informal conversations with instructors who use learning styles information in their classrooms, each class has a slightly different combination of preferred learning styles. This summary of descriptive statistics provides a depiction of 77 students in three classes. According to Dunn (2004), if an instructor modified classroom teaching to suit the student’s learning style the most pragmatic and effective change would be understanding the differences between global and analytic students. Secondly, the perceptual styles of the students could be considered by both the student and teacher to improve achievement. Table 13 presents descriptive data on the learning style preferences of the 77 students in this study. The center column depicts the large number of students who responded “it depends” on the BE Inventory.
Table 13  
*Number of Students in Each Learning Style Category*

<table>
<thead>
<tr>
<th>Learning Style Measured</th>
<th>Strong</th>
<th>Moderate</th>
<th>Integrated</th>
<th>Moderate</th>
<th>Strong</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perceptual</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditory</td>
<td>0</td>
<td>13</td>
<td>32</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Visual Picture</td>
<td>0</td>
<td>2</td>
<td>18</td>
<td>42</td>
<td>15</td>
</tr>
<tr>
<td>Visual Text</td>
<td>0</td>
<td>6</td>
<td>32</td>
<td>33</td>
<td>6</td>
</tr>
<tr>
<td>Tactile</td>
<td>0</td>
<td>0</td>
<td>41</td>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>1</td>
<td>4</td>
<td>34</td>
<td>30</td>
<td>8</td>
</tr>
<tr>
<td>Auditory Verbal</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>39</td>
<td>16</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound</td>
<td>18</td>
<td>21</td>
<td>24</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Light</td>
<td>4</td>
<td>12</td>
<td>33</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>Temperature</td>
<td>3</td>
<td>9</td>
<td>30</td>
<td>19</td>
<td>16</td>
</tr>
<tr>
<td>Setting</td>
<td>4</td>
<td>10</td>
<td>46</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td><strong>Physiological</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td>2</td>
<td>13</td>
<td>45</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>Early Morning</td>
<td>22</td>
<td>17</td>
<td>23</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Late Morning / Early</td>
<td>3</td>
<td>5</td>
<td>33</td>
<td>25</td>
<td>11</td>
</tr>
<tr>
<td>Afternoon</td>
<td>8</td>
<td>9</td>
<td>34</td>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>Late Afternoon</td>
<td>16</td>
<td>11</td>
<td>34</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Evening</td>
<td>10</td>
<td>27</td>
<td>16</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Mobility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Emotional</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motivation</td>
<td>0</td>
<td>2</td>
<td>56</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Task-Persistence</td>
<td>0</td>
<td>1</td>
<td>37</td>
<td>30</td>
<td>9</td>
</tr>
<tr>
<td>Conforming</td>
<td>4</td>
<td>17</td>
<td>53</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Structure</td>
<td>2</td>
<td>7</td>
<td>49</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td><strong>Sociological</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alone</td>
<td>2</td>
<td>12</td>
<td>35</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Pairs</td>
<td>2</td>
<td>5</td>
<td>39</td>
<td>28</td>
<td>3</td>
</tr>
<tr>
<td>Small Group</td>
<td>7</td>
<td>10</td>
<td>31</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Team</td>
<td>15</td>
<td>27</td>
<td>24</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td><strong>Psychological</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analytic/Global</td>
<td>9</td>
<td>30</td>
<td>23</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Reflective/Impulsive</td>
<td>5</td>
<td>23</td>
<td>43</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note. N = 77*
In many qualitative studies, the context and subjectivity of the researcher and his/her background is stated to give the reader an understanding of any motivations or opinions that have been left between the data. The author is a graduate student, administrator, husband, and father. He has worked for 12 years managing student services and recruitment at colleges. His educational and professional background prior to working in education was in Social Work. He currently serves as the principal at a Catholic Elementary and Middle School where the evaluation of student learning styles is being introduced. In the pursuit of a doctoral degree in education he has considered many research topics and was encouraged to study learning styles at a large suburban community college. The college administration was recently admitted into the International Learning Styles Network and research is required of the college to remain in this prestigious network of learning institutions. The college dedicates considerable resources to learning style assessment, instruction, and facility design. The researcher was interested in this study and the effectiveness of learning styles pedagogy from the different perspectives of the student, the faculty and the administration.

Summary

The quantitative results of this study were limited by the number of participants in the population. A two-factor ANOVA was used to statistically analyze the effect of the learning styles treatment on the achievement of the remedial math students comparatively in each of the three sections taught by the same instructor. Based on the between groups ANOVA statistical analysis there was no significant difference between the final exam scores taken from participants \((N = 69)\) at the conclusion of the class G1, G2, or G3 \((f =\)
0.892, \( p = 0.415 \)). The research hypothesis associated with question #1 was rejected due to the limited sample size and power of this study.

A t-test was used to compare the achievement of the moderate analytic and moderate global learners. The relatively large number of integrated learners was left out of this test to see if there was a noticeable difference in these two variations to research question #2. The second t-test was an even smaller sample size of \( N=20 \) and thus had even lower power and did not show any significant difference between the mean scores of the analytic and global/integrated learners on the final exam in MAT 0024. From the results of the t-test, the hypotheses associated with question #2 was not supported.

The 19 subjects who participated in the qualitative focus group provided data which supported the hypothesis that learning styles information was seen as accurate and useful information. Random comments from other participants, the instructor, and conversations in the focus groups also generally supported this hypothesis.

Although the 19 students who participated in P2 generally found the learning styles information presented interesting and useful, half of the population (10 out of 19 students) admitted to changing their study habits as a result of the information presented in the profile and learning style seminars. It was noted in accounts from the participants that some students had received similar information before or had already made modifications to their study habits based on their own self assessment of their learning style preferences. This fact may have altered the data. In some cases, this assessment served as a reminder to students to act on what they already knew about their own perceptual, psychological or environmental preferences.
After statistically testing all four research questions, valuable information was obtained about the students’ use of learning style information. Although the expected hypotheses that the use of learning styles information does improve achievement could not be supported and no correlations were made between one’s psychological learning style and the relative achievement in math, this research did create a framework for further quantitative studies and reported qualitative data that may be useful in understanding student opinions regarding learning styles information.
Chapter Five

Discussion

This chapter begins with a general overview of the study and a review of the results obtained. Important conclusions and hypotheses that were reached will also be reiterated in this section. In the third, fourth and fifth sections of this chapter, the potential implications this study has drawn in terms of future research and the practice of teaching and learning are considered in the opinion of the researcher. The chapter concludes with a summary of the study through a final examination of the research questions and hypotheses drawn at the beginning of the study.

Overview of the Study

The purpose of this research is to determine whether a student’s knowledge of his/her learning style and subsequent tutorials on how to interpret and use the results of a learning styles inventory affect a student’s score on the state-mandated exit exam in developmental math. Valuable qualitative data was collected from the full-treatment group during the information seminars provided during the class. Generally, students were appreciative of the information provided and 10 out of 19 students in the qualitative study indicated that they modified their study habits to suite their learning style.

Three groups of developmental (remedial) math, taught by the same instructor, within the same campus and semester, were given a computerized, nationally-recognized assessment of their unique learning style. The BE Survey has been tested for many years by Dunn and Dunn Inc. to obtain a high level of reliability and validity. The BE Survey
is also being widely used by the college where this study was conducted; and the qualitative survey was validated by the researcher using the review and input from faculty at the same college.

Group 1 \((n = 29)\) was given the B.E. Survey and were instructed that the results of the assessment and an interpretation would be provided to them at the conclusion of the class. The partial treatment group, G2 \((n = 24)\), was given the BE Survey and also provided the printed profile after they completed this computerized test. Group 2 was not given any explanation of how to interpret the test until the final week of class. The full treatment group, G3 \((n = 30)\), was given the test and told at the beginning of class that the researcher would be visiting the class regularly to meet with participants. These three brief seminars were to be held during class to assist them with using the BE Profile they received on the first week of class.

Seminars were scheduled in advance with the instructor and communicated to the students. On September 16, September 25, and October 7, 2008, the G3 class was visited and divided into six groups according to their psychological and perceptual learning styles. Each group was pulled from the class into a neighboring classroom for approximately 15-20 minutes at a time to discuss specific sections of the BE Profile. The BE Profile was reviewed in detail with the group and individually at each information seminar, and practical examples were used to make the time productive and enjoyable. Participants were asked to read and provide feedback which required their active involvement. According to reports from the instructor and students, these three 15-minute seminars did not detract from the learning that took place in the classroom.
At the conclusion of the class, the remaining students in G3 were divided into the six focus groups again and were surveyed on their opinions about the value of the assessment and seminars. They were asked to write and orally respond to questions and about whether they had used the information presented in the profile and explained in the seminars to modify their study habits.

Unfortunately, seven students did not complete the course in G2 and seven students did not complete the course in G3. Of the 23 participants that remained in G3 at the end of the course, a group of 19 students were present when the P2 final qualitative data was collected during the last week of class.

