EXPLORING THE RELATIONSHIP BETWEEN

HIGH SCHOOL COURSEWORK IN MATHEMATICS

AND PRE COLLEGE STUDENT DEVELOPMENT

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CHAPTER I

INTRODUCTION

In recent years, the skyrocketing cost of public higher education has been of great concern to both students and taxpayers. Many states have initiated either performance or incentive based funding for public institutions based on various indicators (Underwood & Rieck, 1999). One of the main areas of concern is student success. Policymakers want explanations for student persistence, transfer, and completion rates (Colbeck et al., 2003). Graduation rates have become an important measure of institutional accountability (Astin, 1993; Kuh, 1972). This emphasis on accountability and the rise in the use of performance or incentive based funding will cause persistence/attrition/retention/ graduation rates to remain a focus for policymakers (Underwood & Rieck, 1999). Adelman (1999) argues “degree completion is the true bottom line for college administrators, state legislators, parents, and most importantly, students--not retention to the second year, not persistence without a degree, but completion” (p. v).

Traditional college admissions criteria evaluate ACT/SAT scores, grade point averages, and class ranks of prospective high school students. These criteria are designed to offer access to those students, who from an academic standpoint, are prepared for the college experience. What relationship does the non-academic preparation of high school students have with persistence/retention/attrition? Extra-curricular activities, leadership roles, participation in clubs and organizations, etc. can give insights about students’ non-academic development, but the lack of standardized measures makes it difficult to evaluate the specific contribution of these activities to student success.

Many research studies have used pre-college characteristics/attributes to focus on retention/attrition/persistence/success in college. Such models from Tinto (1975), Astin (1977), Pascarella and Terenzini (l980), and Bean (1983), all have an academic preparation component that attempts to explain/predict why students make the decision to stay and persist to graduation or leave (attrition). Research studies of this type have consistently explained only 20% to 37% of the total variance in persistence (Eaton & Bean, 1995; Mutter, 1992).

A worthy challenge for social scientists is to find measures of pre-college characteristics that pertain to both academic and non-academic development. Here, non-academic development is meant to relate to various aspects of student development. Crookston (1972) defined student development as the application of the philosophy and principle of human development in the educational setting. In this study, human development in the educational setting will relate to cognitive, psychosocial, and moral/ethical growth. Finding such measures are important, as Cabrera, Castaneda, Nora, and Hengstler (1992) speculate that persistence and attrition are the result of interactions among pre-college characteristics/attributes, college environments, adjustments to college (all elements of non-academic preparation), and academic preparation. If pre-college characteristics that relate to both academic and non-academic development can be found, then better admissions/screening criteria can be developed that would more accurately identify those students who are likely to persist during the challenges and demands of college and obtain a degree. The discovery of such measures could also improve persistence/attrition prediction models by increasing the total variance explained over previously developed models.

In recent years, a shift in focus has moved away from investigating the use of traditional admissions criteria (ACT/SAT scores, grade point averages, and class ranks) or “can do” components, in predicting college performance and retention. Currently, studies exploring the use of personality characteristics (Tross, Harper, Osher, & Kneidinger, 2000) and academic curriculum, or “will do” components (Adelman, 1999; Alexander, Riordan, Fennessey, & Pallas, 1982; Trusty & Niles, 2003) are receiving more attention. In other words, a change is under way to look more at what students have accomplished (will do) instead of their ability or potential (can do). This shift in emphasis points to the fact that the use of these established admissions measures has a tendency to deny access to under-represented populations. As a whole, these students have not traditionally had equal opportunities in regards to academic preparation (Adelman, 1999; Colbeck et al., 2003). Another reason for this shift lies in the fact that the results of studies linking the traditional admissions measures to college performance are mixed. After reviewing studies that connected ACT/SAT scores and high school GPA as predictors of college success, Rogers (1990) noted that the results of using ACT/SAT scores were inconsistent. She found that in some cases ACT/SAT scores were statistically more significant as predictors of college success, but in other investigations background characteristics (e.g. gender, ethnicity, SES, etc.) were more prominent in predicting student success in college. However, her review of the literature indicated support for the use of high school GPA as a predictor of college persistence and performance.

Even though research on using high school curriculum as a predictor of college success is decades old (Beecher & Fischer, 1999), recent studies in this area have produced interesting and promising results. Two studies in particular, Adelman (1999) and Trusty and Niles (2003) are most prominent.

Adelman (1999) conducted a longitudinal study of a national cohort of students that tracked their academic progress from tenth grade in 1980 until 1993. The focus of Adelman's study was not on persistence/attrition/retention, but success in college (operationally defined as completing a bachelor's degree). Among his findings were: (a) when considering the academic resources that students bring to college, 41% of the variance in degree completion rates can be attributed to high school curriculum, 30% to test scores (ACT/SAT), and 29% to class rank/GPA. Regardless of how the students were grouped, the curriculum measure had more predictive power relating to bachelor's degree attainment than either of the other two measures. The curriculum measure also correlated higher with completion of a bachelor's degree (.54) than did either test scores (.48) or class rank/GPA (.44); and (b) when specifically looking at high school curriculum, the highest level of mathematics a student completes "has the strongest continuing influence on bachelor's degree completion. Finishing a course beyond the level of Algebra II more than doubles the odds that a student who enters post-secondary education will complete a bachelor's degree" (p. vii).

Trusty and Niles (2003) conducted a similar study using a national longitudinal sample that tracked students from eighth grade to eight years after high school (1988 - 2000). Their study focused on the effects of intensive high school mathematics course taking, identified by Adelman (1999) as a key variable. Among their findings were:

> Preliminary analysis revealed that of all high school curricular areas and courses, credits in intensive math courses were most strongly related to degree completion. For example, the math-intensity variable was correlated more highly to degree completion than the science-intensity variable, the total number of units in math, total units in science, and total units in foreign language. However, the relationships of chemistry and physics credits to degree completion were relatively strong. (p. 102)

What is it about completing rigorous math courses in high school that enables students to persist and obtain a college degree? This study will attempt to investigate an apparent link between completing advanced math courses in high school and enduring the challenges and demands of college.

The purpose of this project is to explore a theoretically derived proposition based on the findings of Adelman (1999) and Trusty and Niles (2003). It will be argued that high school students who complete higher level math courses enhance/refine cognitive skills, which promote attribute development (e.g., achievement, conscientiousness, coping skills, discipline, goal setting, locus of control, motivation, performance, persistence, resiliency, time-on-task, etc.) necessary for upward movement along the cognitive, psychosocial, and moral/ethical dimensions of student development. Academic preparation for college is important, but so is a student’s ability to cognitively assess social situations/life experiences during college and develop appropriate responses (psychosocial development). These responses are hypothesized to be governed, in part, by a student’s value system or moral/ethical beliefs (Kohlberg, 1969, l972, l975; Perry, 1970). When students, with their current levels of cognitive skills, are unable to develop appropriate responses to social situations/life experiences, disequilibrium or dissonance occurs (Parker, Widick, & Knefelkamp, 1978; Piaget, 1964). If students do not have the cognitive capabilities to resolve situations that cause disequilibrium/dissonance, then they most likely will not persist and complete a college degree.

According to *Report: U.S. Students More Prepared Academically Than 20 Years Ago* (2005), 55 percent of the high school students surveyed in 2000 did not take math courses beyond Algebra II or geometry. The reluctance of students to take advanced math courses in high school may be, in part, an indication of the cognitive disequilibrium/ dissonance created when challenged by upper-level math classes. If this proposition has merit, then it follows that students who complete intensive mathematics courses have experience and are better prepared to work through the disequilibrium/dissonance process and restore cognitive balance. It is the position of this study to advocate that students who successfully navigate the rigors and demands of intensive, upper-level math courses are further advanced along the cognitive, psychosocial, and moral/ethical developmental dimensions and are better prepared to meet and overcome the challenges and opportunities encountered during college.

This study will first explore the relationship that a student's terminal high school math course has with a general cognitive/academic ability/skill measure, the ACT Assessment composite score. It is important to first investigate whether students who complete higher-level mathematics courses are more advanced when measuring general cognitive/academic abilities/skills than those students who only complete the courses required in the basic high school mathematics core (traditionally Algebra I, geometry, and Algebra II). Theoretically, those students who demonstrate advanced cognitive skills should also score higher on various aspects of psychosocial and moral/ethical student development. According to this belief, this study will examine the hypothesis that the level of math course completed relates to the scores that measure different components of a student's psychosocial and moral/ethical student development.

Need for the Study

Attrition rates for college students are alarmingly high. Twenty-five to forty percent of all students who enter college do not persist to graduation (Choy, 2002). Funding for higher education is shrinking and students have to bear more and more of the expense of obtaining a post-secondary education.

More research is needed that investigates the pre-college characteristics of students and, specifically, looks at common threads between academic preparation and persistence to degree completion in college. This research is vital because the ability to provide better academic preparation opportunities for students is within the control of those responsible for both public and private education. Alexander, Riordan, Fennessey, and Pallas (1982) were advocates of this issue over two decades ago when they argued "The more pressing problem seems to be to assure that all youth who desire a college education acquire the sorts of academic resources that will enhance their prospects of doing so" (p. 330).

Many aspects of a student's pre-college development are beyond the control of the educational system and the student. A student's environmental situation, social economic status (SES), educational level of parents, gender, and ethnicity are among the variables tested in studies that explored relationships between a student's pre-college characteristics and persistence/retention/attrition/success in college. Neither the student nor the educational system has control over any of these factors that influence pre-college development. However, the types and intensity levels of courses taken in secondary education could be much more controllable--as is a student's willingness to challenge himself/herself to be a participant in such course offerings to the extent that these courses are offered in the student's school and the student meets the necessary prerequisites.

The identification and exploration of factors that enhance student development before adolescents matriculate into college can be of benefit in at least three ways. First, better admissions criteria can be developed that will screen and identify students who are more likely to persist during college and complete a bachelor's degree. Fewer dropouts and lower attrition rates mean that less funding dollars are inadvertently spent on students who perhaps lack the preparation necessary to persist to degree completion. Second, students who are better prepared academically need fewer remediation courses at the university level. A decrease in the demand for remediation frees up monies and resources for other areas, thus enabling under-funded institutions of higher education to stretch their budgets. According to Alexander and Pallas (1984), Brenneman and Haarlow (1998), Levine and Cureton (1998), and Smittle (2003), one of the most prevalent areas of student remediation is in the core curriculum discipline of mathematics. Third, institutions of higher education are facing increasing demands for accountability (Adelman, 1999; Colbeck et al., 2003; Pascarella, 2001). Retention/attrition and graduations rates are the types of measures that officials in government and higher education look at when judging the efficiency and effectiveness of institutions and their programs. Those institutions that demonstrate higher retention and graduation rates are looked upon more favorably when requesting funding.

Statement of the Problem

One of the underlying questions to be raised in this study pertains to the relationship between completing rigorous, upper-level mathematics courses in high school and the enhancement of developmental attributes such as achievement, conscientiousness, and resiliency. Tross, Harper, Osher, and Kneidinger (2000) proposed using the personality characteristics of achievement, conscientiousness, and resiliency (along with high school GPA and total SAT score) to predict college performance and retention. They stated:

> Achievement, conscientiousness, and resiliency are hypothesized to impact college retention both directly and indirectly through their impact of college performance. The direct versus indirect effect of personality characteristics on college retention refers to the difference between individuals who are likely to be forced to leave college due to unacceptable academic performance (involuntary attrition) and those who are likely to leave for other reasons (voluntary attrition). Individuals possessing more achievement, conscientiousness, and resiliency should be more likely to voluntarily stay than individuals with lower levels of these characteristics. (p. 325)

However, of the three personality characteristics tested, only conscientiousness reached statistical significance when predicting college performance and retention. So, why study the other two? The answer is that, from a theoretical perspective, both achievement and resiliency play an important role in moving students along the psychosocial and moral/ethical dimensions of student development.

In *College Students: The Evolving Nature of Research* (1996), Pascarella and Terenzini hypothesize that student development occurs along cognitive, intellectual, value, attitudinal, psychosocial, and moral dimensions. A parsimonious grouping of these dimensions could be structured as: (a) cognitive (intellectual), (b) psychosocial, and (c) moral/ethical (value, attitudinal). One of the questions to be investigated in this study is if completing intensive, upper-level mathematics courses beyond the basic high school mathematics core (Algebra I, Algebra II, and geometry) relates to a student's advancement along these three developmental dimensions before reaching college. More specifically, is it reasonable to consider that a relationship may exist between the attributes that a student uses/develops when faced with the demands and rigors of completing upper level math courses in high school and the development of personality characteristics such as achievement, conscientiousness, and resiliency, which enable a student to grow developmentally?