Phase 1 of the study required a statistical analysis of the effect that the treatments had on the full and partial treatment groups, G2 and G3. The variance in the numeric percentile scores on the state-mandated final exam for MAT 0024 was used as the indicator of success in the course.

**Research Questions**

This study focused on the development of the following four research questions: Questions 1 and 2 are referred to as phase one (P1) and questions 3 and 4 are referred to as phase two (P2).

1. What is the relationship between students’ recently-acquired knowledge of how to use their learning-styles profile and their score on the exit exam in remedial math (MAT 0024)?

2. What is the relationship between students’ psychological learning styles and their score on remedial mathematics?
3. To what degree do the participants value: The BE Survey, accuracy of the assessment results, and the purpose of the tutorial information?

4. What is the students’ self-evaluation of their use of the learning-style information and their application of the study skills that were provided to them in class?

**Overview of the Results**

Research Question 1 asked what the relationship was between the participants’ understanding of their own learning style and their achievement on the state-mandated MAT 0024 exit examination. In P1 of the study, the exam grades in G1, G2, and G3 were all compared in an ANOVA statistical analysis of variance. Based on the between groups ANOVA shown below in Table 14, the researcher was unable to support the hypothesis that learning styles information had an affect on achievement of the treatment groups ($n = 69$) G1, G2, or G3 ($f = 0.892, p = 0.415$).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>P-Value</th>
<th>F crit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>166.0043</td>
<td>2</td>
<td>83.00215</td>
<td>0.892404</td>
<td>0.414554</td>
<td>3.135918</td>
</tr>
<tr>
<td>Within Groups</td>
<td>6138.633</td>
<td>66</td>
<td>93.0096</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6304.638</td>
<td>68</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Research Question 2 asked if the psychological learning style of global and analytic learners had any indirect effect on achievement. This question was aimed at affirming past research that concluded that analytic learners, who learn best through sequenced instructions, are more likely to excel in a traditional math course than global learners. A standard T-test was used to measure the variable effect of a student’s learning
style on achievement in math. In table 15 below, the results from a t-test show that the
difference in achievement between the two groups was not significant enough to support
the hypothesis that there was a difference in achievement between global and analytic
students. (t=0.6896, p=0.4992). Table 15 compares analytic learners’ achievement with
global and integrated learners from the remainder of the population.

Table 15
Two-Sample T-Test (assuming unequal variances) to Measure the Difference in Final
Exam Scores Between Analytic vs. Global and Integrated Learners

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Analytic</th>
<th>Global and Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Score</td>
<td>83.75</td>
<td>81.88</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>57</td>
</tr>
</tbody>
</table>

Note. N = 69, df = 18, t = 0.6896, p = 0.4992

In Table 16, a t-test was used to compare the achievement of just the analytic and
global learners. The relatively large number of integrated learners were left out of this
test to see if there was a noticeable difference in these two variations to research question
#2. The second t-test was an even smaller sample size of N = 20 and thus had an even
lower power and did not show any significant difference between the mean scores
between analytic and global learners on the final exam in MAT 0024.

Table 16
Two-Sample T-Test (assuming unequal variances) to measure the difference in final exam
scores Between Analytic and Global Learners

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Analytic</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Score</td>
<td>83.75</td>
<td>85</td>
</tr>
<tr>
<td>N</td>
<td>12</td>
<td>8</td>
</tr>
</tbody>
</table>

Note. N = 20, df = 14, t = 0.3163, P (T <= t) one-tail = 0.3782, P (T <= t) two-tail = 0.7564
In P2 of this study, qualitative data was collected from students from G3 that summarized the students’ opinions on the use of learning styles in improving achievement.

The 19 participants in G3 were asked two closed and two open-ended questions aimed at determining the participants’ opinion of the value of the BE Survey and tutorial information.

Table 17
*Answers to Survey Questions #3 and #4*

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3  Was information accurate?</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>#4  Was information useful?</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 17 shows that participants generally supported the hypothesis that learning styles information, presented in the BE Profile, would be perceived as accurate and useful information. Random comments from other participants, the instructor, and conversations in the focus groups also generally supported this hypothesis.

In addition to the closed questions, the participants were asked two open-ended questions in the survey to obtain opinions on the value of the instrument and information presented in the seminars. Fifteen participants responded favorably to the use of learning styles information and occasionally elaborated on how the learning styles information improved their study habits. Some of the direct quotes taken from questions #6 and #8 are listed below:
1. “It helped me with what I needed to cope with in and out of a classroom.”
2. “I learned about myself and the best way to study for tests.”
3. “Helped me to understand how I learn best.”
4. “The learning styles profile helped me by showing me the way I learned, so that I could study more efficiently.”
5. “I learned my style and I took advantage of it. Knowing how I learned helped me out, to understand how I learn/study.”
6. “In the way I learned and knowing how I learned.”
7. “Because where I can study and how I study well.”
8. “Confirmed temperature of environment and time of day I work best.”
9. “In some cases the profile was a reminder as to what circumstances enable more effective studying.”
10. “I accommodated my environment to fit my learning style.”
11. “I have a better understanding now of how I study best.”
12. “Knowing in what light or time of day is best for me to study is helpful.”

To answer the final qualitative research question related to the practical use of the learning styles information, the following two questions were asked of the participants:

#5 Did you modify the way that you study at home or in class after learning more about your learning style?

#7 If you answered “yes” to #5, please elaborate on what types of changes you made to your study habits.

Table 18 below shows the split response to survey question #5.
Table 18

*Survey Question #5*

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5 Did you modify your study habits?</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

Although students generally found the information presented interesting and useful, only half of the population (10 out of 19 students) admitted to changing their study habits as a result of the information presented in the profile and learning style seminars. These results should be interpreted in light of the fact that some students had received similar information before or had already made modifications to their study habits based on their own self-assessment of their learning style preferences. In some cases, this assessment served as a reminder to students to act on what they already knew about their own perceptual, psychological or environmental preferences.

**Implications in Terms of Future Research**

In order for future researchers to support the hypotheses presented in this study, the sample size needed to be larger. The qualitative data was valuable in understanding the students’ motivation to learn more about their learning style and whether they would apply what they have learned. The student opinion survey may be valuable to college administrators who wish to make decisions regarding the usefulness of future investments of time and money into learning styles assessments. However, the quantitative data in this study does not statistically support the hypotheses that learning styles information has an affect on achievement or that there is a difference in global and analytic learners as it relates to math achievement.
It would have been interesting to study the correlations between student demographics, math background, and a student’s learning style. The data on demographics and math background was collected in the student profile. However, the data were not used to answer any research questions in this study. This data may have been useful to learn more about the variables that affect the learning styles and math achievement of students.

From 40% - 60% of the total population of 77 students who were given a learning styles assessment answered the questions on the survey “it depends.” The variation in the percentage of the total population fluctuated in the different areas of learning styles being assessed. This population of students who answered “it depends” was definitely the largest group in the study. Unfortunately, the research was designed to measure the differences between students who were identified in a specific learning style by a “moderate” to “strong” preference. The research design unintentionally left out the largest group in the total population, the group who felt that their learning style depended on other factors not mentioned in the survey questions. This is a significant limitation to this research study. One could speculate but not conclude that the largest group of students believes that one’s learning style is dynamic and depends on both the way that information is presented and the complex variables involved in the learning environment. Much could be learned in future research by considering how to report this data prior to beginning the research.

Other variables that were not considered in this study that may be interesting to explore in further research are the effects of class meeting times on achievement. The classroom design, the campus, and the time in class may also be variables that affect
student achievement. The scheduling choices of students and the times and locations where they take their classes could be related in some way to their learning styles.

Yet another variable considered that may be interesting to explore in future research is the number of students withdrawing from each class and the learning style of these students. The significance of the students who left very early in the class, who were not included in the study, was not considered in this research. The treatment of learning styles information should have a positive effect on retention as well as the final exam grade. However, a larger sample size would be necessary to obtain more conclusive findings.

**Implications in Terms of Teaching and Learning**

After reading this dissertation study, the author hopes that the reader would have gained an informed opinion on the potential value of using learning styles assessments in the classroom to improve student studying and subsequently improve achievement. The students in G3 appreciated the information and half of the group did use the information to change the way they studied. If a teacher or professor at any level of education can first accept the validity of the assessment, then the appreciation of students using the information provided to improve their learning should be assigned some value in the context of improving achievement.

This study focused primarily on the student making modifications to their study habits based on their knowledge of their unique learning style. There are many learning style research studies that have been done that have considered how the modification of the learning environment and pedagogy affect achievement. Although these modifications are considered controversial in many traditional higher education
institutions, I do believe that institutions that are truly concerned about student success must consider the customizations that will improve the students’ retention of information. Teaching all students in the same way with little concern about the uniqueness of each student is contrary to the core values of most educators. The use of learning style information in classrooms is being embraced by teachers who believe student achievement and student success can be influenced and improved. Both students and teachers should adapt and compromise their teaching and learning methods as they engage in the process of learning together.

The faculty who are concerned about a student’s learning styles being the source for excuses to avoid studying or failing an exam should evaluate the basic principles and objectives of their teaching methodology. Teaching should be an exchange based on mutual respect earned by both teacher and student alike. The dialogue regarding the learning style of a student is based on the trust that the student wants to learn. When that trust is broken the student looses respect of the teacher and the privilege to receive accommodations from the teacher. The days of using only the traditional Socratic methods of instruction where the teacher speaks and the students learn are becoming less accepted as standard teaching pedagogy.

Summary

In conclusion, this study provided insights, conceptual frameworks and student opinion on the use of learning styles in and out of the remedial math classroom. Over half of the students who express interest in a college education at a community college must take MAT 0024. Due to circumstances that may not be controllable by higher
education staff and faculty, students have difficulty obtaining the skills necessary to pass college-level math.

The general hypothesis of this research was that learning styles information as an intervention to improve study habits would have a positive effect on math achievement. The two quantitative hypotheses could not be supported using this research design. Community colleges are dedicated to improving learning and the retention of those students who need encouragement and support. The addition of learning styles as a retention intervention is one more effort that is being made in community colleges and universities throughout the United States. The effectiveness of the use of learning styles has been proved and disproved in recent research. This study has provided additional insights to the researcher, to the college faculty and administration at the college used for this research, and to other graduate students who may use this research as a resource to learn more about learning styles as an intervention in remedial education.

Although the sample size was too small to support the quantitative hypotheses, the qualitative hypotheses could be useful in better understanding the student opinion and their use of the information provided by the BE Learning Styles Report. Half of the class studied confirmed using the learning styles information to improve their study skills. A majority of the class believed the information was useful. The opinions collected generally supported the use of learning styles information as an intervention.

In future research, larger sample sizes may assist a similar quantitative study in accepting the hypothesis that learning styles information does positively affect achievement in remedial math courses.
References


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Appendices
Appendix A

An Introduction to the Building Excellence Survey

Susan M. Rundle
Performance Concepts International

An Introduction to the Building Excellence Survey 2
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Introduction
This document provides an overview of the statistical research used for the development of the Building Excellence (BE) Survey by S. Rundle and R. Dunn, 1996-2000. In 1994, Susan M. Rundle and Dr. Rita Dunn began collaborating on the development of a new instrument for business and higher education. Since its introduction, BE has continued to mature from the original paper/pencil format, BE 1996, 1998, 1999, 2000 to BE 1998, 1999, 2000, 2003, 2005, the first of five versions of the web-based online assessment. After rigorous testing procedures, the 1st version of the BE Survey (BE 1996—English and Finnish) in paper/pencil format was released at the 19th Annual Leadership Conference held in New York City in 1997. The 2nd version of BE was released in 1998 (English) and the 3rd version became available in 1999 (English). The 4th version, BE 2000 (English and German), is the most current version in use. The 5th version (BE 2003) include Swedish, Norwegian, and Mandarin languages. BE 2006, the 6th version of BE, will be released in the spring of 2006. The following languages will be released during 2006 and 2007: Danish, German, Finnish, Norwegian, Malaysian, Mandarin, Spanish, and Swedish.

The BE Survey is based on the original Dunn and Dunn Learning Style Model. The introduction that follows is a brief overview. The information included in this document, and additional detailed information, is available in the Building Excellence Survey Research Manual, Stockham, E., Rundle, S., & Honigsfeld, A., (In Press), which will be released in 2006. This manual provides a detailed description of the history of BE from 1996 to present, applications for use, articles, abstracts, and the statistical research that supports the reliability and validity spanning the ten year history of the Building Excellence Survey®. Detailed information in reference to the testing procedures administered for the language version of BE is available in the research manual.

Section I—Overview
The purpose of this section is to provide a brief overview of the Building Excellence Survey.

In 1926, Lindeman provides this insight in his book, the meaning of adult learning: “If we were bravely intelligent, we should beg people to give us their difference, not their sameness”. In keeping with Lindeman, the results from the BE Survey allows individuals to acquire a comprehensive picture of their unique learning and productivity.
Appendix A: (Continued)

strengths and preferences. Persons are easily able to compare and contrast their differences and sameness from a learning- and productivity-style perspective based on the report provided. BE 2000 is a web-based online assessment which identifies and measures a combination of twenty-six characteristics that may affect, positively or negatively, how well each individual achieves and performs in educational and work-based learning environments. The twenty-six characteristics are crucial as these variables can promote or obstruct learning, productivity, and individuals’ ability to concentrate on new and difficult information. Respondents normally complete the self-administering BE online survey in 20 to 25 minutes. Scoring is automatic and, upon completion, a comprehensive Learning and Productivity Style (LPS) report, which is 18 to 20 pages in length, is generated. The LPS report is available for printing immediately and includes a one-page graphic overview, narrative descriptions of preferences, and recommended strategies from which to choose. Also included is a 30-60 and 90-120 day action planner so that respondents may glean vital insights about their learning strengths and productivity preferences from which individuals may then create individualized solutions and concrete action plans directed at improving learning and performance in both education and workplace settings. © Copyright 2006 Susan M. Rundle

Perceptual Elements
One’s predisposition for learning and retaining new knowledge skillfully: Auditory, Visual Picture, Visual Text, Tactile and/or Kinesthetic, and Verbal Kinesthetic

Physiological Elements
The conditions that affect one’s ability to remain energized and alert while completing school assignments and working tasks: Time of Day, Intake, and Mobility

Psychological Elements
One’s preferences for processing new information, making decisions, and solving problems: Analytic, Global, Integrated, Reflective, and Impulsive

Emotional Elements
The preferences that influence how effectively and how quickly one completes challenging and complex tasks: Motivation, Task Persistence, Conformity, and Structure

Environmental Elements
The stress-related elements in the immediate surroundings that affect one’s ability to concentrate and focus on tasks for extended periods: Sound, Light, Temperature, and Seating (Design)

Sociological Elements
Preferred ways of learning and interacting effectively with others: Alone/Pairs, Small Group, Team, Authority, and Variety
Perceptual Elements
The perceptual elements focus on one’s predisposition for learning and retaining new knowledge skillfully. The five preferences include: auditory—learning by listening; visual picture—learning by seeing images in the mind’s eye or illustrations and pictures; visual text—learning by reading; tactile kinesthetic—learning through a hands-on approach or by doing; and verbal kinesthetic—learning by verbalizing and making personal connections. Whenever possible, one should use his/her strongest perceptual preference first. This will help insure that individuals retain more information for later recall. Because teachers/trainers will not always take into consideration the various perceptual elements, we advocate that each person become responsible for applying the strength/preference that will help him/her retain the most information. The perceptual elements are a collection of senses (also known as modalities). The modalities affect the way we learn and retain information. Ordinarily, when we think of senses, we think of the five with which we are most familiar: seeing, hearing, smelling, tasting, and touching. Within the context of learning, however, you can view senses from an even broader perspective—one that focuses on the most efficient way for an individual to remember new material. Perceptual preference seems to be biologically determined based on the work of Thies (1979,1999-2000), Restak (1979), and Schmeck and Lockhard (1983). Consequently, individuals may have limited control over their preferences (Ingham, 1991). In light of this, one objective of this manual is to present strategies that help learners maximize their learning-styles preferences, which include the perceptual strengths.

In his article published in the Harvard Business Review (2001), author Nick Morgan provides this perspective: “…think of all those hours having said slides read aloud or explained in excruciating detail. And all for naught, really: study after study shows that presentations are a particularly ineffective way to transmit information, … people just don’t absorb much of what they hear” (p. 113). While this may not be true for all types of learners, such as those with an auditory preference, it provides another perspective in relation to the perceptual elements.

Psychological Elements
The psychological elements include inclinations for processing new information—analytic and global elements—and preferences for making decisions and solving problems—reflective and impulsive elements. It is important to bear in mind that the brain possesses and uses both analytic and global qualities. The analytic thinker prefers to receive information when it is presented in an orderly, logical, and sequential fashion. Analytic thinkers prefer a detailed, systematic process that builds to an understanding. Conversely, global thinkers process information in a more random, abstract fashion, and prefer less detail rather than more. Global thinkers need to understand the concept first and prefer an introduction that includes humor, anecdotes, and illustrations.
Appendix A: (Continued)

Years of experience and observations remind us that people have become all too familiar with the common practice of labeling individuals either analytic or global. Whereas an individual may have a distinct preference for one or the other, humans possess both dimensions. Learners that process analytically prefer new information to be presented sequentially, one fact after another, each fact gradually building up to an understanding. Conversely, global processors are thinkers who tend to be random and spontaneous in their thought processes. They need to understand the concept in relationship to what they are learning first. Without this understanding, global processors are less likely to follow a fact-by-fact presentation. Those who do not have a strong preference for analytic or global processing fall into a category called integrated, which means their preference falls between the analytic and global patterns. Because these individuals process information both analytically and globally with less effort, they often are able to interpret the different perspectives. Imagine a game of ping-pong in which a discussion between an analytic and a global ensues. As one watches, one sees the interpreter’s head move back and forth while saying silently, “Aren’t they saying the same thing, simply saying it differently?”