Purpose of the Study

This study seeks to find evidence of a relationship between completing intensive, upper-level high school mathematics courses beyond the basic high school mathematics core (Algebra I, Algebra II, and geometry) and pre-college student development. The studies conducted by Adelman (1999) and Trusty and Niles (2003) found statistical evidence that completing rigorous math courses enhanced a student's chances of completing a college degree. Both studies concluded that above and beyond the background characteristics of SES, gender, ethnicity, and parents' level of education and the academic resources of overall curriculum, standardized test scores (ACT/SAT), and class rank/GPA, completing intensive mathematics courses beyond Algebra II had the greatest predictive power in relation to success in college (operationally defined as completing a bachelor's degree). Both the Adelman and the Trusty and Niles studies came to the same conclusion, but neither study offered a theoretical explanation for this phenomenon. Therefore, the purpose of this study is to conduct an investigation regarding the hypothesis that completing advanced math courses beyond the basic high school mathematics core enhances/refines/sharpens the cognitive skills needed for growth of critical thinking, recall, decision-making, and problem solving skills. In turn, a higher level of growth in these skills promotes attribute development (locus of control, motivation, goal setting, performance, achievement, conscientiousness, resiliency, persistence, discipline, time on-task, coping skills, etc.) necessary to face and overcome the challenges and adversities faced during college.

Definition of Terms

Achievement: Achievement can be defined as the tendency to succeed, to improve on one's past performance, and/or to strive for competence in one's work. A more achievement-oriented person works hard, is active, and takes work seriously. One who is not achievement-oriented does not feel that hard work is desirable and does not put forth extra effort (Hough, 1992; Raymark, Schmit, & Guion, 1997).

Basic High School Mathematics Core: A recognized high school mathematics core curriculum consists of Algebra I, geometry, and Algebra II. Completion of these three math courses is a state-mandated requirement for admission into any of the public four-year colleges and universities in the state in which this study was conducted. In some states the sequence of the courses may differ. Some students may take the courses in the sequence of Algebra I, Algebra II, and geometry instead of Algebra I, geometry, and

Algebra II. The students (subjects) in this study will have completed all three of the mathematics core courses of Algebra I, Algebra II, and geometry.

Cognitive Development: Piaget (1964) articulated cognitive development from a structuralist point of view. He believed that development along this dimension was to be seen as a sequence of irreversible stages that resulted in changes in the processes by which individuals saw and perceived their environments. Piaget envisioned that the process of developmental change was interactive. Cognitive conflict is caused when individuals are presented with situations that cause conflict and demand a change in thought patterns to resolve the conflict.

Conscientiousness: This attribute is described by the tendency to carry out tasks in a careful manner until completed. Conscientiousness is characterized by being diligent, disciplined, careful, and planning ahead. Individuals who are less conscientious are unreliable, imprecise, disorganized, and impetuous (Hogan, Curphy, & Hogan, 1994; Hough, 1992; Raymark, Schmit, & Guion, 1997).

Locus of Control: Locus of control is characterized as the extent to which an individual views his/her outcomes and experiences to be the result of internal or external forces. Individuals with an internal locus of control believe that they are instrumental in their own successes or failures, whereas persons with an external locus of control believe that past successes or failures are due to fate or chance (Bean & Eaton, 2002).

Moral/Ethical Development: This involves the ways in which people come to think about and take responsibility for what they believe, know, and value (Perry, 1970). Individuals recognize the existence of different perspectives and the need to treat everyone equally (Kohlberg, 197l).

Persistence: Tinto (1975) states that persistence is a measure of a student's commitment to an institution and to the goal of college graduation.

Psychosocial Development: Parker, Widick, and Knefelkamp (1978) see psychosocial development as a chronological sequence, which at certain times of life, particular facets of personality will emerge. These facets are a central concern that must be addressed because the timing and ways that they are addressed is heavily influenced by the society and culture in which an individual lives.

Resiliency: Kobasa, Maddi, and Kahn (1982) specify that resiliency is best demonstrated by an individual who commits to a course of action when faced with adversity. Those who possess resiliency maintain composure under stress and look upon challenges as opportunities. Others who are less resilient suffer inhibited performance under stress.

Self-Concept: Self-concept refers to self-perceptions formed through interactive experiences with the environment (Marsh & Craven, 1997). Self-concept beliefs are heavily influenced by processes of social comparison (Bong & Clark, 1999) and incorporate affective responses to the self (Pajares & Miller, 1994; Pajares & Schunk, 2002).

Self-Efficacy: Self-efficacy refers to beliefs in one's capabilities to organize and execute courses of action required to achieve certain performance outcomes (Bandura, 1997). The stronger that individuals perceive their own self-efficacy, the higher the goal challenges they will set for themselves and the more committed they will be to accomplishing them (Bandura, 1991). Bandura (1993) further posits "those who have a high sense of efficacy visualize success scenarios that provide positive guides and supports for performance.

Those who doubt their efficacy visualize failure scenarios and dwell on the many things that can go wrong" (p. 118).

Student Development: Student development can be defined as the transformational processes by which students make gains along cognitive, psychosocial, and moral/ethical dimensions. Crookston (1972) defines student development as the application of the philosophy and principle of human development in the educational setting.

Success in College: Adelman (1999) defines success in college as the completion of a bachelor's degree by age 30. Trusty and Niles characterize success in college as having completed a bachelor's degree within eight years of finishing high school.

Assumptions

1. Each student provided certain demographic/background data (e.g. age, gender, ethnicity, number of leadership positions held in high school, each parent's highest level of education, choice of college major, etc.). All data self-reported by the students was assumed to be accurate.

2. For each student who participated in this study, copies of his/her high school transcript were obtained from the registrar's office at the university where the study was conducted in order to obtain his/her high school GPA, last mathematics course completed, number of math courses completed, ACT Assessment composite score, and ACT Mathematics Usage Test score. The data from all high school transcripts were assumed to be accurate.

Limitations

1. Traditional, first semester college students come to the university setting varying on many pre-college characteristics such as cognitive skills, SES, gender, ethnicity, and academic preparation. Also, students elect to take advanced mathematics courses for a

variety of reasons that may be related to student development. Given the data accessible to the researcher and the limited time that students were available for assessment, it was difficult to isolate the factors that contribute to the relationship between a student's terminal high school mathematics course and student development.

2. The participants used in this study come from a small-to-medium size public institution of higher education in a rural area. In comparison to other similar studies, the smaller sample of participants may have influenced the results due to lack of differences in family background, SES, and ethnic diversity. The results of this study need to be replicated using a larger and more diverse pool of students in order to more strongly argue for generalizability across the student populations of colleges and universities that vary in size, location, and demographic makeup.

3. Because of limited access to the students who were included in the sample, only the psychosocial and moral/ethical dimensions of student development were assessed. The moral/ethical dimension of student development was assessed using a subtask score and a scale score from the psychosocial instrument. The psychosocial dimension of student development was assessed using two different task scores from the psychosocial instrument administered for this study. The cognitive dimension of student development was not directly assessed.

4. A proxy measure of students' general cognitive/academic skill level (ACT Assessment composite score) was used. Using a student's ACT composite score as a measure of general cognitive/academic skill level was not an ideal measure to use in this study, but it was the best available given the data accessible to the researcher and the limited time that students were available for assessment.

5. The choice of cluster/convenience sampling or sampling in which groups, not subjects, are randomly selected could be a limitation of the study (in this study, only those classes whose instructors gave their permission to be assessed were sampled).

6. This study seeks to explore the proposition that regardless of a student's mathematics ability, those students who complete rigorous, intensive, upper level mathematics courses beyond the basic high school mathematics core (Algebra I, geometry, and Algebra II) are perceived to benefit from enhancing their cognitive skills, which in turn, hypothetically allows them to move further along the cognitive, psychosocial, and moral/ethical dimensions of student development before college. Therefore, students who are more advanced developmentally are better equipped to cope with the demands and pressures of college and successfully integrate into college life. In this study it is difficult, from an experimental design standpoint, to determine how much a student's mathematics/ cognitive ability/skill influences his/her math course taking while in high school. In other words what is more theoretically sound, to posit that a student's mathematics/cognitive ability/skill influences his/her high school math course selection or argue that the completion of rigorous, intensive math courses helps enhance/augment cognitive skills? This issue will be addressed in Chapter 5.

Significance of the Study

The results of this study should be of benefit/interest to several audiences. Those responsible for establishing admissions criteria at universities and colleges may wish to consider outcome/performance measures in specific high school curriculum areas in addition to GPA, class rank and standardized test scores (ACT/SAT) when making admissions decisions.

An emphasis on having high school students complete rigorous, upper-level mathematics courses should eventually translate into lower remediation rates for incoming freshmen. This could directly or indirectly improve retention/attrition/success rates in college. Lower remediation rates and higher retention/success rates would give a more positive response to those demanding accountability in higher education. Fewer taxpayer dollars would be wasted on remediation and student attrition, thus demonstrating better fiscal responsibility among public colleges and universities.

Rogers' (1990) review of literature on student retention and attrition in college noted the lack of a theoretical base. "The literature reflected a tendency on the part of researchers to attempt to link numerous variables to success, but made little attempt to identify the theory or theories which generated the link between variables" (p. 318). Bean (1982) argues that theory is important in prediction studies because it helps to guide the researcher's choice of variables. Theory helps to determine which variables should be studied and how those variables are posited to relate to the subject under investigation. This study could add to the findings of Adelman (1999) and Trusty and Niles (2003) by providing a possible link between taking intensive upper-level mathematics courses and equipping students with the attributes needed to persist to degree completion.

A student's choice to engage in intensive mathematics courses has career development implications as well. Alschuler (1969) postulates that for students to perceive that engagement in mathematics is worthwhile they need to experience a relatively high degree of success in that area. Oldfather (1992) posits that the tendency for students to recall bad experiences may explain why students' liking of mathematics decreases when they get older and why enrollment in higher-level mathematics courses declines. This follows Krumboltz's (1979) belief that course taking in high school and choice of a major in college are career-related decisions. He stated:

> It is the sequential cumulative effects of numerous learning experiences affected by various environmental circumstances and the individual's cognitive and emotional reactions to these learning experiences and circumstances that cause a person to make a decision to enroll in a certain educational program. (p. 37)

Finally, as a result of this study, researchers may be able to identify and test other related variables that would increase the explained variance of predictive models of student retention/attrition/success in college.

Research Questions

1. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with general cognitive skill level?
2. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with psychosocial student development?
3. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with moral/ethical student development?
4. Does gender have a statistically significant relationship with the scores that measure psychosocial and moral/ethical student development when evaluated alone (tested as a main effect) or in combination with completion of intensive mathematics courses beyond the basic high school mathematics core (tested as an interaction effect)?

Organization of the Study

Chapter one briefly discussed the research that has been conducted linking the completion of rigorous, upper-level mathematics courses in high school and bachelor's degree completion in college. A concise, theoretical explanation of the importance of this new line of research was given along with its implications for the future of higher education. The purpose of this study is to investigate a possible relationship between the completion of higher-level mathematics courses in high school and the development of the skills and attributes needed to enhance the likelihood that students will persist until completion of a bachelor's degree. The hypothesis offered proposes that those students who complete advanced math classes are further along the cognitive, psychosocial, and moral/ethical dimensions of student development and, therefore, are better equipped to integrate into college and cope with its demands.

Chapter two discusses the pertinent literature and previous research relating mathematical development to the cognitive, psychosocial, and moral/ethical dimensions of student development.

Chapter three outlines a description of the participants, instruments, procedure, and research design/data analysis used in this study. Chapter four presents an analysis and summary of the data collected. Chapter five gives a summary, discussion, and conclusion based on the results of the study and also offers suggestions for further research and practice.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

In Chapter 1, the demand for accountability, the skyrocketing cost of higher education, and the lack of academic preparation (need for remedial classes) were discussed. *Measuring Up 2004* (National Center for Public Policy and Higher Education, n.d.) painted an improved but still dismal picture of the readiness of high school students and the money required to obtain a college degree.

> The improved preparation of high school graduates for college has not brought about commensurate gains in college participation or in completion rates of associate or baccalaureate degrees. Also, paying for college has become increasingly difficult for most American students and families; the cost of college, even with financial aid represents a larger share of the income of most American families than it did ten years ago. In short, the nation's progress toward college opportunity and effectiveness has stalled.
>
> We find it ironic and discouraging that this national plateau occurs at a time when the knowledge-based global economy is stimulating other nations to challenge the United States' previously unqualified world leadership in higher education. According to the most recent international studies, several nations have overtaken the United States in important measures of college participation and attainment. The momentum for their improvement derives from the understanding

> that nations with best-educated populations will have major advantages in the intensified global economic competition. Conversely, the twenty-first century economy relentlessly punishes undereducated nations, states, communities, and individuals. (p. 6)

Clearly, the academic preparation of high school students who wish to participate in post-secondary education is of vital interest to everyone. More research is needed that connects student pre-college preparation and characteristics to admissions criteria and retention/attrition/persistence/success in college.