The psychological domain also includes reflective and impulsive preferences, which influence the approach one chooses when making decisions and solving problems. Reflective individuals prefer to contemplate and weigh all his/her options before rendering a decision, whereas the impulsive individual tends to dive in without much thought for details.

Boscoe Pertwee (eighteenth-century author) provides us with this humorous viewpoint: “I used to be indecisive but now I’m not so sure” (Kant and The Platypus, 1997, p. 2). In Hamlet, Shakespeare provides us with yet another perspective: “There is nothing good or bad, but thinking makes it so.”

Environmental Elements
The environmental elements are stress-related factors that affect one’s ability to concentrate and focus on tasks. Stress is a major variable that contributes to or detracts from learning efficiently and working productivity. People’s needs differ considerably when it comes to the environmental elements. Moreover, people often are unaware of the degree to which stress-related factors can inhibit or stimulate their ability to remain alert and productive for extended periods.

I have found through my experience and observations that people often are unaware of the degree to which stress-related factors within the environment can inhibit an individual’s ability to concentrate and learn. It has become increasingly clear over the years that people’s needs differ considerably in educational and work environments. When there is a mismatch between the physical environment and an individual’s needs, the resulting stress diminishes learning efficiency and productivity.
Appendix A: (Continued)

In their book Primal Leadership: Realizing the Power of Emotional Intelligence (2002), authors Goleman, Boyatzis, and McKee emphasize the effect of stress and learning, “When a person’s stress increases—or his power motives are aroused—the body reacts by secreting more adrenaline and noradrenaline, the body’s stress hormones. That leads to higher blood pressure, getting the individual ready for action. At the same time, the body secretes the stress hormone cortisol, which is even longer lasting than adrenaline and which interferes with new learning.” The authors go on to say, “When stress is high and sustained, the brain reacts with sustained cortisol secretion, which actually hampers learning by killing off brain cells in the hippocampus that are essential for new learning” (p. 163).

In her book, Smart Moves (1995), Carla Hannaford writes, “The hippocampus of the limbic system, key to memory and learning, is profoundly affected by stress.” Hannaford also writes, “In my own experience in the classroom, I have observed the remarkable effect of just turning off the fluorescent lights. There is often a physical sigh from the students, and the excited energy decreases markedly” (p. 150). Hannaford also cites research at McGill University that “concluded that increased cortisol correlated with decreased learning and memory as well as attention problems. When we are under stress, we normally remember less than we otherwise would, and this relates directly to increased cortisol in the system. No wonder it is difficult to focus and remember under stress!” (p. 162).

Peter Senge, noted author and director of the Center for Organizational Learning at MIT’s Sloan School of Management asserts, “Until people can make their ‘workspace’ a learning space, learning will always be a ‘nice’ idea—peripheral, not central (The Fifth Discipline Fieldbook, 1994, p. 35).

Physiological Elements
The physiological elements affect one’s ability to remain energized and stay alert in learning and working environments. Much research has been focused on the individuals’ preferred time of day. While humans work at various times, evidence supports the fact that it is important to be aware of preferred time of day as it relates to individual energy levels, quality of learning, decision-making, problem-solving, and productivity.

The physiological elements are biological preferences that determine one’s ability to concentrate and focus. Hans Selye, a physician, endocrinologist, and the founder of modern stress research began his work around 1930. Based on Selye's impressive findings and theories, he has been referred to as “the Einstein of medicine.” Mark Johnson, author of The Body and the Mind (1987), asserts that “Selye was the first to define stress as a biological syndrome, as a general reaction to some shock to an organism's system” (p. 127). Johnson goes on to say, “Selye's main thesis is that stress is a general reaction that occurs in response to a variety of different stimuli…an adaptive syndrome (the General Adaptation Syndrome).” As humans, we experience the frustrations of stress daily. When distressed, a person’s capacity to focus and concentrate
begins to diminish. Individuals become less productive because their mental resources are diverted to managing the distress rather than focusing on completing task. The fluidity of productivity—one’s ability to remain alert and focused, and access to logic, reasoning, and thinking—are compromised. As tasks increase in complexity, the more stress compromises one’s ability to stay alert and focus. While individuals may not always have control of their working environment, they can manage the way they react to stress by understanding the contributing factors.

Time of Day—Roger Callan
In his article, Giving Students the (Right) Time of Day, Roger Callan begins with the following perspective:

In the 18th century, an academic argument broke out in France concerning the humble heliotrope flower. The purple bloom of this flower closes up in the evening, then reopens in the morning, as if to welcome the sun—as the flower’s Greek name implies. The controversy concerned the role of the sun in the plant’s behavior. One side claimed that without the sun, the flower would never open, that it was the sun’s rays that gave the signal. The other side claimed that the sun’s presence was coincidental: the flower had the capacity to open despite the sun—and on cloudy days, it did. To settle the argument, the scientists placed the flower in a light-proof box. When they opened the box the following afternoon, they found the flower in full bloom (no doubt wondering where the sun’s rays were). They repeated the experiment several times with the same result. It proved that the flower had its own internal timing mechanism. Like the heliotrope, we humans have our own internal timing mechanisms. They’re called the circadian rhythms—biological patterns that recur about every 24 hours.

Callan goes on to write, “One wonders how many students are at a serious disadvantage because school hours are totally at odds with their peak hours. Any teacher knows the challenge of teaching a class of sleepy young people at 8:30 in the morning. These same students may be alert and responsive during classes later in the day.”

Emotional Elements
The emotional elements influence how and how quickly one completes challenging and complex tasks. These elements are developmental preferences determined by one’s stage in life, the social environment, and their experiences. Preferences are a combination of strategies one has learned and adopted to manage work and home life. Human emotions, a major part of an individual’s learning system, are linked directly to each person’s life experience. Consequently, if positive, we do what we do based on what has been successful for us in the past.
Appendix A: (Continued)

With the exception of persistence, the emotional elements are essentially developmental preferences determined by one’s stage in life, environment, and experiences. Learning style preferences are a combination of strategies we have learned and adopted as a way to manage our life at work and at home. Human emotions, a major part of individuals’ learning system, link directly to a person’s life experiences. It is from these vast experiences that individuals learn how to approach challenging tasks and complex situations. Within the context of task performance, the emotional domain focuses on helping people build a state for learning by exploring how one’s preferences influence the efficiency with which he/she complete tasks and projects.

Change comes about with freedom of choice, one of the most powerful intrinsic motivators of personal growth. A shift in the perception of an individual’s competence is often a result of having a clear understanding of the connection between freedom of choice, intrinsic motivation, and learning competencies. What is most important to bear in mind is that motivation is dynamic and subject to change, depending on the needs and interests of each individual in any given situation. When highly intrinsically motivated, humans become extremely interested in what they are doing and, consequently, experience a “sense of flow.”

Edward L. Deci, Author and Professor of Psychology at the University of Rochester, has been exploring the concepts of autonomy, authenticity, freedom, and true self, anchoring the exploration in motivational concepts for over 25 years. In his book, The Psychology of Self Determination (1980), Deci states that “Intrinsic motivation is based in a generalized, innate need to feel competent and self-determining” (p. 44). He asserts that “Competence emphasizes doing something well; self determination emphasizes deciding for oneself” (p. 44). Deci defines autonomy, a sense of choice versus control, such that it supports our convictions about the necessity for learning style. When individuals have a sense of choice about being taught the way they learn, the potential for tapping their human potential excels. Antithetically, in a controlled, one-size-fits-all environment, demotivation ensues. The emotional elements include self-leadership preferences in completing tasks which are inextricably linked to Deci’s concepts of autonomy, authenticity, freedom, and true self. Deci states that, “Furthermore, when people are denied the opportunity to be self-determining, they lose motivation and their performance and learning become impaired” (p. 45).

Sociological Elements

The sociological elements are preferred ways of learning and interacting effectively with others. Be aware of the differences among how people accomplish tasks productively, the necessity for teamwork, and the dynamics of human interaction. We know from experience that people work most effectively when they work with people they like, with people who share similar interests, and with people who have similar approaches and do things in the same way. Valuing the blending of diverse styles that complement one another and recognizing that each person brings unique talents and areas of expertise to the team is one prescription for high performance. Another is individual social preference.
The necessity for teamwork has been described since time immemorial, and the same problems that existed then live on today—the dynamics of human interaction. What we know is this. People work most effectively when they work with people they like, who share similar interests, and who have similar approaches to completing tasks. What we also know is that this is not always reality. In light of this, it is essential to be aware that emotions are the first filter through which we receive information. Equally important is the knowledge that we react emotionally based on our life experiences. As humans, we know that we cannot always control our emotions. However, if we choose to, we can control the reactions (behaviors) that result from our emotions. Learning diversity is diversity beyond race, class, gender, and ethnicity: It is about recognizing and valuing the need for collaboration when people are different. We are fully cognizant of the life-changing effects that can result from understanding and implementing learning styles from life experience, our research, and the research of others. Thus, we thought it appropriate to provide yet another perspective. In The Fifth Discipline Fieldbook (1994), author Rick Ross asserts his firm conviction (and ours) that, “Each of us has our own learning profile—strategies for learning. Your learning style governs how you approach new projects, how you increase your own capabilities, how you contribute to a team’s results, and whether you find it easy or difficult to get in sync with a particular team. Getting (or developing) a good mix of learning styles can be critical to a team’s long-term success” (p. 421).

**BE Survey Results**
The results from BE establish a framework for developing individualized solutions and concrete action plans to improve learning and performance, thus resulting in:
- Enhanced individual accountability and responsibility;
- Improved attitudes and behavior;
- Improved interpersonal relationships;
- Strengthened communication;
- Enhanced team interactions; and
- Reduced anxiety and stress.

**BE Applications**
- Educational and Work-Based Learning
- Student Achievement and Productivity
- Team/Cohort Building and Team/Cohort Development
- Educators, Trainers and Facilitators
- Leaders, Managers and Supervisors
- Self-Development Tool
- Coaching and Counseling
- Human Resource Development
Appendix A: (Continued)

Section II— Learning Style Approaches
In her book, Learning Styles: A guide for teachers and parents (revised), Givens (2000) provides proof through her research that learning styles is not a new concept. “The idea that people have unique learning styles evolved from the study of individual differences beginning thousands of years before the birth of Christ” (p. 5). In their paper, Honigsfeld and Schiering (2004) describe what may be one of the first documented references to learning styles. “Though the first documented reference to learning styles may be Confucius’ famous saying: “I hear and I forget, I see and I remember, I do and I understand,” the concept of learning styles—the understanding that individuals master new and difficult information or skills in different ways—is believed to have emerged from cognitive style research in the mid-20th century (Sternberg & Grigorenko, 1997).” (Honigsfeld, A., & Schiering, M., Diverse approaches to the diversity of learning styles in teacher education, Educational Psychology Vol. 24, No. 4, August 2004). Thus to provide insight into a few of the various learning-style assessments, brief descriptions of five of the more than 100 instruments developed to identify individual learning styles are listed below:

The Dunn and Dunn Learning-Style Model
Learning styles are a combination of many biological and experientially imposed characteristics that contribute to concentration, each in its own way and all together as a unit. Learning style is more than merely whether a student remembers new and difficult information most easily by hearing, seeing, reading, writing, illustrating, verbalizing, or actively experiencing; perceptual strength is only one part of learning style. It is also more than whether a person processes information sequentially or analytically rather than in a holistic, simultaneous, global fashion; information-processing style is just one other component of style. It is important to recognize not only individual behaviors, but to explore and examine the whole of each person’s inclinations toward learning (Dunn, Thies, & Honigsfeld, 2001).

Learning style, as such, is the way in which each learner begins to concentrate on, process, absorb, and retain new and difficult information (Dunn & Dunn, 1992; 1993; 1999). The interaction of these elements occurs differently in everyone. Therefore, it is necessary to determine what is most likely to trigger each student’s concentration, how to maintain it, and how to respond to his or her natural processing style to produce long-term memory and retention. To reveal these natural tendencies and styles, it is important to use a comprehensive model of learning style that identifies each individual’s strengths and preferences across the full spectrum of physiological, sociological, psychological, emotional, and environmental elements. Since 1967, Drs. Rita and Kenneth Dunn have been compiling and scrutinizing educational literature and research concerned with how people learn. They found an abundance of research, dating as far back as 80 years, which repeatedly verified the individual differences among how students each begin to concentrate on, process, absorb, and retain new and difficult information.
Appendix A: (Continued)

• Initially, in 1972, the Dunns identified 12 variables that significantly differentiated among students; three years later, they reported 18 (1975); by 1979 they had incorporated hemispheric preference and global/analytic inclinations into their framework. Over the past two decades, research conducted by the Dunns, their colleagues, doctoral students, graduate professors, and researchers internationally have documented that when students are taught according to their identified learning-style preferences, they display statistically increased academic achievement, improved attitudes toward instruction, and better discipline, than when they are taught without attention to their preferred styles (Research on the Dunn & Dunn Model…2005).

The current Dunn and Dunn Model includes 20 elements that, when classified, reveal that students are affected by their:
• Environment (sound, light, temperature, seating design);
• Emotionality (motivation, task persistence, responsibility/conformity, structure);
• Sociological preferences (learning alone, in pairs, in a small group of peers, as part of a team, with an adult, with variety or routines);
• Physiological characteristics (perceptual strengths, time of day, need for intake, mobility while learning); and
• Psychological processing inclinations (global/analytic, impulsive/reflective).

The Dunn and Dunn Learning-Style Model has spawned several diagnostic instruments to evaluate learning style; the first one (Learning Style Inventory, LSI) was introduced in 1976 and Building Excellence…The Learning Individual Survey (BE) was tested nationally in 1996, and Learning Styles: Clue to You! (LS:CY!) (Burke & Dunn) for middle school students in 1998.

Kolb
Kolb defines learning styles as one’s preferred methods for perceiving and processing information. His definition evolved through his four-stage experiential learning cycle: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). The first continuum — CE and AC — represents how one prefers to perceive the environment or grasp experiences in the world. The second continuum — RO and AE — represents how one prefers to process or transform incoming information. Each of these four learning modes has unique characteristics. Abstract individuals comprehend information conceptually and symbolically. Concrete individuals rely on the tangible qualities of immediate experience. Active individuals interact with the environment by external manipulation. Reflective individuals engage in internal reflection on the external world (p. 239).

Appendix A: (Continued)

**McCarthy**
Based on Kolb, McCarthy (1997) defines learning as a process in which the learner makes meaning by moving through a natural cycle — a movement from feeling to reflecting to thinking and, finally, to acting. She identifies four learning types of learners: imaginative (Type 1), analytic (Type 2), common sense (Type 3), and dynamic (Type 4). In her 4MAT framework, she encourages all students to gain expertise in every learning style. Thus, the 4MAT lessons are designed as cycles built around core concepts, each of which includes the four learning types: experiencing (Type 1), conceptualizing (Type 2), applying (Type 3), and creating (Type 4).


**Grasha**
Grasha defined learning styles as personal qualities that influence (a) a student’s ability to acquire information, (b) to interact with peers and the teacher, and (c) otherwise to participate in learning experiences (as cited in Diaz & Cartnal, 1999, p. 10). The six styles defined around the three classroom dimensions above are avoidant/participant, competitive/collaborative, and dependent/independent.


**Hill**
Hill believed that 90% of the students with normal ability can learn 90% of the material 90% of the time if the teaching methods and media are adjusted to the student’s educational cognitive style” (Hill, 1976, p. 3). Educational cognitive style is the product of four sets of variables as they interact: symbols and meanings, cultural determinants, modalities of inference and educational memory.


**Section III—Psychometric Properties**

**Factor Analysis**
Principle Component Factor Analysis that employed Kaiser Normalization and Varimax rotation, in combination with reliability analysis, was used during the development of the BE Survey to verify the construct validity of the six parts and their respective scales. A scientific approach was followed beginning with the adaptation of the Dunn and Dunn model and ending with the final statistical studies of the survey’s validity and reliability. A total population of 7,304 was used for the final statistical studies using the BE 2000
version. Reliability of BE was determined for different genders, age groups, education levels, countries, and position and type of work settings. Due to the possible differences in culture and language usage between the USA (N = 5337) and International (N = 1967) samples, the data were divided for statistical purposes. A random sample (N = 1195) was extracted from the total population (N = 7304) to determine the BE Survey reliability displayed in Table 4.
Appendix B

Learning Styles Research Award Winners

Research on the Effect of Learning Styles on Achievement

Copy of Appendix A from: The Complete Guide to the Learning Styles In-Service System
Allyn and Bacon (1999)  Author: Rita and Kenneth Dunn


Appendix B: (Continued)


DellaValle, J. (1984). An experimental investigation of the relationship(s) between preference for mobility and the word recognition scores of seventh-grade students to provide supervisory and administrative guidelines for the organization of effective instructional environments. Doctoral dissertation, St. John’s University, New York. Dissertation Abstracts International 45(02)A, 359. Recipient: (a) Phi Delta Kappa National Award for Outstanding Doctoral Research, 1984; (b) National Association of Secondary School Principals Middle School Research Finalist Citation, 1984; and (c) Association of Supervision and Curriculum Development Finalist Award for Best National Research, (Supervision), 1984.


Appendix B: (Continued)


Dear Student,

Thank you for your willingness to participate in this research study. Participation in this study will not take up much of your time; it should help you to learn more about yourself, and will help the college improve its student services and teaching techniques.

If you agree to participate, you will take a Learning Styles Inventory on ____________ in the computer lab located in room ____________. This assessment of your preferred learning style will not cost you any money. The $3.00 cost of this professionally-developed and research-tested survey is an investment that IRCC is making towards your success in this class.