In “College Students: The Evolving Nature of Research,” Stage (1996) makes it clear that more research is needed that ties characteristics, attitudes, experiences, and achievements together conceptually. He goes on to state:

> Despite the general coalescence of knowledge on the topic, a satisfactory explanation of outcomes eludes researchers. They cannot predict with assurance the success or failure, satisfaction or dissatisfaction, persistence or attrition of a student with certain background characteristics and attitudes, studying in a certain environment and participating at a particular level of campus experiences. (p. 275)

Echoing Stage, Pace (1984) argues for the need for research that ties student characteristics to educational outcomes by positing that theorists no longer view achievement and satisfaction as constructs that can be predicted from easy to obtain variables.

These “easy to obtain variables” (ACT/SAT scores, high school class rank, and GPA) have been used in admissions decisions and to predict college success and retention/attrition/persistence (Murtaugh, Burns, & Schuster, 1999; Myers & Pyles, 1992). However, these pre-college measures explain less than forty percent of the variance in those prediction models. Other models recognize the lack of predictive power when using only ACT/SAT scores, high school GPA, and class rank to predict retention/ attrition/persistence/success in college. The theories of these enhanced models attribute linking retention/attrition/persistence/success in college to a student's pre-college academic and non-academic characteristics and his/her level of social integration into the institutional setting. A brief review of several of these integrative models will illustrate the importance of considering non-academic variables.

Persistence/Retention/Attrition Models

One of the first noted models of student attrition came from Tinto (1975). Tinto expanded on Spady's (1970) model of the college drop-out process. Tinto posits that the characteristics, goal commitments, and prior experiences of an individual and his/her integration into the academic environment of the institution influence a student's decision to persist and succeed or to leave. Pascarella and Chapman (1983) described Tinto's model as a student's decision to persist or dropout being originally influenced by their pre-college characteristics, background variables, and individual attributes which are then brought into focus when integrating into the academic and social environment of the institution. Pascarella and Terenzini (1983) conducted a path analytic validation of Tinto's model and concluded that the variables used discriminated between persisters and voluntary withdrawals with 80 percent accuracy.

Bean and Eaton (2000) have developed a highly regarded model that attempts to describe the psychological processes of students that lead to academic and social integration and retention in college. The four psychological theories that form the basis for their model are (a) behavior theory that provides the overall structure for the model, (b) coping behavioral (approach-avoidance) theory, (c) self-efficacy theory, and (d) attribution (locus of control) theory that affects academic and social integration. This model hypothesizes that a student enters an institution with psychological attributes that are shaped by his/her self-assessments, abilities, and past experiences. Bean and Eaton believe that psychological theories can be used to help explain social and academic integration. They believe that in order for a student to become socially and academically integrated into an institution's environment, he/she needs certain attributes. Bean and Eaton list these entry characteristics as past behavior, personality, initial self-efficacy, initial attributions, normative beliefs, coping strategies, motivation to attend, and skills and abilities. Bean and Eaton (2002) argue:

> They (students) need to believe that they are effective in their social environments. They need to believe they are effective academically and believe they are in charge of their own outcomes. They need to develop coping skills and to be motivated to approach academic and social challenges. When they develop positive attitudes toward their institution, feel they fit in, achieve good grades, and want to graduate from the school, they are more likely to succeed and graduate. (p. 85)

For nearly four decades, Astin (1968, 1977, 1984, 1993) has developed and refined a conceptual model for studying student development. He calls this guide the input-environment-outcome (IE- O) model. Inputs relate to the characteristics that a student possesses at the time of initial entry into college. The environment pertains to the various aspects of the educational experiences the institution has to offer. These aspects can include the faculty, peers, policies, and various programs of the university. Outcomes refer to the changes in the student's characteristics as a result of being exposed to the environment of the institution.

Astin believes that studying student development should involve assessing the impact of the various environmental experiences offered during college and measuring the change or growth in the student as a result. Astin's position is that college presents the first real academic challenge to a student's academic motivation and skills and that students who are better prepared before they reach the university level (inputs), have a better chance to successfully adapt to the demands, culture, and climate of the college setting (environment) which helps the student to grow developmentally (outcomes). Even though Astin's I-E-O model involves looking at the complex interaction between a student's pre-college characteristics and his/her institutional environment when explaining/predicting developmental change during college, it is clear that possessing certain attributes before reaching the university level is paramount in order to successfully adapt and integrate into college.

Pascarella and Terenzini (1980) set out to develop and validate a multidimensional instrument that assessed the major dimensions of Tinto's (1975) model of student attrition. Pascarella and Terenzini (using Tinto's model as a guide) wanted to select variables they believed would accurately measure "the extent to which the assessment of differential levels of social and academic integration and institutional goal commitment contribute to the prediction of persistence/dropout behavior when the influence of pre-college characteristics is taken into account" (p. 63). Pascarella and

Terenzini went on to explain that, again in reference to Tinto's model, the "extent of academic integration is determined primarily by the student's academic performance and his or her level of intellectual development" (p. 62). This indicates a belief that both academic ability and overall cognitive ability are necessary in order for a student to persist and obtain a college degree.

It is interesting to note that among the pre-college characteristics that Pascarella and Terenzini (1980) controlled for were academic aptitude (as measured by the SAT) and number of high school extracurricular activities. Also, as part of analyzing their student persistence/attrition instrument, Pascarella and Terenzini conducted a setwise discriminant analysis to estimate variable contributions to group discrimination and the predictive utility of the scales developed. Of the five scales developed for institutional integration, institutional and goal commitment produced the largest standardized discriminant function coefficient (.53), which according to Stevens (2002), is analogous to beta weights in multiple regression and may be used to estimate the contribution of each variable to group discrimination.

The review of the four persistence/retention/attrition models found that there were several commonly shared attributes/skills/characteristics that relate to student development. Coping skills, academic and motivation skills, institutional and goal commitment, self-efficacy, attribution (locus of control), and cognitive/intellectual ability were among the attributes/skills/characteristics most mentioned.

A Revisited Direction of Research Pertaining to Success in College

Predicting student success in college (operationally defined as completing a bachelor's degree) is closely related to predicting student persistence/retention/attrition in college. Alexander, Riordan, Fennessey, and Pallas (1982), Adelman (1999), and Trusty and Niles (2003) advocate that degree completion is higher education's targeted goal for students, not retention. Alexander et al. (1982) approached predicting degree completion a little differently than others before them. They believed that the key to analyzing baccalaureate degree completion could be found in exploring two categories of individual student characteristics: social background factors (which had been commonly used in persistence/retention/attribution studies) and academic resources that focused on standardized test scores, class rank, and curriculum. The use of standardized test scores and class rank was and still is a commonly used criterion measure for admission purposes. The extensive use of curriculum as predictor of success in college (degree completion), however, was a revitalized area of research.

The use of a rigorous curriculum to prepare students for the challenges of post-secondary education can be traced back to the l800's. At that time, the theory of learning called "faculty psycholgy" led to accepting high school coursework as a significant predictor of college success (Beecher & Fischer, 1999). Due to the advances made in technology during the Industrial Revolution, training was coupled with rigorous high school coursework in preparation for college. This educational paradigm became known as "formal discipline" and was the predominant educational approach of the late nineteenth and early twentieth centuries (Kingsley, 1946, as cited in Beecher & Fischer, 1999).

By the mid l920's, researchers began to question the validity of this approach and sought empirical evidence to refute or support it. Starting in the mid 1920's, several studies were conducted to determine, if indeed, intensive academic coursework in high school better prepared students for college (Bolenbaugh & Proctor, 1927; Byrns & Henmon, 1935; Clark, 1926; Cook & Martinson, 1962; Kimball, 1972; Leasman, 1955; Thorndike, 1924; Vaughan, 1947; Whitener, 1974, as cited in Beecher & Fischer, 1999). All came to the conclusion that it did not. Beecher and Fischer (1999) did not elaborate on the reasons why.

Ramifications of the Cold War and the call for better accountability in higher education created pressures demanding that curriculum standards be revisited. One of the results of this outcry was an intensive study of educational practices in the United States. In 1983, the National Commission on Excellence in Education called for the “Five New Basics” which was reported to be the solution to the problems presented in American secondary education at that time.

A study conducted by Alexander et al. (1982) began to reverse the trend in research proposing that academic coursework in high school did not effectively better prepare students for college. Of the two categories of variables used by Alexander et al., social background factors and academic resources (preparation) at the time of high school graduation, academic preparation characteristics were by far the strongest predictors of degree completion. Alexander et al. stated “for all groups of youths, academic resources were potent predictors of success in negotiating the transition from high school to college” (p. 317).

How could the findings of Alexander et al. (1982) be in such contrast to those that were reported decades ago? The theory offered here is that from the late 1800”s until approximately the 1970’s, most college bound students were those who had better academic preparation and/or came from affluent families which tended to exert positive influences on academic preparation. In other words, the vast majority of students who chose to enter college were probably better prepared academically. When access to college for underrepresented populations (women, non-traditional aged students, students of different races/ethnicities, students from disadvantaged SES backgrounds, etc.) became a politicized issue, admission standards were changed to allow a more diverse population of students to enter college. This larger, more diverse pool of students also varied greatly in their academic preparation. Consequently, academic preparation became a key facet of college success.

Alexander et al. (1982) began the new line of research that looked at the relationship between high school course curriculum and degree completion. Their study used the 1979 follow-up wave of National Longitudinal Survey data (n = 3120) to examine baccalaureate degree completion rates according to two categories of individual characteristics: social background factors (race, gender, and SES) and academic resources obtained through high school (ACT/SAT scores, class rank, and curriculum). This research involved using logistic regression, which is the preferred regression design when the dependent variable is categorical and, in this case, dichotomous (Pedhazur, 1997).

The first part of the study looked at comparing the logistic regression results of college graduation on each of six predictor variables (done separately) in order to determine the magnitude of contribution for each of the individual variables relative to degree completion. The results of this part of the study indicated that the three academic resource variables of ACT/SAT scores, class rank, and curriculum were, on an individual basis, stronger predictors of degree completion than what the three background variables of SES, gender, and race were (also evaluated on an individual basis).

Next, Alexander et al. (1982) tested various combinations of the three background variables (SES, gender, and race) to determine which main effect(s) and interaction grouping(s) produced the greatest predictive power in relation to degree completion. The combination of SES and race produced the best model fit and gave the highest predictive power, indicating that gender was not a significant predictor. The third step taken in the study was to add various combinations of the academic resource variables of ACT/SAT scores, class rank, and curriculum to the background variables of SES and race in a series of logistic regression models. The researchers wanted to consider the academic and background variables jointly in order to determine the magnitude of background variables net of the academic resources variables. As a result, the increase in R^2 was evaluated after the academic resource variables were added to the logistic regression model. The addition of the academic resource variables increased R^2 from .075 to .235. In discussing their findings, Alexander et al. commented:

> Our results reveal a complex interplay between academic and nonacademic factors as predictors of baccalaureate degree attainment. Academic resources are far more relevant to college completion than students' social backgrounds are. Also, although, it is difficult to quantify precisely given the analysis procedures used here, some of the observed disparities associated with social background characteristics seemingly are because of correlated differences in academic resources. Thus, success in the completion of a college degree appears much more closely tied to relevant academic considerations that it is to the sociodemographic student characteristics of race, gender, and SES origins. (p. 328)

Adelman (1999) replicated the Alexander et al. (1982) study using over 10,000 students selected from the National Center for Education Statistics: High School & Beyond/Sophomore cohort, NCES CD #98-135. This study was built on the information taken from high school and college transcripts, test scores, and surveys of the students from the time they were in tenth grade in 1980 until roughly age 30 in 1993. The populations in all National Center for Educational Statistics (NCES) age-cohort longitudinal studies are national probability samples first drawn when the students are in high school or middle school. The High School & Beyond/Sophomore (HS & B/So) data base used for this study involved first selecting a stratified sample of secondary schools with an over-sampling of schools in minority areas, and then a random sample of tenth grade students within those schools. The original sample was thus weighted to match the national census of all tenth grade students in 1980. Since attrition was a factor in tracking these students over a 13-year period, the weights carried by participants were modified for each subsequent survey conducted.