Your results, name, and any other personal information shared in this study will be anonymously used in the study and your identity will only be shared with the researcher, Kevin Hoeffner.

If you are willing to participate in this anonymous study of how knowledge of learning styles affects the achievement of Introductory Algebra students, please fill out the attached profile sheet and sign and date the top of the form. The randomly-selected student number at the top of the form will be used to represent you in this study to ensure anonymity.

Thank you for assisting me with this research and for your cooperation with this learning opportunity for the both of us.

Sincerely,

Kevin Hoeffner
Doctoral Student
University of South Florida
Appendix D

Student Opinion Survey / Interview

Student Identification #:_____________________________________________
Date:____________________________________________________________

Please circle the appropriate answer to questions 1-5 and provide a written response to questions 6-8. If you need additional space than what is provided, please use the back of this survey.

1. Did you take the Building Excellence Learning Styles Survey?   Yes No
2. Did you receive a profile of your learning style with recommendations on how to use the information you received? Yes No
3. Did you find the profile of your learning style to be an accurate assessment of your learning style? Yes No Not Sure
4. Did you find the learning styles profile to be useful to you? Yes No
5. Did you modify the way that you study at home or in class after learning more about your learning style? Yes No

6. If you answered “yes” to #4, in what way did you find the learning styles profile useful?
________________________________________________________________
________________________________________________________________
________________________________________________________________

7. If you answered “yes” to #5, please elaborate on what types of changes you made to your study skills?
________________________________________________________________
________________________________________________________________
________________________________________________________________

8. Please provide any additional positive or negative comments about the learning styles survey, profile and information that were provided in this class. Thank you for your participation in this research study.
________________________________________________________________
________________________________________________________________
________________________________________________________________

Appendix E

115
A Letter to the Instructor

A letter to the instructor who is volunteering to participate in the study.

The purpose of this letter is to request your assistance with my study of how Learning Styles Information affects the achievement of College Preparatory Math Students. If you agree to assist me, I would like to begin the study this spring, 2008 in three of your MAT0024 classes. Before beginning, I will be requesting approval to begin this study from my doctoral dissertation committee and the review boards at both IRCC and USF.

As IRCC has recently earned a new designated status as the first Community College in the International Learning Styles Network, it is required to share its knowledge of Learning Styles practice and research with the community it serves. This study aims to contribute to that deposit of research that is required by the Learning Styles Network. I hope that you will consider the class time that is required to participate in this study as an investment in the success of your students.

The title of the study is, “The Effects of Learning-Styles Information on the Achievement of Community College Developmental Math Students.” Your class will be the only class used in the experimental portion of this study. The mixed-methodology that is being used will consist of a quantitative phase (P1) and a qualitative phase (P2). A list of research activities that would affect your class time is listed below. Total estimated class time should not exceed 3 hours total and will be scheduled for five days during the semester that are convenient for you and your class.

List of research activities that participants will be involved in.

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-a description of the study at the beginning of class (15 min.)&lt;br&gt;-filling out the consent form and the Student Profile Survey (15 min.)</td>
</tr>
<tr>
<td>2</td>
<td>-taking the BE Survey in a computer lab (45 min.)&lt;br&gt;-returning the Learning and Productivity Styles Report (LPS) to group 2 and group 3 with no explanation of the report (10 minutes).</td>
</tr>
<tr>
<td>3-12</td>
<td>-One class (Group 3) would receive one 30-minute meeting with me during scheduled class time, to review the student’s Learning and Productivity Style (LPS) Report and discuss how to use the information to improve their study habits (30 minutes for each student totaling 12 hours and 30 minutes).</td>
</tr>
<tr>
<td>Final Day</td>
<td>-One class (Group 3) would organize at separate times into five small groups of participants to complete a brief questionnaire outside of the classroom on the value of the learning styles information and briefly discuss with me their insights on their use of the Learning Styles Information (20 minutes for each of the five small groups from Group 3)</td>
</tr>
</tbody>
</table>

After reviewing the investment of class time that would be invested in this research, I hope you are still willing to participate in this study. If so, will you please send me a signed letter that states your intent?

Kevin Hoeffner
Doctoral Student, University of South Florida
Appendix F
Student Profile Survey

By signing and completing this form you are voluntarily agreeing to participate in the research study that was just explained to you. This research study will assist the college and others to better understand how to improve student achievement in Math classes. The results of this survey will be published and shared with others. However, your name, identity, and any information shared throughout this study will be associated with a randomly assigned number and not with your name in order to protect your identity.

Name:__________________ Signature:__________________________

Date:__________________

Please Check the Appropriate Space for Each Question.

1. Your age group is: 16-20_____  21-25_____  26-30_____  over 30_____

2. Your ethnic group is: Hispanic_____ Black_____ Asian_____ White_____
   American Indian or Alaskan Native_____ Other_____

3. Your gender is:  Female_____ Male_____

4. The number of math courses you passed in high school:
   1 course_____  2 courses_____  3 courses_____  4 courses_____   

5. Did you take Introduction to College Algebra (MAT0024) at IRCC prior to taking this course?
   Yes_____  No_____ 

6. Did you take any of the College Prep Courses at any college?
   Yes_____  No_____
If learning is fundamental to everything we do, then understanding one’s unique learning style is fundamental to learning. The principle action that exemplifies individuals’ success is recognizing, understanding, appreciating and, most importantly, valuing the diversity of learning, thinking, and working styles. Self-awareness of one’s learning strengths and productivity preferences provides an illuminating perspective that may enrich one’s personal and professional well being. When these unique characteristics possessed by others are valued, a positive shift in attitude often ensues. BE provides you with a personalized report that includes a one-page overview, a brief summary overview, detailed narrative descriptions and recommended strategies. When strategies are implemented, the following benefits may take place: (a) reduced anxiety and stress; (b) individual responsibility for learning; (c) improved learning attitudes; (d) enhanced self-leadership; (e) strengthened communication; and (f) improved performance in educational and work-based learning environments.
### BE Two-Page Profile
#### Learning-Style Strengths

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Appendix G: (Continued)

![BE Two-Page Profile](image)

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<td>Less Variety</td>
<td></td>
<td></td>
<td>More Variety</td>
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</tbody>
</table>
BE Brief Introduction to Your Strengths and Preferences

It Depends...Auditory
It depends describes an element that essentially does not affect you. You are encouraged to utilize one of your strengths when learning new and difficult information.

Moderate...More Visual Picture
Your MODERATE preference for learning new and difficult information by creating mental images in your mind's eye or seeing illustrations and graphs is one of your strengths. Exercise this preference much of the time.

It Depends...Visual Word
It depends describes an element that essentially does not affect you. You are encouraged to utilize one of your strengths when learning new and difficult information.

Moderate...More Tactual
Your MODERATE preference for learning new and difficult information through hands-on activities that make use of your small-motor skills is one of your strengths. Exercise this preference much of the time.

Moderate...More Kinesthetic
You have a MODERATE preference for learning new and difficult information by doing activities that make use of your large motor skills, rather than sitting and listening or reading. This is one of your strengths: exercise it much of the time.

It Depends...Auditory Verbal
It depends describes an element that essentially does not affect you. You are encouraged to utilize one of your strengths when learning new and difficult information.

Moderate...Global
You have a MODERATE preference for processing information globally; you assimilate and understand information best when the conceptual framework is presented first. In other words, you prefer to begin with the end in mind.

Moderate...Reflective
You have a MODERATE Reflective preference. This means that you prefer to think about and weigh all your options before making a final decision.

Moderate...Sound
You have a MODERATE preference for Sound when concentrating or learning new information. This means you are able to block out the sound in your immediate surroundings, like people around you talking or the radio playing.

It Depends...Light
Light is a non-essential element and, for the most part, does not affect you one way or the other. You work and learn well regardless of whether your immediate surroundings are bright or softly illuminated.
BE Brief Introduction to Your Strengths and Preferences

Moderate...Cool Temperature
You have a MODERATE preference to be cooler (not cold) rather than warmer when you are concentrating on difficult tasks and learning new things. When you accommodate your needs, your ability to concentrate for an extended period improves thereby reducing stress and increasing productivity and the quality of your work.

Moderate...Formal Seating
You have a MODERATE preference for Formal Seating arrangements when concentrating on difficult tasks and learning new things. Formal Seating includes sitting at a desk or sitting at a library table.

Moderate...Early Morning
You have a MODERATE preference for dealing with complex tasks and assignments first thing in the morning. You are most effective when you can tackle complex problems and tasks, attend class, or study at this time of day.

It Depends...Late Morning / Early Afternoon
Late Morning / Early Afternoon is a non-essential element that usually does not affect you. You may find another time of day is more productive for you.

It Depends...Late Afternoon
Late Afternoon is a non-essential element that usually does not affect you. You may find another time of day is more productive for you.

Strong...Evening
You have a STRONG preference for dealing with complex tasks and assignments in the evening. Because of this, the night shift may be your cup of tea.

Moderate...More Intake
You have a MODERATE preference for snacking on food while you are working on complex tasks or assignments. Snacking helps you to concentrate.

Moderate...More Mobility
You have a MODERATE preference for more Mobility. You often need to move around in order to complete tasks productively and study effectively.

It Depends...Motivation
Motivation is a non-essential element. Generally speaking, you are not affected one way or the other.

Strong...Multi-Task Persistent
You have a STRONG preference being Multi-Task oriented. You frequently are more productive when you work on several tasks at the same time.
BE Brief Introduction to Your Strengths and Preferences

Moderate...Less Conforming
You have a MODERATE preference toward being Less Conforming. You usually prefer to complete work tasks and school assignments the way you think they could be done based on your experiences.

It Depends...Structure
Structure is a non-essential element. You generally are not affected either way.

Moderate...Alone More Preferred
You have a MODERATE preference for working Alone. Even though you value working with others, you often are more productive completing tasks when you work Alone.

It Depends...Pair
Pair is a non-essential element. You generally are not affected either way.

Moderate...Small Group Less Preferred
You have a MODERATE preference for working in ways other than with a Small Group of people. You will be more productive when you exercise one of your strengths.

Strong...Large Group Less Preferred
You have a STRONG preference for working in ways other than with a Large Group of people. You definitely will be more productive completing tasks when you exercise one of your strengths.

Moderate...Less Authority
You have a MODERATE preference toward having Less Authority present. You prefer to complete tasks and learn when people in positions of authority, such as superiors/teachers, are available only when needed.

It Depends...Variety
Variety is a non-essential element. You generally are not affected either way.
**BE Descriptions of Your Strengths and Preferences**

<table>
<thead>
<tr>
<th>Auditory</th>
<th>Less Auditory</th>
<th>More Auditory</th>
</tr>
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<tr>
<td><strong>It Depends...Auditory</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It depends describes an element that essentially does not affect you. You are encouraged to utilize one of your strengths when learning new and difficult information.</td>
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</table>

**BE Recommended Strategies**

No strategies necessary.

<table>
<thead>
<tr>
<th>Visual Picture</th>
<th>Less Visual Picture</th>
<th>More Visual Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate...More Visual Picture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Your MODERATE preference for learning new and difficult information by creating mental images in your mind’s eye or seeing illustrations and graphs is one of your strengths. Exercise this preference much of the time.</td>
<td></td>
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</tr>
</tbody>
</table>

**BE Recommended Strategies**

- Create pictures either literally or in your “minds eye”, when you listen to someone talk. Break eye contact, listen, and create mental pictures of what you hear. Associate pictures with words by creating/seeing an image of the word in your “minds eye.”
- Learn by watching someone show you how to do something.
- Ask people to use overheads, charts, flip charts, and handouts that include graphics, flow charts, and illustrations into their presentations.
- Use the concept of Mind Mapping (Tony Buzan).
- Ask for a map (drawing) of directions with landmarks instead of or in addition to the written directions.
## BE Descriptions of Your Strengths and Preferences

### Visual Word

<table>
<thead>
<tr>
<th>Less Visual Word</th>
<th>More Visual Word</th>
</tr>
</thead>
</table>

**It Depends...Visual Word**

It depends on the element that essentially does not affect you. You are encouraged to utilize one of your strengths when learning new and difficult information.

**BE Recommended Strategies**

No strategies necessary.

### Tactual

<table>
<thead>
<tr>
<th>Less Tactual</th>
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</tr>
</thead>
</table>

**Moderate...More Tactual**

Your MODERATE preference for learning new and difficult information through hands-on activities that make use of your small-motor skills is one of your strengths. Exercise this preference much of the time.

**BE Recommended Strategies**

- Take notes, doodle, highlight text, or underline key words while you listen. This engages the tactual modality.
- Write your thoughts and create outlines on index cards, sticky notes, or white boards. This engages the tactual modality.
- Keep a stress ball, rubbing stone, or stress ball handy to help calm your nerves and keep you focused. This is not "child's play" it is a valid adult concept. This engages the tactual modality.
# BE Descriptions of Your Strengths and Preferences

## Kinesthetic

<table>
<thead>
<tr>
<th>Less Kinesthetic</th>
<th>Moderate</th>
<th>More Kinesthetic</th>
</tr>
</thead>
</table>

**Moderate...More Kinesthetic**

You have a MODERATE preference for learning new and difficult information by doing activities that make use of your large motor skills, rather than sitting and listening or reading. This is one of your strengths; exercise it much of the time.

**BE Recommended Strategies**

- Walk around as you read, as long as it is not distracting to others. This engages the kinesthetic modality. If you have a low preference for mobility, this may not work for you.
- You think best on your feet. Volunteer to take meeting notes by recording the key points on chart paper. This engages the kinesthetic modality.

## Auditory Verbal

<table>
<thead>
<tr>
<th>Less Auditory Verbal</th>
<th>Moderate</th>
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</thead>
</table>

**It Depends...Auditory Verbal**

It depends describes an element that essentially does not affect you. You are encouraged to utilize one of your strengths when learning new and difficult information.

**BE Recommended Strategies**

No strategies necessary.
## BE Descriptions of Your Strengths and Preferences

### Analytic / Global

<table>
<thead>
<tr>
<th>Moderate...Global</th>
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<tbody>
<tr>
<td>You have a MODERATE preference for processing information globally. You assimilate and understand information best when the conceptual framework is presented first. In other words, you prefer to begin with the end in mind.</td>
</tr>
</tbody>
</table>

**BE Recommended Strategies**

- When you are stuck in a random, abstract thinking pattern, find someone with an analytic preference and use his/her strength to complement your strengths.
- Create or request a bulleted list of key points in order to reduce the amount of detail. Be patient and learn from your analytic counterparts who seek facts and details. The balance often provides insights that otherwise may be overlooked.
- Organize your work or study area so that you can see what you are looking for. Otherwise, you may experience "out of sight, out of mind." You tend to organize randomly rather than sequentially. To the outside world, your office may look disorganized due to your preference for piles rather than files. However, you usually find what you are looking for quickly.
- Create a request a one-page graphic that provides the big picture and overall concept. Develop a plan that provides basic guidelines without too much detail.
- Value the differences between your preferences and those of an analytic thinker. Do not let your desire for less detail block the creative process. Because creativity and innovation are the result of free-flowing information, an inquiring, synergistic form of dialogue, it is a process which takes time. Remember, "When two people always agree, one of them is unnecessary."

### Reflective / Impulsive

<table>
<thead>
<tr>
<th>Moderate...Reflective</th>
</tr>
</thead>
<tbody>
<tr>
<td>You have a MODERATE Reflective preference. This means that you prefer to think about and weigh all your options before making a final decision.</td>
</tr>
</tbody>
</table>

**BE Recommended Strategies**

- Explore all of the options before making important decisions and solving complex problems. Avoid being forced to make decisions too quickly.
- Make a list of the pros and cons before making complex decisions or solving difficult problems.
- Identify the smaller parts of a decision first, and then build toward the final decision.
- Avoid "analysis paralysis." Check with your impulsive counterpart for a different point of view, think about it, and then decide.
**BE Descriptions of Your Strengths and Preferences**

### Sound

<table>
<thead>
<tr>
<th>Quiet</th>
<th>Sound</th>
</tr>
</thead>
</table>

**Moderate...Sound**

You have a MODERATE preference for Sound when concentrating or learning new information. This means you are able to block out the sound in your immediate surroundings, like people around you talking or the radio playing.

**BE Recommended Strategies**

- Play background music without lyrics. If you listen to music with lyrics, the words may be distracting and interfere with your ability to concentrate.
- Use headphones so as not to disturb others.
- Talk to someone from time to time when you are trying to focus your attention and concentrate.
- Hum to yourself softly if others are present.

### Light

<table>
<thead>
<tr>
<th>Low Light</th>
<th>Bright Light</th>
</tr>
</thead>
</table>

**It Depends...Light**

Light is a non-essential element and, for the most part, does not affect you one way or the other. You work and learn well regardless of whether your immediate surroundings are bright or softly illuminated.

**BE Recommended Strategies**

No strategies necessary.
BE Descriptions of Your Strengths and Preferences

Temperature

<table>
<thead>
<tr>
<th>Warm Temperature</th>
<th>Cool Temperature</th>
</tr>
</thead>
</table>

**Moderate...Cool Temperature**

You have a MODERATE preference to be cooler (not cold) rather than warmer when you are concentrating on difficult tasks and learning new things. When you accommodate your needs, your ability to concentrate for an extended period improves thereby reducing stress and increasing productivity and the quality of your work.

**BE Recommended Strategies**

- Use a fan to cool down your body temperature.
- Wear clothing made of material that eathies.
- If you are near a window during the winter, open it slightly.
- Evaluate the lighting to determine how much heat is being emitted.