The approach used by Adelman (1999) involved using both logistic regression (l = degree completion, 0 = otherwise) and linear regression to construct the best possible prediction model for degree completion. Since the dependent variable was categorical and dichotomous, logistic regression was the model used and tested most often. However, Adelman also used linear regression as a tool to aid in interpretation and to add clarity to logistic regression results. The main difference between the Alexander et al. (1982) and the Adelman studies was how Adelman constructed his academic curriculum variable. Whereas Alexander et al. used a logistic approach to enter curriculum into the prediction equation (l = college preparatory track, 0 = otherwise), Adelman looked at the credit distribution in the five core curriculum areas of English, mathematics, science, history and social studies, and foreign languages. He then converted the classes taken in each of the core areas into Carnegie unit equivalents, which were based on empirical clusters of credits on transcript records from different kinds of high schools with different credit systems and in accordance with state requirements. As a result, Adelman created an academic intensity variable that could measure each individual student's academic preparation, according to the total number of Carnegie units completed. One might commonly think of this Carnegie credit distribution as containing four units of English, three units of mathematics, three units of science, three units of history/social studies and two units of foreign language, or a total of 15 Carnegie units required as a standard for high school graduation. Students whose transcripts indicated more than 15 Carnegie units completed would theoretically be better prepared academically than those students whose transcripts contained less than 15 Carnegie unit equivalents. Adelman constructed a total academic resources variable (ACRES) that included three components. These components included high school curriculum (see above), standardized test scores (ACT/SAT), and class rank/GPA. In order to judge the relative magnitude of each component of the ACRES composite variable, Adelman calculated the percentage of students who completed a bachelor's degree and categorized this data by quintile of performance for each of the three ACRES components. The curriculum intensity variable emerged as the strongest individual component.

According to Adelman (1999), mathematics is the only high school subject that is presented in a distinct hierarchy of courses and that is required for graduation in all states. He hypothesized mathematics as part of a larger construct that "helps us refine gradations of intellectual capital accumulation and adds a quality dimension to curricular intensity" (p. 18). As a result, Adelman conducted another logistic regression that predicted bachelor's degree completion from individual mathematics courses, after controlling for SES. The individual math course categories used were less than Algebra II, Algebra II, trigonometry, pre-calculus, and calculus. The results indicated that for each advance upward along the math course sequence, the odds of completing a bachelor's degree increased by a factor of 2.59 to 1. By comparison, movement upward on each successive SES quintile ladder (created to match the five step mathematics ladder) increased the odds of degree completion by l.68 to l. Further analysis indicated that Algebra II was the course that separated those students who were more likely to complete a college degree from those who were less likely. This result motivated Adelman to posit that it is not the number of course credits that count, but the level of courses completed that should be the unit of analysis.

Eventually, Adelman (1999) used both logistic and linear regression to determine the relative strengths of both academic and background variables in predicting degree completion. The academic variable used was the composite academic resources variable, ACRES. The background variables used were SES, race, gender, parenthood prior to age 22, and the developed construct of "educational anticipations." Both types of regression models gave statistical evidence that both gender and race did not add significant predictive power relative to degree completion. In addition, ACRES was by far the strongest predictor of those variables tested. Under selected findings, Adelman (1999) wrote:

> Of all pre-college curricula, the highest level of mathematics one studies in secondary school has the strongest continuing influence on bachelor's degree completion. Finishing a course beyond the level of Algebra II (for example, trigonometry or pre-calculus) more than doubles the odds that a student who enters postsecondary education will complete a bachelor's degree. Academic Resources (the composite of high school curriculum, test scores, and class rank) produces a much steeper curve toward bachelor's degree completion that does socioeconomic status. Students from the lowest two SES quintiles who are also in the highest Academic Resources quintile earn bachelor's degrees at a higher rate than a majority of students from the top SES quintile. (p. vii)

The most recent contribution to this line of research comes from Trusty and Niles (2003). Their study used student data from the National Education Longitudinal Study (1988 - 2000) Data Files. Again, the study was designed to investigate the effects of background variables and students' high school math curricula on completion versus noncompletion of bachelor's degrees. The students were tracked over a 12-year period from eighth grade until eight years after high school (1988-2000). The math intensity variables used in their study were high school Carnegie units taken in Algebra II, trigonometry, pre-calculus, and calculus. The background variables used included gender, SES, race, and eighth grade cognitive ability (in reading and mathematics).

The sample used in the Trusty and Niles (2003) study was a cross-sectioned collection of 5,257 students from all parts of the United States and representing the Asian American (5 percent), Latino (9 percent), African American (11 percent), Native American (1 percent), and Caucasian (74 percent) ethnic groups. One of the major differences in the Trusty and Niles study versus the Adelman (1999) study was that Adelman summed all the mathematics courses together, along with the courses from four other curricula areas, and created a total curriculum intensity variable. Adelman hypothesized that mathematics was the only high school subject presented in a distinct hierarchy and that the rigor of mathematics helps to develop a student's intellectual ability. This influenced his decision to run a logistic regression, using five levels of math (below Algebra II, Algebra II, trigonometry, pre-calculus, and calculus) and the quintiles of SES as independent variables against the dependent variable of degree completion. This particular logistic regression analysis did not include the other background variables of gender and race. The study conducted by Trusty and Niles included the math course component and the background variables of SES, race and gender at the same time. In addition, the Trusty and Niles study included an additional background variable, eighth grade cognitive ability. This was done in order to assess the effects of course taking in high school, net the influences of students' reading and math ability in eighth grade. This was a very important experimental design component in the Trusty and Niles study because for the first time, this line of research addressed the potential effect of pre-high school individual differences in both math and reading ability.

Trusty and Niles (2003) ran two sets of logistic regressions. The first set only included the background variables of gender, SES, race (broken out by the five categories given earlier), and eighth grade cognitive ability in reading and mathematics (entered as separate variables). The second logistic regression added the individual math courses of Algebra II, trigonometry, pre-calculus, and calculus to the model. This was done in order to analyze the effects of math courses on degree completion net the effects of the background variables after the math course variables were entered into the model. The odds ratios produced by the logistic models produced some significant findings. First, there was very little change in the odds ratios of the background variables of gender, SES, and race when comparing the two models. Second, the effect (odds ratio) of eighth grade reading ability did not change appreciably from the first model to the second, but eighth grade math ability did. When adding the block of variables representing the different math courses into the model, the effect (odds ratio) of eighth grade math ability all but disappeared. Trusty and Niles commented:

> The effect of eighth grade reading ability was significant and positive. This effect did not change as the math course-taking variables were added to the equation; that is, the reading ability effect was unchanged across Models 1 and 2. The effect of math ability was stronger, but this effect decreased dramatically when math course-taking variables were added to the equation. That is eighth grade math ability affected math course-taking in high school, which in turn affected bachelor's degree completion. Stated differently, early math ability had an indirect effect on degree completion via math course-taking in high school. (p. l03)

In summarizing their findings, Trusty and Niles (2003) concluded:

> Units in intensive high school mathematics courses showed the strongest effects in the logistic regression models. These findings are consistent with earlier findings of Adelman (1999) that completing these courses is salient to participants' completion of the bachelor's degree. We found strong effects for all intensive math courses—Algebra II, trigonometry, pre-calculus, and calculus.

> Taking one high school unit in any of these courses more than doubled the likelihood of young people completing the bachelor's degree versus not completing the bachelor's. These strong effects of credits in intensive math courses were independent of the influences of eighth grade reading and math ability, gender, SES, and racial-ethnic group membership. Early math ability did have an influence on math course-taking in high school. That is, students with higher ability tended to finish more intensive math courses. However, the positive effects of math course-taking on bachelor's degree completion extended well beyond the influences of early math ability; this finding adds to earlier findings of Adelman. (p. 103)

Exploring the Relationship Between Mathematics and Student Development

The studies of Alexander et al. (1982), Adelman (1999), and Trusty and Niles (2003) all failed to address an important question. Why do completing intensive upper-level mathematics courses so significantly increase the odds of degree completion? From an intuitive standpoint, the completion of rigorous math courses should enhance/sharpen the cognitive skills of students. Critical thinking, the ability to think logically and abstractly, and the talent to organize and synthesize information are all skills developed in the course of completing higher lever math classes. But beyond that, what might be some of the possible benefits? The argument posited here is that the rigor of advanced math enhances cognitive skills (academic preparation), which elevates a student along the cognitive, psychosocial, and moral/ethical dimensions of student development (non-academic preparation). Put simply, students who complete intensive mathematics courses are further along the cognitive, psychosocial, and moral/ethical dimensions of student development, which in turn, better prepares them to adapt and integrate into the college environment. Students who are initially better prepared for the challenges and demands of university life have a better chance to persist (be retained) and eventually obtain a college degree.

How might completion of demanding upper-level mathematics courses enhance/accelerate student development in traditional, incoming freshmen? The explanation given in this study will be framed from a constructivist epistemology. Perhaps the best way to develop this theory is to look at a decomposition of the cognitive, psychosocial, and moral/ethical dimensions of student development. Definitions of these three aspects of student development are now given in order to better interpret the decomposition to follow.

The moral/ethical facet of student development relates to the rule, decision-making, and problem solving strategies that are based on one's level of cognitive ability and are affected by changes in cognitive schema as a result of organizing and integrating social experience (Smith, 1978). The moral/ethical dimension of student development is, according to developmental theorist, a part of the cognitive aspect (Kohlberg, 1969, l972, l975; Perry, 1970).

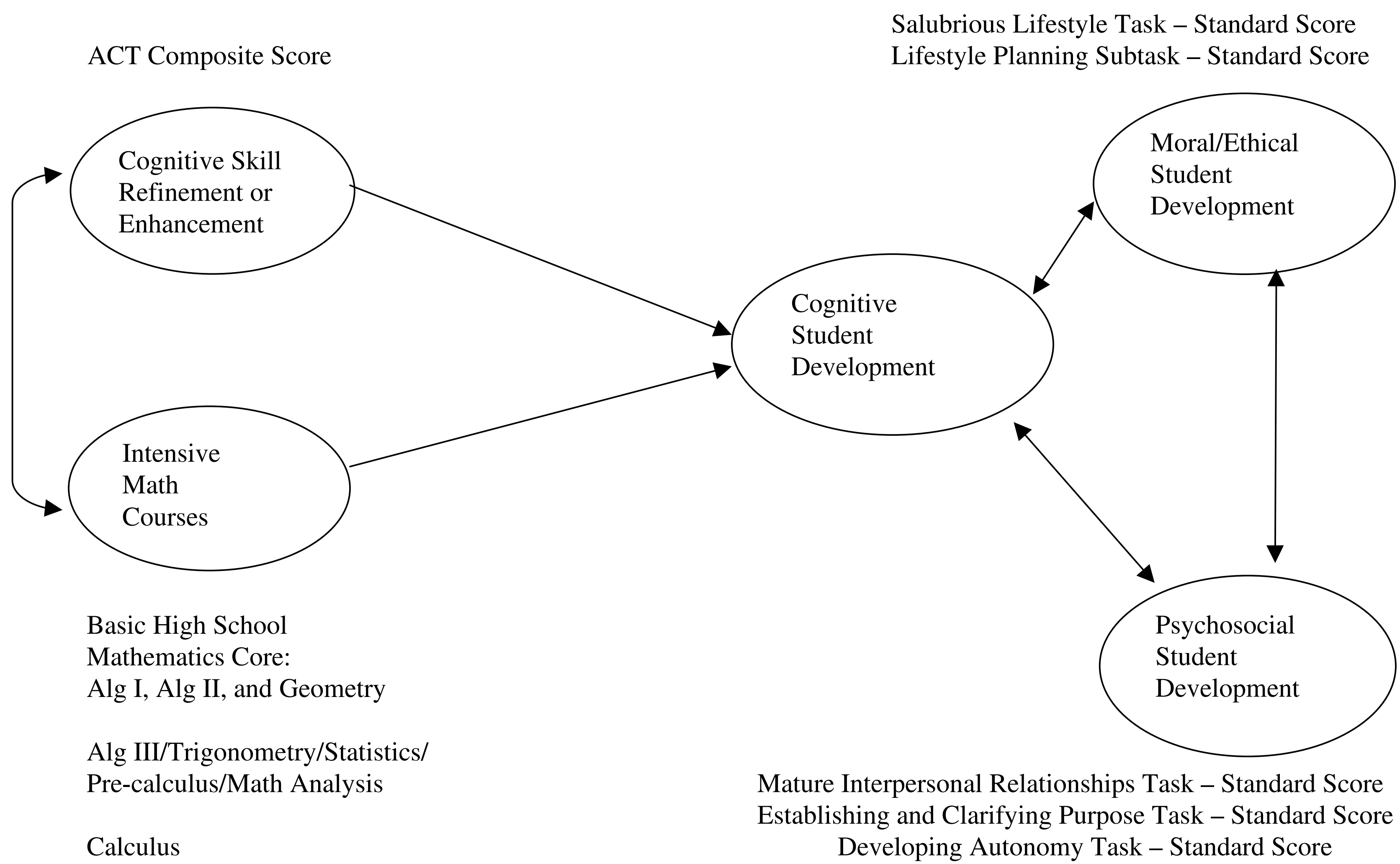
The psychosocial component of student development pertains to how one chooses to act, behave, and respond in various social situations which are influenced by the challenges and responses offered by members of society and the environment (Parker, Widick, & Knefelkamp, 1978). In order for students to advance along the psychosocial dimension, they must continue to develop and grow cognitively (Chickering, 1969; Erickson, 1963).