Seating

<table>
<thead>
<tr>
<th>Informal Seating</th>
<th>Formal Seating</th>
</tr>
</thead>
</table>

**Moderate...Formal Seating**

You have a MODERATE preference for Formal Seating arrangements when concentrating on difficult tasks and learning new things. Formal Seating includes sitting at a desk or sitting at a library table.

**BE Recommended Strategies**

- Work and study at a desk or table with a firm straight-backed chair.
- Select a hardwood or plastic chair to sit in, especially when the task requires your undivided attention.
- Place a solid floor mat under your chair to provide more stability.
BE Descriptions of Your Strengths and Preferences

**Early Morning**

**Moderate...Early Morning**
You have a MODERATE preference for dealing with complex tasks and assignments first thing in the morning. You are most effective when you can tackle complex problems and tasks, attend class, or study at this time of day.

**BE Recommended Strategies**
- Plan challenging tasks and critical decisions at your most preferred time of day first, followed by your second, third, and fourth preferences.
- When you cannot accommodate your preference, focus your mental energy on the task at hand.
- Do less challenging and creative activities during your least preferred time of day.
- Rotate meetings and study group times to accommodate everyone's needs.
- Investigate the option of flextime at work.
- Consider your preference when scheduling classes.

**Late Morning / Early Afternoon**

**It Depends...Late Morning / Early Afternoon**
Late Morning / Early Afternoon is a non-essential element that usually does not affect you. You may find another time of day is more productive for you.

**BE Recommended Strategies**
No strategies necessary.
## BE Descriptions of Your Strengths and Preferences

### Late Afternoon

**It Depends...Late Afternoon**

Late Afternoon is a non-essential element that usually does not affect you. You may find another time of day is more productive for you.

**BE Recommended Strategies**

No strategies necessary.

### Evening

**Strong...Evening**

You have a STRONG preference for dealing with complex tasks and assignments in the Evening. Because of this, the night shift may be your cup of tea.

**BE Recommended Strategies**

- Plan challenging tasks and critical decisions at your most preferred time of day first, followed by your second, third, and fourth preferences.
- When you cannot accommodate your preference, focus your mental energy on the task at hand.
- Do less challenging and creative activities during your least preferred time of day.
- Rotate meetings and study group times to accommodate everyone’s needs.
- Investigate the option of flextime at work.
- Consider your preference when scheduling classes.
## BE Descriptions of Your Strengths and Preferences

<table>
<thead>
<tr>
<th>Intake</th>
<th>Less Intake</th>
<th>More Intake</th>
</tr>
</thead>
</table>

**Moderate...More Intake**

You have a MODERATE preference for snacking on food while you are working on complex tasks or assignments. Snacking helps you to concentrate.

**BE Recommended Strategies**

- Keep healthy snacks around.
- Chew sugarless gum.
- Drink water to enhance learning.

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Less Mobility</th>
<th>More Mobility</th>
</tr>
</thead>
</table>

**Moderate...More Mobility**

You have a MODERATE preference for more Mobility. You often need to move around in order to complete tasks productively and study effectively.

**BE Recommended Strategies**

- Take short breaks to keep your energy flowing. Productivity and retention of new knowledge improve when you pay attention to your physical (biological) need for more mobility.
- Stand or move quietly in the back of the room when you are in a meeting, listening to a presentation, or listening to a lecture. This will help you focus your attention on the discussion or task at hand.
- Think through important information while walking or pacing back and forth, without distracting others.
- Take short walks for stress management. Swing your leg or tap your foot (which you probably do unconsciously anyway), but keep the action or sound as unobtrusive as possible.
## BE Descriptions of Your Strengths and Preferences

### Motivation

**IT Depends...Motivation**

Motivation is non-essential element. Generally speaking, you are not affected one way or the other.

**BE Recommended Strategies**

No strategies necessary.

### Task Persistence

**Strong...Multi-Task Persistent**

You have a STRONG preference being Multi-Task oriented. You frequently are more productive when you work on several tasks at the same time.

**BE Recommended Strategies**

- Use your multi-task strength whenever possible by working on several tasks at the same time. Be aware that if you multi-task too much, chaos takes over.
- Keep an eye on the time. Set attainable, timely goals and then follow through.
- Limit the number of tasks or assignments on which you work at any one time. The danger is not completing any of them. Trying to do too many things may cause you to lose out crucial steps of a task, so be certain to check your work.
- Take short breaks to help you stay focused on the task at hand or what you are learning. When you become bored or get stuck, work on a different task take a walk, check your e-mail, and so forth. Keep in mind that for some people, working on several tasks at the same time is like taking a break.
BE Descriptions of Your Strengths and Preferences

**Conformity**

<table>
<thead>
<tr>
<th></th>
<th>Less Conforming</th>
<th>More Conforming</th>
</tr>
</thead>
</table>

**Moderate...Less Conforming**

You have a MODERATE preference toward being Less Conforming. You usually prefer to complete work tasks and school assignments the way you think they could be done based on your experiences.

**BE Recommended Strategies**

- Challenge the status quo respectfully and agree to disagree. Viewing a situation from a different perspective leads to less conflict and improved working relationships.
- Take time to listen to other viewpoints, which leads to a greater understanding that there may be more than one way to accomplish a task.
- Balance the intuitive sense and logical reasoning before taking action.
- Engage your intuitive sense (gut level feelings). Make certain that your record of success based on the influence of intuition is high, and then advocate respectfully for your sense for knowing.

**Structure**

<table>
<thead>
<tr>
<th></th>
<th>Less Structure</th>
<th>More Structure</th>
</tr>
</thead>
</table>

**It Depends...Structure**

Structure is a non-essential element. You generally are not affected either way.

**BE Recommended Strategies**

No strategies necessary.
**BE Descriptions of Your Strengths and Preferences**

### Alone

<table>
<thead>
<tr>
<th></th>
<th>Alone Less Preferred</th>
<th>Alone More Preferred</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Moderate...Alone More Preferred</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You have a MODERATE preference for working Alone. Even though you value working with others, you often are more productive completing tasks when you work Alone.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BE Recommended Strategies**

- Volunteer to complete tasks that you can accomplish on your own and then come back and work with your team members.
- Work in situations that are opposite to your preference for self-development purposes.

### Pair

<table>
<thead>
<tr>
<th></th>
<th>Pair Less Preferred</th>
<th>Pair More Preferred</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>It Depends...Pair</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair is a non-essential element. You generally are not affected either way.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BE Recommended Strategies**

No strategies necessary.
### BE Descriptions of Your Strengths and Preferences

#### Small Group

<table>
<thead>
<tr>
<th>Small Group</th>
<th>Small Group Less Preferred</th>
<th>Small Group More Preferred</th>
</tr>
</thead>
</table>

**Moderate...Small Group Less Preferred**

You have a MODERATE preference for working in ways other than with a Small Group of people. You will be more productive when you exercise one of your strengths.

**BE Recommended Strategies**

- Compare your alone, pair, small group, and large group scores. Focus your attention on those which are strong preferences.

#### Large Group

<table>
<thead>
<tr>
<th>Large Group</th>
<th>Large Group Less Preferred</th>
<th>Large Group More Preferred</th>
</tr>
</thead>
</table>

**Strong...Large Group Less Preferred**

You have a STRONG preference for working in ways other than with a Large Group of people. You definitely will be more productive completing tasks when you exercise one of your strengths.

**BE Recommended Strategies**

- Compare your alone, pair, small group, and large group scores. Focus your attention on those which are strong preferences.
### BE Descriptions of Your Strengths and Preferences

#### Authority

<table>
<thead>
<tr>
<th>Moderate...Less Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>You have a MODERATE preference toward having Less Authority present. You prefer to complete tasks and learn when people in positions of authority, such as superiors/teachers, are available only when needed.</td>
</tr>
</tbody>
</table>

**BE Recommended Strategies**
- Request tasks that require you to work independently from people in positions of authority.
- Do not disregard people in positions of authority. Recognize that they can offer different perspectives and provide insights based on their experiences.
- Gain the trust of your superior/teachers by insuring that they see your capability of progressing with less input.
- Demonstrate that you are responsible and accountable for your actions.

#### Variety

<table>
<thead>
<tr>
<th>IT Depends...Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety is a non-essential element. You generally are not affected either way.</td>
</tr>
</tbody>
</table>

**BE Recommended Strategies**
- No strategies necessary.
About the Author

Kevin Hoeffner is a graduate student, administrator, husband, and father. He has worked for 12 years managing student services and recruitment at colleges. His educational and professional background prior to working in education was in Social Work. He currently serves as the principal at a Catholic Elementary and Middle School where the evaluation of student learning styles is being introduced. In the pursuit of a doctoral degree in education he has considered many research topics and was encouraged to study learning styles at a large suburban community college. The college administration was recently admitted into the International Learning Styles Network and research is required of the college to remain in this prestigious network of learning institutions. The college dedicates considerable resources to learning style assessment, instruction, and facility design. The researcher was interested in this study and the effectiveness of learning styles pedagogy from the different perspectives of the student, the faculty and the administration.