Cognitive development involves how one processes, stores, and retrieves information. Piaget (1964) believed that cognitive growth involved three central developmental assumptions. (a) Individuals need to impose a meaningful order or "structural organization" to processed information; (b) There is a series of hierarchical stages in which humans learn a qualitatively different way of thinking. Each stage represents a more differentiated and integrated structural organization subsuming that of previous stages; and (c) Development is the result of learning how to restore balance when dissonance or disequilibrium occurs in an individual as a result of his/her interaction with the environment. When environmental stimuli cannot be handled by existing constructs, cognitive structures must be altered in order to admit and accommodate more complexity.

Decomposing cognitive, psychosocial, and moral/ethical development involves understanding that both psychosocial and moral/ethical advances are not theoretically possible without cognitive growth. Cognitive growth will not occur unless one's interaction with environmental and social situations creates a state of mental discord that requires cognitive organization of a new set of schema structures. These new schemas must be sufficient in giving guidance to resolving the discord created by the environmental/social situation. In order to work through the dissonance to balance sequence of cognitive activity, an individual must first be presented with a social/environmental situation that creates disequilibrium (Kohlberg, 1972; Piaget, 1964). In this study, dissonance/disequilibrium is theorized to be created as students engage in the rigors and demands of successfully completing an intensive upper-level mathematics course.

Given below is a visual representation of a deconstruction model that illustrates the theoretical relationship between completion of intensive mathematics courses and student development:

Figure 1. Hypothesized Model Relating the Relationship of High School Math Courses and Student Development



An explanation of the model is based on the hypothesis that intensive math courses relate to cognitive student development directly and both moral/ethical and psychosocial student development indirectly through the enhancement of cognitive skills. In this study, individuals are posited to receive feedback from actions taken in social and environmental situations. This feedback is interpreted and then organized into existing schema structures. Feedback that cannot be stored into existing structures creates a need for reorganization and development of new schema structures. Therefore, since actions taken in social and environmental situations are based on cognitive skills and abilities and the responses to those actions may create the need to develop new schema structures and cognitive competence, the cognitive, psychosocial, and moral/ethical dimensions of student development are hypothesized to all have two-way relationships among each other.

It might be useful to create a list of the potential skills, constructs, and attributes that may be developed or enhanced during the completion of intensive upper-level mathematics courses and then focus attention on what past studies and theorists say about these skills, constructs, and attributes and their development.

Table 1 gives a listing of the skills, constructs, and attributes that are believed to be developed or enhanced, either directly or indirectly, as a result of successfully completing intensive, rigorous, upper-level mathematics courses beyond the basic high school mathematics core (Algebra I, geometry, and Algebra II):

Table 1

List of the Skills, Constructs, and Attributes Hypothesized to be Developed/Enhanced by Completing Intensive, Rigorous, Upper-Level Mathematics Courses

Skills	Constructs	Attributes
critical thinking	academic self-efficacy	achievement
decision making	cognitive self-efficacy	conscientiousness
problem solving	social self-efficacy	coping skills
recall	self-concept	discipline
	self-confidence	goal setting
		locus of control
		motivation
		performance
		persistence
		resiliency
		time-on-task

How do these skills, constructs, and attributes, hypothesized to be developed/enhanced by completing demanding math courses, relate to student development? The argument offered here starts with the developmental relationship between mathematics and critical thinking/problem solving skills. An elevated ability to solve problems and think critically raises one’s self-efficacy and self-concept. As an individual’s self-efficacy and self-concept increases, so does his/her motivation and internal locus of control. If a student believes that he/she is capable of putting forth effort and obtaining a positive, desired result (internal locus of control), then more ambitious goals and higher levels of achievement are possible. This, in turn, can lead to an increase in motivation that positively influences goal and task accomplishment. More motivation can elevate an individual’s conscientiousness, resiliency, and persistence. These attributes make it easier for students to cope with the ambiguities and challenges of the college environment. Put simply, the enhancement of critical thinking, problem solving, recall, and decision making skills raises self-efficacy and self-concept. Developmental gains in these constructs lead to gains in attributes, which are key to moving students further along the cognitive, psychosocial, and moral/ethical dimensions of student development.

What role does literature play in this argument? Facione and Facione (1994) wrote that critical thinking could be looked upon as the cognitive engine that drives problem solving and decision-making. Williams (2001) argues that critical thinking is related to the ability to link conclusions from available evidence and that measures of critical thinking have been correlated with many different cognitive and academic variables, suggesting that critical thinking may have considerable potential as a predictor of academic performance. Pascarella and Terenzini (199l) describe critical thinking as involving:

> The individual's ability to do some or all of the following: identify central issues and assumptions in an argument, recognize important relationships, make correct inferences from data, deduce conclusions from information or data provided, interpret whether conclusion are warranted on the basis of data given, and evaluate evidence or authority. (p. 118)

Is this not, at least in part, a major developmental aspect of studying mathematics?

The growth in critical thinking skills increases one's problem solving ability. Successful problem solving increases self-efficacy (Bandura, 1986). As a construct, self-efficacy is normally thought of as domain specific. Bandura (1997) defines self-efficacy as one's personal belief in the capability to organize and execute actions to produce outcomes in a given domain. Self-efficacy beliefs can reinforce general constructs such as ability (Bandura, 1993), academic self-efficacy (Bandura, 1997; Zhang & RiCharde, 1998), and self-concept (Pajares & Schunk, 2002). Pajares and Schunk also postulate that self-efficacy relates to self-confidence in achieving certain outcomes, whereas self-concept relates to self-perceptions of general ability. Clearly, self-efficacy beliefs in various domains act together in forming an individual's overall appraisal of his/her general ability to function in both academic and social contexts. Bandura (1977, 1993) posits that self-efficacy beliefs represent primarily cognitive assessments of competence and that these beliefs can have strong effects on development well beyond just academics. Bong and Skaalvik (2003) argue that self-efficacy relates to cognitive appraisals of competence, whereas self-concept evaluates competence through both cognitive and affective components.

Pietsch, Walker, and Chapman (2003) suggest that significant conceptual overlap appears to exist between self-efficacy and self-concept. Even though these constructs are not totally interchangeable, self-efficacy, will be used in the following discussion as pertaining to a more general cognitive ability to perform in both academic and non-academic (social) contexts.

According to Middleton and Spanias (1999), students tend to internalize their experiences in mathematics into their self-concept (a general construct) more than in other subject areas. The authors speculate that this may be due to the importance and difficulty of the subject. Perhaps students who are not gifted in math, but yet persevere and complete a rigorous course beyond the basic high school mathematics core, improve their self-concept by realizing that they can successfully navigate and overcome challenges not previously thought possible. They may help explain why both Adelman

(1999) and Trusty and Niles (2003) found Algebra II (normally the last course completed in the basic high school mathematics core) to be the specific course in the sequence of math course offerings that most dramatically separated the students who persisted to college degree completion from those who did not. Most state graduation requirements list Algebra II as the last math course needed to graduate. If marginally gifted students do not challenge themselves beyond this point in mathematics while in high school, they may not enhance/sharpen their cognitive skills (critical thinking, recall, decision making, and problem solving) enough to develop the self-efficacy beliefs necessary to successfully integrate into the academic and social environments of college. The sense of accomplishment felt and achieved when a student completes a difficult task can motivate him/her to set goals for more difficult challenges (Bandura, 1993). Those students who complete math courses beyond Algebra II are postulated to develop cognitive skills, which improve self-efficacy (self-concept) and enhance attributes such as locus of control, motivation, performance, achievement, conscientiousness, resiliency, and persistence. These attributes are needed to cope with the challenges faced in college. Development of these skills, constructs, and attributes are believed to advance students along the cognitive, psychosocial, and moral/ethical dimensions of student development.

Perhaps a more in-depth look at the relationship of self-efficacy to some of the attributes mentioned will help to establish their connection to student development. First and foremost, perceived self-efficacy has a direct influence on motivation. Self efficacy has been shown to act as a determinant of how much effort an individual is willing to put forth to complete a task (Bandura, 1997). Students with self-efficacy can overcome limited ability and achieve goals. Others who lack self-efficacy may lack motivation and exert minimal effort. Self-efficacy influences choice of activities, effort expended, persistence, and task accomplishment (Schunk & Hanson, 1989). Schunk (198l) believes that self-efficacy influences motivation. Bandura (1992) posits that efficacy beliefs influence how people feel, think, motivate themselves, and behave.

Motivations give individuals reasons for behaving in a certain way, given a certain context. They are a part of one's goal structures, one's beliefs about what is valued, and help determine if one will engage in a particular activity (Ames, 1992). One's level of motivation is affected by his/her locus of control. Thomas, Iventosch, and Rohwer (1987) describe self-efficacy as combining the concept of locus of control with aspects of perceived competence and self-worth (self-confidence, and/or self-concept). Locus of control indicates the extent to which individuals see their past experiences and outcomes to be the result of internal or external forces. Internal locus of control results from an individual's belief that he/she is instrumental in achieving successful outcomes. An external locus of control results from an individual's conviction that successes or failures are caused by influences beyond his/her control. If students believe that academic success is related to their own efforts (internal locus of control), they will be more motivated to work hard. A student who looks upon academic success and achievement as being beyond his/her control (external locus of control) will be much less motivated to put forth effort toward success (Bean & Eaton, 2002).

Self-efficacy beliefs contribute to motivation by influencing how individuals set goals, how much effort they are willing to put forth, how long they will persevere in the face of difficulties, and to be resilient despite occasional failure. Strong perseverance can pay off in performance accomplishments (Bandura, 1993). According to Nettles and

Pleck (1993), resilience is defined as overcoming the odds, coping with the stress of life, and recovering from trauma. One of the main factors associated with the development of resiliency in youth is the nurturing and development of self-esteem (self-concept) and self-efficacy. Kobasa, Maddi, and Kahn (1982) hypothesize resiliency as the tendency to stay committed to a course of action when challenged, to stay calm and emotionally stable when faced with ambiguity, and to rebound when faced with adversity. A more resilient person maintains composure when stressed and sees challenges as opportunities. A less resilient person is easily irritated and suffers inhibited performance under stress.

Motivation influences both persistence and resiliency, and also conscientiousness. Conscientious people tend to carry out tasks in a careful manner until completed. A more conscientious individual is diligent, disciplined, careful, and organized. Those who are less conscientious are unreliable, imprecise, disorganized, and impetuous (Hogan, Curphy, & Hogan, 1994; Hough, 1992). Conscientiousness is most likely a must attribute for students who challenge themselves by taking upper-level math courses. These classes normally involve a large volume of homework. It is also common that some aspect of these courses requires attention nearly every day (night). Studying mathematics generally requires long uninterrupted periods (Hagedorn, Siadat, Nora, & Pascarella, 1997). Discipline/time-on-task is an issue that confronts those students who are not gifted in mathematics. Time-on-task has been used as an index of motivation (Dickinson & Butt, 1989).

Other attributes that are connected to self-efficacy are achievement (performance) and a closely related item, goal setting. Bandura (199l) offers that the stronger an individual's efficacy beliefs are, the higher the goal challenges he/she will set and the firmer the commitment to those goals. Perceived self-efficacy influences performance both directly and through its strong effects on goal setting and analytical thinking. It also promotes academic achievement both directly and by raising personal goals (Bandura, 1993). Persistence and self efficacy should both predict achievement (Schunk, 198l).

The bottom line is that as a result of successfully navigating the tasks and demands of challenging math courses, students are posited to enhance their critical thinking, problem solving, recall, and decision-making skills. Development of these skills helps to elevate cognitive, academic, and social self-efficacy. Students who have higher perceived self-efficacy are more likely to have more self-confidence and better self-concepts. These individuals tend to have an internal locus of control, are more motivated, perform/achieve better, and set higher goals for themselves. In order to accomplish those goals, enhanced self-efficacy enables students to demonstrate more discipline (time-on-task), conscientiousness, persistence, and resiliency. These attributes are postulated to advance students further along the cognitive, psychosocial, and moral/ethical facets of student development. Students who are further along these dimensions of student development are equipped to better cope, adapt, and integrate into the college environment.

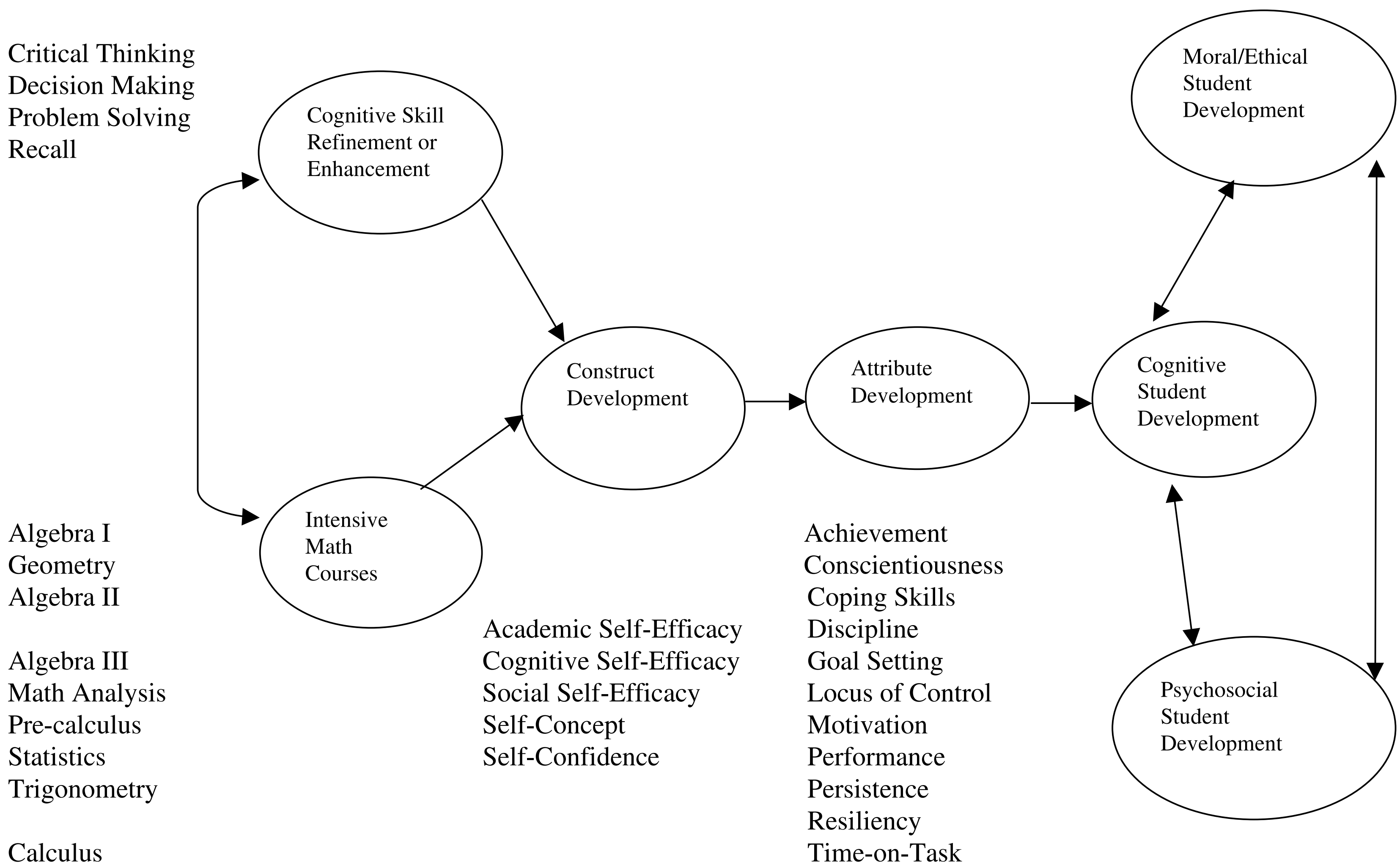
Self-efficacy influences coping behavior by giving individuals the cognitive abilities/skills and confidence to deal with and overcome ambiguity and anxiety of academic and social situations. This, in turn, enables college students to better matriculate into college life. Students who have a low sense of efficacy toward academic demands are vulnerable to achievement anxiety. Meece, Wigfield, and Eccles (1990) have shown that past academic successes and failures affect anxiety through perceived self-efficacy. Bandura (1993) speculates that developing cognitive capabilities and self-regulated skills that manage academic task demands and overcoming self-debilitating thought patterns are important in reducing scholastic anxiety. The position taken in this study is that the attributes developed while completing advanced math classes empowers students to directly address such concerns.

Bandura (1993) also believes that children who have high academic and self-regulative efficacy behave more prosocially, are more popular, and experience less rejection by their peers than those children who beliefs in academic efficacy are lacking. As children grow older, their lack of belief in their academic efficacy causes an even stronger effect on socially discorded behavior. This may, at least indirectly, relate to the psychosocial and moral/ethical aspects of student development.

The retention and social integration model offered by Bean and Eaton (2002) proposes that academic and social integration are affected by self-efficacy assessment, coping behavior, and locus of control. When individuals believe they are competent, they gain self-confidence and develop higher levels of task persistence and set higher goals for task achievement. Bean and Eaton further state, “An individual enters an institution with psychosocial attributes shaped by particular experiences, abilities, and self-assessments. Among the most important of these psychosocial factors are self-efficacy assessments” (p. 75).

A more elaborate model that hypothesizes the relationship between completing math courses beyond the basic high school mathematics core (Algebra I, geometry, and Algebra II) and the affected skills, constructs, and attributes follows:

Figure 2. Revised Hypothesized Model Relating the Relationship of High School Math Courses and Student Development



Cognitive Student Development Theory

This section will explore the relationship of these skills, constructs, and attributes to growth along the cognitive, psychosocial, and moral/ethical dimensions of student development. Cognitive development theory offers a conceptual framework for distinguishing among distinctly separate stages of human development. Postulated to occur in a hierarchical order of permanent, unchangeable steps, cognitive development occurs as a reorganization of mental schema(s) in response to an individual's experiences. Movement toward more advanced stages of cognitive development represents a sequentially advanced developmental outlook that an individual uses for conceptualizing new experiences (Dewey, 1960). Certain experiences are needed at precise moments of the developmental continuum in order to evolve to the next stage (Piaget, 1964).

Cognitive developmental theorists favor explaining development using a structuralist approach first articulated by Piaget (1964). Development occurs as a sequence of irreversible stages that involve changes in the ways that individuals see and reason about the world they live in. The process by which development takes place is believed to be interactive: Individuals are presented with problems, dilemmas, or ideas that cause cognitive conflict (disequilibrium) that cannot be resolved unless a change in cognitive structure(s) occurs (Parker, Widick, & Knefelkamp, 1978).

Almost all student development theories have evolved, in one way or another, from the work of Jean Piaget. Piaget has been labeled as an interactionist as well as a constructivist. He believed that cognitive development occurred as a result of a child's interaction with his/her environment. How stimuli were interpreted and the corresponding responses given in each contextual situation were based on existing schema (mental) structures of knowledge. These existing structures were constructed on the basis of the interaction of prior environmental experiences with existing knowledge. If the responses processed by a child were in line with existing mental structures (the responses were anticipated and made sense), then no change in knowledge was needed. On the other hand, if the responses processed did not fit into existing schema(s) (were not anticipated), then new schema(s) had to be constructed so that assimilation of these responses could be interpreted (Piaget, 1964).

Piaget worked extensively with children and believed they reason differently at different stages in their lives. He postulated that all individuals pass through an unchanging sequence of four qualitatively distinct stages. Piaget argued that all children pass through these stages in exactly the same order, but the ages at which each child passed from stage to stage could vary. The four stages are: (a) *sensorimotor* - birth to two years; (b) *preoperational* - two years to seven years; (c) *concrete operational* - seven years to eleven years; and (d) *formal operational* (abstract thinking) - eleven years and up. Each stage has major cognitive tasks that must be accomplished. In the sensorimotor stage, mental structures are mainly concerned with the mastery of objects. The preoperational stage occurs when the mastery of symbols takes place. Children learn mastery of classes, relationships, numbers, and reasoning in the concrete stage (Piaget, 1964).

Intellectual growth involves three fundamental processes: assimilation, accommodation, and equilibration. Assimilation incorporates new events into preexisting cognitive structures. Children then have to change their existing structures to accommodate the new information. This dual process of assimilation-accommodation enables children to form schema. Equilibration occurs when a child finds himself/herself in balance with the environment, between assimilation and accommodation. When a child experiences a new event, disequilibrium sets in until he/she is able to assimilate and accommodate the new stimuli and thus return to equilibrium. Equilibration is a major factor in explaining why some children advance more quickly in the development of cognitive abilities/skills than do others (Piaget, 1964).

Perry (1970) devised a model of intellectual and ethical development based on a study of college students (eighty-two men and two women). Perry's model reflects the critical joint combination of cognitive and affective perspectives as a student progresses through the challenges of the college experience. Perry believed that in order to navigate this difficult journey, a student needed to develop more complex forms of thought in order to accommodate his/her changing views about the world, his/her discipline/area of study, and self. Perry was convinced that the most powerful learning involved significant qualitative changes that affected how students approached their learning and subject matter. Perry's model breaks down into nine distinct stages (Perry preferred to call them "positions") from which students' views about the world change and evolve. Positions one through five describe the primarily intellectual portion of the model moving from systematic, structural change toward increasing differentiation and complexity. In positions six through nine, the focus changes to resolving issues of identity and commitment in a relativistic world. The nine positions are traditionally grouped into four major categories: (a) *dualism*, (b) *multiplicity*, (c)*contextual relativism* , and (d) *commitment in relativism*.

Dualism (positions 1-2) proposes that students view the world in absolute terms: right or wrong, black or white, etc. Learning situations that involve options or multiple perspectives are confusing. Statements are accepted as fact without question or substantiation.

Multiplicity (positions 3-4) allows students to acknowledge that multiple perspectives to any given topic or problem do exist. However, they cannot adequately evaluate various points of view and believe that all judgments and opinions have merit.

Relativism (positions 5-6) brings individuals to the point developmentally where they recognize that knowledge is contextual and relative. This is the point where the context from which various points of view are made affects how "truth" is established. By the time students reach position six, they begin to realize the need to evolve and endorse their own choices from the multiple "truths" that exist in a relativistic world.

Commitment in Realism (positions 7-9) recognizes that students have progressed developmentally to the point where they establish just who they are (a sense of identity). They are also now able to adequately manage responsibilities and make personal commitments out of a relativistic frame of reference.

The Perry model reflects two central interwoven dynamics: (a) confronting and coping with diversity and uncertainty with respect to new learning, and (b) the evolution of making meaning about learning and one's self. As students confront these different forms of diversity and multiple perspectives, meaning shifts and evolves in predictable ways. They can move from a passive receiver of facts to an active participant in defining arguments and creating new knowledge (Moore, 1991).

Moral/Ethical Student Development Theory

Other theorists such as Lawrence Kohlberg (1969, 1971) and Douglas Heath (1968, 1977) connect moral/ethical development to cognitive development. Their theories have been labeled as cognitive-developmental (Parker, Widick, & Knefelkamp, 1978). Kohlberg based his model on the ideas of Dewey (1939) and Piaget (1965). His work involved studying the moral development of fifty boys ranging in age from ten to sixteen. Kohlberg's research led him to identify three general levels of moral thought with each level consisting of two stages (six stages in all).

Smith (1978) indicates that the key to understanding Kohlberg's theory is grasping the concept of stages of moral development. He describes moral judgment "as proceeding through various stages of development. A moral stage represents a model or structure of thought. Each is qualitatively different in its structure from other stages" (p. 54). Smith goes on to explain, "The structure of moral thought includes such components as the rule or decision-making system, the social perspective, and the underlying logic employed in making a moral choice" (p. 54). An outline of Kohlberg's model follows:

Level 1: Preconventional Level – at this level children respond to cultural rules and the concepts of good/bad and right/wrong. They interpret these concepts in relation to consequences of the action (punishment, reward, exchange of favors) or the physical power of those who set the rules. *Stage 1: Obedience and Punishment* – the first stage of moral thought in which children assume that authorities hand down a fixed set of rules which must be obeyed without question. *Stage 2: Individualism, Instrumentalism, and Exchange* – the second stage in which children recognize that right action consists of what instrumentally satisfies their own needs and occasionally the needs of others.

Level 2: Conventional Level – at this level children are able to perceive that maintaining the expectations of their families, or different groups is valuable in its own right, regardless of immediate and obvious consequences. *Stage 3: Good Interpersonal Relationships* – children behave well because good behavior is what pleases or helps others. Behavior is frequently judged by intention. *Stage 4: Maintaining Social Order* – occurs when individuals become oriented toward authority, fixed rules, and the maintenance of social order. Proper behavior consists of doing one's duty, showing respect for authority, and maintaining the status quo.

Level 3: Post-Conventional Level – individuals make clear efforts to define moral values and principles that have meaning and application apart from authority of a group and from identification with a group. *Stage 5: Social Contract and Individual Rights* – right action tends to be defined in terms of general individual rights and standards that have been critically examined and agreed upon by society. There is a clear awareness of the relativism of personal values and opinions and a corresponding emphasis upon procedural rules for reaching consensus. *Stage 6: Universal Principle Orientation* – individuals establish self-chosen ethical principals and rules that define justice. Justice requires that all individuals be respected and treated with dignity.

Kohlberg believes that each stage emerges as individuals think about moral/ ethical problems. Social experiences do promote development, but they do so by stimulating our mental processes. As individuals discuss and debate with others, they find their views questioned and challenged and, therefore, become motivated to create new, more complex and comprehensive viewpoints. New stages unfold as a result.

Douglas Heath (1968, 1977) contrived a model of "maturity" that is based on trying to identify the processes that are characteristic of a mature person. Knefelkamp, Widick, and Parker (1978) argue, "Heath's model is clearly a developmental theory; however, he uses the term 'maturing' rather than development as his central construct" (p. 79). This model is more complex and comprehensive than many others that address development.

Heath (1968, 1977) took a broad perspective by providing a conceptual scheme that explains and gives order to the many changes that occur as an individual matures. Heath developed a classification scheme that specifies four self-systems and five growth dimensions. The four self-systems are: (a*) intellect*, (b) *values*, (c)*self -concept*, and (d) *interpersonal relationships*. The five developmental growth dimensions are given as: (a) *becoming more able to represent experience symbolically*, (b) *becoming allocentric or other-centered*, (c) *becoming integrated*, (d) *becoming stable*, and (e) *becoming autonomous*.

According to Heath's model, maturing involves movement along the five growth dimensions in each of the four individual self-systems. The self-systems are fairly self-explanatory. The growth dimensions require further explanation. *Becoming more able to represent experience symbolically* means that an individual has increased cognitive capabilities to the point to where he/she can differentiate, examine, and articulate all aspects of life.

In order to pass through the *becoming allocentric* growth dimension, individuals must possess the capacity to see the world through others' eyes, not just their own. This enables people to construct a more complex and realistic picture of their social environment.

When people have passed through the *becoming integrated* growth dimension, they have developed a more unified personality. Individuals at this stage can: (a) think analytically and solve problems, (b) develop a world-view, (c) increase the harmony between behavior and self-image, and (d) become more open and intimate in relationships.

Characteristics of individuals who pass through the *becoming stable* stage include: (a) increasing the capacity to reason under stress, (b) developing more consistently held values, (c) exhibiting less fluctuation in self-images, and (d) expanding capacity to make lasing commitments to other people.

As individuals pass through the last of the five growth dimensions, *becoming autonomous*, they exhibit: (a) an increased ability to make judgments without being unduly influenced by personal biases, (b) the ability to stick to a principled code of behavior, even when threatened or challenged by others, (c) the skills to consider others' points of view while maintaining their own, and (d) the capacity to establish relationships with those who have different needs or loyalties.

In their critique of Heath's model, Widick, Parker, and Knefelkamp (1978) give the opinion that it is essentially one of an adaptive process. The person is viewed as a developing system operated by an internal equilibrium mechanism. If this mechanism becomes unbalanced, then a self-created principle operates to direct the person to try new responses in order to reestablish harmony. The environment interacts with intrinsic cognitive development to move individuals along more mature functionings.

Psychosocial Student Development Theory

Psychosocial theories address developmental issues or tasks and events that occur throughout an individual's lifetime. These tasks and events tend to occur in sequence and are associated with chronological age. Individuals progress through the various stages by accomplishing related developmental tasks or resolving crises. In order for students to be able to examine their own identities, self-concepts, and interactions with the outside world (environment), they must acquire various kinds of substantive knowledge and cognitive competence (Pascarella & Terenzini, 1996). In other words, each environmental context interacts with existing cognitive skills to determine how successful an individual feels he/she will be in resolving a task or event. If existing intellectual capabilities are judged to be insufficient to obtain an acceptable resolution of the current task or event, the individual must rely on adaptive skills to reshape decision-making and behavior accordingly. This interactive process between the person and the environment moves him/her along the various stages of development. The two theorists most prominent in psychosocial developmental theory are Erik Erikson and Arthur Chickering.

Erickson (1959, 1963, 1964) refined and expanded Freud's theory of stages. Unlike Freud, Erickson believed that development did not stop at the end of childhood, but progressed throughout one's lifetime. Erikson postulated eight psychosocial stages that humans encounter during their life. The stages are *Trust vs. Mistrust*, *Autonomy vs. Shame and Doubt*, *Initiative vs. Guilt*, *Industry vs. Inferiority*, *Identity vs. Role Confusion*, *Intimacy vs. Isolation*, *Generativity vs. Stagnation*, and *Integrity vs. Despair*. At each of these stages, biological, cognitive, and social demands interact to create development challenges or "crises." As apparent from the way that Erikson named the stages, each stage presents a polar decision point. At this decision point, an individual has a choice whether to resolve any uncertainty. If unresolved, further development is restricted. Resolution of this uncertainty represents developmental progress and helps to create a new sense of self.

Movement through stages one to four is hypothesized by Erickson to occur between birth and age 11 to 12. Stage one, *Trust vs. Mistrust*, involves an infant's ability to develop trust for a caregiver while learning to discriminate between honest and dishonest persons. Stage two, *Autonomy vs. Shame and Doubt*, occurs in toddlers as they learn to develop a sense of self-control and independence without embarrassment and loss of self-esteem. Stage three, *Initiative vs. Guilt*, is characterized by a child's action to assume some control (responsibility) over his/her life and how he/she deals with the resulting feelings of accomplishment or inadequacy. Stage four, *Industry vs. Inferiority*, occurs between age six and puberty. Learning is now a very active component. Successful learning experiences give a child a sense of industry, competence, and mastery. Unsuccessful learning experiences create a sense of inferiority and inadequacy. Stages one through four are the building blocks that enable a child to reach stage five, *Identity vs. Role Confusion*. During adolescence, individuals struggle to find their true selves. This is the period that the identity concern reaches its climax. Stage six, *Intimacy vs. Isolation*, takes place during young adulthood. Intimacy with other people is possible only if a reasonably well-integrated identity emerges from stage five. Stages seven and eight are postulated to occur between the ages of about 25 to 30 and death; therefore, they will not be discussed here.

Perhaps the most widely known and applied theory of student development is Chickering's psychosocial model (1969). Based on Erickson's identity vs. role confusion stage of development, Chickering proposed seven vectors along which traditionally aged college students develop. This model was refined and updated by Chickering and Reisser (1993). The seven vectors of development are general tasks of identity resolution requiring cycles of differentiation and integration that are stimulated by social interaction.

Developing Competence, the first vector, is characterized by a student's ability to cope with challenges and to achieve goals relating to intellectual, social, and physical skills. The second vector, *Managing Emotions*, occurs when a student's ability to manage emotions of aggression and sex are tested. An individual broadens his/her range of emotions during this stage and becomes increasingly aware of his/her own feelings. Vector three, *Developing Autonomy*, requires both emotional and instrumental independence. As competence develops, the individual decreases dependence on parents and recognizes the importance of others. The first three vectors need to be successfully navigated before a student is ready to progress through vector four, *Establishing Identity*.

Establishing Identity entails creating a sense of self by clarifying physical needs, characteristics, and personal appearance. This sense of self evolves from socially acceptable sexual identification, roles, and behaviors. Vector five, *Freeing Interpersonal Relationships*, moves students developmentally to the point where they can interact comfortably with others. They can now demonstrate tolerance and respect for those of different backgrounds and value beliefs. Relationships are now built on trust, independence, and individuality. Few traditional age students move beyond vector five during the college years. The sixth vector, *Developing Purpose*, involves assessment and clarification of interests and pursuits of many post-college activities. Individuals matriculate into vector seven, *Developing Integrity*, only when they have progressed developmentally to the point where they can define a set of personal values that will guide behavior.

The psychosocial model of student development proposed by Chickering (1969) and Chickering and Reisser (1993) offers that college students progress through the first three vectors simultaneously during their freshman and sophomore years. Progression along the first three vectors is a prerequisite for vector four. Students are believed to generally progress through the fourth vector during their sophomore and junior years. During their junior and senior years, some students may progress simultaneously through the last three vectors. Development is not simply viewed as a maturation process, but requires stimulation through challenge and support.

Summary

Students begin college at varying levels of cognitive, psychosocial, and moral/ethical student development. Intuitively, background and demographic characteristics such as SES, gender, ethnicity, family's level of education, etc. should account for some of the developmental differences. However, the studies conducted by Adelman (1999) and Trusty and Niles (2003) gave evidence that the strong effects of credits in intensive math courses were virtually independent of such influences. Adelman stated:

> The only demographic variable that remains in the equation at its penultimate iteration is socioeconomic status, and by the time students have passed through their first year of college, SES, provides but a very modest contribution to

> eventual degree completion. No matter how many times (and in different formulations) we try to introduce race as a variable, it does not meet the most generous of threshold criteria for statistical significance. (p. vi)

Trusty and Niles (2003) addressed the relationship between background characteristics, intensive math courses, and degree completion. They commented:

> These strong effects of credits in intensive math courses were independent of the influences of eighth grade reading and math ability, gender, SES, and racial-ethnic group membership. Early math ability did have an influence on math course-taking in high school. That is, students with higher ability tended to finish more intensive math courses. However, the positive effects of math course-taking on bachelor's degree completion extended well beyond the influences of early math ability; this finding adds to earlier findings of Adelman. (p. 103)

In this study, the developmental differences in students that affect retention/attrition/persistence, completion, or non-completion of a bachelor's degree are hypothesized to be influenced, at least in part, by the development of skills, constructs, and attributes necessary to move individuals forward along the cognitive, psychosocial, and moral/ethical dimensions of student development. This is posited to be the result of enhanced cognitive skills that are shaped by the intellectual demands and requirements of completing intensive, rigorous, advanced math courses.

What ties the proposed retention/attrition/persistence models of Tinto (1975), Astin (1977), Pascarella and Terenzini (1980), and Bean and Eaton (2000) to this study? All these theorists argue, to varying degrees, that both academic preparation and development of attributes and intellectual capabilities are necessary in order for students to face and overcome adversity during college.

Literature gives a guide on how the attributes of locus of control, motivation, goal setting, performance, achievement, conscientiousness, resiliency, persistence, discipline, time-on-task, and coping skills are developed. The growth of critical thinking, recall, decision-making, and problem solving skills promotes self concept, self-confidence, and self-efficacy beliefs that enhance attribute development. Of all high school course curricula, mathematics is generally the most cognitively demanding and challenging. Math courses beyond the basic high school mathematics core of Algebra I, geometry, and Algebra II provide the mental stimulation needed to advance critical thinking, recall, decision making, and problem solving skills.

Cognitive growth and attribute development are the key to upward movement along the stages/positions/vectors/dimensions of cognitive, psychosocial, and moral/ethical student development. All of the student development theorists discussed in this study argue that cognitive growth is necessary to accommodate the new schema structures needed to resolve "disequilibrium" or unfamiliar/unanticipated responses to environmental/contextual situations. This study posits that as a result of completing advanced math courses in high school, students enhance/refine cognitive skills that enable them to restore cognitive balance when confronted with social situations/life experiences to which existing schema structures cannot accommodate. Existing beliefs/values serve as a guide to how students respond to social situations/life experiences (Kohlberg, 1972). If existing beliefs/values are inappropriate/inadequate to respond suitably to various social situations/life experiences, then enhanced/refined cognitive skills enable students to develop new schema (a result of the experience gained while working through the rigors of intensive, upper-level math classes) which empowers them to modify their belief/value systems so that they are able to respond appropriately in such situations.

Piaget (1964) spoke of how the environment can create dissonance or disequilibrium. If individuals are confronted by environmental stimuli that cannot be handled by existing constructs, they are forced to alter their cognitive structures in order to accommodate more complexity. Too much challenge can be overwhelming, causing stage stagnation and inhibiting growth. Kohlberg (1972) wrote about the level of cognitive development required to handle the increasing complexity of information and the reasoning needed to advance to the next stage of moral development. If this level of cognitive development is not present, then movement to the next stage is not possible.

Working through episodes of "disequilibria" is necessary for growth and maturity. Those individuals who have better developed attributes, which enhance coping skills, are better prepared to work through the dissonance to equilibrium process. These individuals would be the students who are postulated to be more likely to persist and complete college. Is there any other high school curricula area that causes more feelings of anxiety, ambiguity, inadequacy, and uncertainty (disequilibrium) than intensive, upper-level mathematics? As students work through dissonance events created as they engage in studying such courses, perhaps they become better equipped to navigate traumatic episodes that occur outside of the academic realm. This helps advance students further along the cognitive, psychosocial, and moral/ethical dimensions of student development before they get to college and are more likely to overcome the challenges and “disequilibrium” associated with the college experience. Bandura (1993) addressed the link between skill (attribute) development and growth or maturity in individuals. “People motivate and guide their actions through proactive control by setting themselves challenging goals that create a state of disequilibrium. Then they mobilize their skills and effort to accomplish what they seek” (p. 132). It is the intent of this study to investigate whether a relationship exists between completing intensive math courses in high school and advancement along the cognitive, psychosocial, and moral/ethical dimensions of student development. Students who are more advanced developmentally are posited to possess the skills, efficacy beliefs, and attributes needed to increase their chances of persisting and completing a college degree.

CHAPTER III

METHOD AND DESIGN

The purpose of this study is to explore a theoretically derived proposition based on the findings of Adelman (1999) and Trusty and Niles (2003). Both studies found statistical evidence that completing a high school mathematics course beyond Algebra II (traditionally the last class taken in the basic high school mathematics core) was the single greatest predictor of bachelor's degree completion—even more so than both background characteristics (SES, gender, and race) and academic preparation in other curricular areas. Why? What is it about completing rigorous math courses in high school that relates to those students who persist and obtain a college degree?

In this study it is hypothesized that high school students who complete higher level math courses have enhanced/refined cognitive skills, which enable them to develop attributes necessary for upward movement along the cognitive, psychosocial, and moral/ethical dimensions of student development. Students who are further advanced along these developmental dimensions are better prepared to meet and overcome the challenges and opportunities encountered during college. Part of this study is designed to investigate the relationship that a student's terminal high school math course has with a general cognitive/academic ability/skill measure, the ACT Assessment composite score. It is important to first determine if a significant relationship exists between the level of terminal math course a student completes in high school and his/her general cognitive/ academic skill level. This is an integral part of the hypothesis that those students who demonstrate advanced cognitive skills should also score higher on various aspects of psychosocial and moral/ethical student development. Accordingly, this study also proposes that the level of mathematics a student completes in high school correlates with the scores that measure different components of his/her psychosocial and moral/ethical student development. The final research question seeks to examine the relationship(s) that both gender and terminal math course completed have with scores that measure various elements of a student's psychosocial and moral/ethical student development.

Research Questions

1. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with general cognitive skill level?
2. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with psychosocial student development?
3. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with moral/ethical student development?
4. Does gender have a statistically significant relationship with the scores that measure psychosocial and moral/ethical student development when evaluated alone (tested as a main effect) or in combination with completion of intensive mathematics courses beyond the basic high school mathematics core (tested as an interaction effect)?

Participants

This study was conducted at a small to medium-sized regional university. The university is located in a rural area, is state-sponsored, and has an undergraduate enrollment of about 5,000 students. This university was selected because it would provide a larger pool of targeted participants for the study. This study targets students whose terminal mathematics course in high school was the last class in the basic high school mathematics core curriculum of Algebra I, geometry, and Algebra II or beyond (such as Algebra III, trigonometry, math analysis, statistics, pre-calculus, and calculus). The admission requirements at a comprehensive university are different from those at a regional university. At a comprehensive university, the terminal high school math course for the vast majority of students would most likely come from Algebra III, trigonometry, math analysis, statistics, pre-calculus, or calculus. This would eliminate the pool of students whose terminal math class was the last one in the basic high school mathematics core (traditionally Algebra II) from the study. Sampling procedures were conducted only after obtaining approval from the university's Human Subjects Review Board (see Appendix B) and the Oklahoma State University Institutional Review Board (see Appendix A).

The population of interest included all traditional, full-time freshman students (first time students who were enrolled in at least 12 hours) who began their college experience in the fall of 2005. The students completed form 1.99 of the Student Developmental Task and Lifestyle Assessment or SDTLA (Winston, Miller, & Cooper, 1999) and a demographic survey (see Appendix E). The best, most systematic way to administer both instruments to the targeted pool of students was to give them in

Freshman Orientation classes. This suggested that cluster sampling be used to select participants from the population. Written permission was obtained from the university's Provost (where the study was conducted) to approach the instructors of the Freshman Orientation classes on an individual basis and to administer the survey instruments used in this study (the SDTLA and the demographic survey) in only those classes where the instructors agreed to do so. The survey instruments took approximately 30 to 35 minutes to complete.

In the fall of 2005, there were 33 sections of freshmen orientation classes at the university where the study was conducted. The survey instruments were given in 19 of the 33 freshman orientation classes (58 percent). The total number of freshmen in the target population was 748. Three hundred six freshman students (41 percent of the target population) completed the SDTLA and the demographic survey during the first eight weeks of the fall 2005 semester. Ten sets of student responses were eliminated from consideration because either all questions on the SDTLA were not completed or the response pattern to the questions on the SDTLA gave very vivid visual evidence that the students did not use due diligence when answering. Out of the 296 sets of responses that were left, another six were omitted from the study because the students scored four or higher (out of a possible six) on the *Response Bias Scale,* which is a part of form 1.99 of the SDTLA. Students who score high on this scale have most likely portrayed themselves in a manner that is beyond realistic expectations. Winston, Miller, and Cooper (1999) suggest that any student who scores higher than three on this scale be eliminated from the sample because validity on the assessment is suspect and probably does not accurately describe the student. The data from the remaining 290 sets of student responses (39 percent of the target population) was used for analysis in this study. Data from only those students whose terminal math course was the last class in the basic high school mathematics core of Algebra I, geometry, and Algebra II or beyond (such as Algebra III, trigonometry, math analysis, statistics, pre-calculus, and calculus) were included in this study. This excluded any students who, for some reason, did not complete the basic high school mathematics core classes required by the state in which the study was conducted.

Tables 2 compares the ACT Assessment composite scores of the sample of students included in this study to the target population of the fall 2005 freshman class (broken out by gender and by total) at the university where the study was conducted. Table 3 compares the ethnic breakdown of the sample of students included in this study to the population of the fall 2005 freshman class from which the sample was taken. Included in Table 3 is a comparative listing of the proportions of ethnicities represented in the Trusty and Niles (2003) study. Table 4 gives a listing of the academic majors declared by the sample of 290 students included in this study. These tables are provided in order to demonstrate that a representative sample of the population was obtained for use in this study.

Table 2

Mean ACT Composite Scores: Comparison of the Sample of First-Time, Full-Time Freshmen Students Used in This Study to the Population From Which the Sample Was Taken (Standard Deviations Given In Parentheses).

	Males	Females	Total
Population	22.23 (4.72) N = 359	22.27 (4.56) N = 389	22.25 (4.61) N = 748
Sample	22.21 (4.83) n = 130	22.14 (4.22) n = 160	22.17 (4.50) n = 290

Source of Population Information: SWOSU Office of Institutional Research

One sample Z-tests (Bartz, 1988) were conducted to determine if there were statistically significant differences between the sample statistics in Table 2 and the corresponding population parameters. In each comparison (by males, by females, and by total), no significant differences were found ($\alpha = .05$). Even though the proportion of males in the sample (44.83 percent) was different from that in the population (48.00 percent) and the proportion of the females in the sample (55.17 percent) was different from that in the population (52.00 percent), there was no evidence to indicate that the sample was not representative of the population.

Table 3

Ethnic Group Representation: Comparison of the Sample Used in This Study to the Population From Which the Sample Was Taken and to the Sample Used in the Study Conducted by Trusty and Niles (2003).

	Percentage of Students in Each Ethnic Group		
Ethnic Group	Sample	Population	Sample (Trusty and Niles)
African American (Black)	7%	7%	11%
Asian	4%	3%	5%
Caucasian (White)	77%	78%	74%
Hispanic	4%	5%	9%
Native American	8%	7%	1%
Sample Size	n = 290	N = 748	n = 5257

Again, one sample Z-tests (Bartz, 1988) were conducted to ascertain if there were statistically significant differences between the proportions of ethnic categories represented in the sample of students used in this study and the population from which the sample was taken. The results indicated no differences ($\alpha = .05$). The proportions of ethnicities involved in this study appear to match favorably with those reported by Trusty and Niles (2003). The only exceptions would be the apparent under-representation of Native Americans and over-representation of Hispanics in the Trusty and Niles study (which used a national sample) in comparison to the Native American and Hispanic populations from the state in which the study was conducted.

Table 4

Breakdown of the Declared Academic Majors of the 290 Students Included in This Study.

College	Major Declared	Number of Students	Percentage
Arts and Sciences			
	Art	0	0.00%
	Biology	16	5.52%
	Chemistry	6	2.07%
	Communication Arts	0	0.00%
	Criminal Justice	4	1.38%
	Engineering Physics	4	1.38%
	Engineering Technology	2	0.69%
	English	4	1.38%
	Graphic Design	0	0.00%
	History	0	0.00%
	Mathematics	7	2.41%
	Music (Education, Performance, and Therapy)	7	2.41%
	Political Science	0	0.00%
	Total	50	17.24%
Graduate and Professional Studies			
	Athletic Training	9	3.10%
	Business	22	7.59%
	Computer Science	9	3.10%
	Education	21	7.24%
	Health and Physical Education	3	1.04%
	Industrial Technology	0	0.00%
	Nursing and Health Sciences	27	9.31%
	Park and Recreation Management	0	0.00%
	Physical Therapy	17	5.86%
	Pre-Medicine	13	4.48%
	Psychology	12	4.14%
	Total	133	45.86%
Pharmacy		58	20.00%
Undecided		41	14.14%
Other (The major declared by the student was not offered at the university.)		8	2.76%

Table 4 (Cont.)

Grand Totals	290	100.00%

Table 4 gives an indication of a distribution that is not to heavily skewed toward majors that require a solid mathematics background (sciences, medicine, business, etc.). The distribution of declared academic majors also appears to not be skewed toward majors that require very little, if any math background (language arts, education, performing arts, etc.). Because of the high number of students who did not declare a major (undecided) and the few students who declared majors that were not offered at the university where the study was conducted (evidently, these students knew that they would eventually transfer to a institution that offered a degree in the field of study that they listed), it was not feasible for comparison purposes to obtain a breakdown of the academic majors declared for all 748 first-time, full-time freshman students who represented the target population for this study.

If the majority of students in the sample had indicated that they were pursuing degrees in majors that required an advanced mathematics background, the results of this study most likely would have been marginalized. The hypothesis of this study is dependent upon the premise that completion of rigorous, intensive high school math courses correlate with enhanced cognitive skills which enable students to advance along the cognitive, psychosocial, and moral/ethical dimensions of student development before attending college. Therefore, it was only prudent when sampling to determine if the sample included a balance of students who needed upper-level math courses in high school in order to pursue the degrees of their choice with a similar number of students who did not need such math courses in order to study in their chosen academic fields.

Instruments

Two instruments were used in this study. The *Establishing and Clarifying Purpose Task* score, the *Developing Autonomy Task* score, and the *Developing Mature Interpersonal Relationships Task* score from form 1.99 of the SDTLA (Winston, Miller, & Cooper, 1999) were used to assess each student's level of psychosocial student development. Included in the SDTLA are the *Lifestyle Planning Subtask* and the *Salubrious Lifestyle Scale* scores, which were used as measures of moral/ethical student development in this study.

The second instrument that provided data for this study was the American College Testing (ACT) Assessment (American College Testing Services, 1997). The ACT consists of four subtests (English, Mathematics, Reading, and Science) of educational development and cognitive/academic skill/ability. The ACT Assessment composite score (the average of the four subtests) was used in the data analysis. The score scales for the ACT Assessment range from 1-36 on the four main subtests and on the composite score. The ACT Assessment composite score was used as a measure of each student's general cognitive aptitude/skill level. Even though the use of the ACT Assessment composite score as a measure of cognitive aptitude/skill level may be questioned because there is some overlap as to what the ACT Assessment measures (ability versus achievement), it was the best assessment of the construct that could be obtained due to the time constraints and the limited access to data under which this study was conducted. It is reasonable to use the ACT Assessment as a measure of cognitive aptitude/skill level because of the relationship it has with the SAT (Scholastic Assessment Test) and the correlation the SAT has with IQ. Frey and Detterman (2003) conducted two studies to establish the relationship between the SAT and g (general intelligence, or IQ). In the first study, they examined existing records of 11,878 students who had taken the Armed Services Vocational Battery, recognized in 1979 as a probe of IQ. Nine hundred seventeen of those students had also taken the SAT. The results of the two tests correlated very closely (estimated to be .86). In the second study, Frey and Detterman gave the Raven Test of Progressive Matrices (a very abstract IQ test that tests pattern recognition) to 104 Case Western students who had valid SAT scores on file. The correlation between those two sets of scores was reported to be .72. Frey and Detterman believe that the results of the studies indicated that the SAT is mainly a test of IQ. The SAT I has been shown to be highly correlated with the ACT. Dorans (1999) reported that correlations between SAT I and ACT scores range from .89 to .92. Using the ACT Assessment composite score as a measure of general cognitive aptitude/skill level was not ideal, but should suffice for this study.

Another proxy measure, the ACT Mathematics Usage Test score was used as a measure of mathematical aptitude/ability in this study. The ACT Assessment Technical Manual (American College Testing Services, 1997) and O'Hearn (1984) describe the ACT Mathematics Usage Test as measuring both math ability and achievement. Studies conducted by Loyd and Sebastain (1984) and Heritage, Harper, and Harper (1990) used the ACT Mathematics Usage Test as a measure of math aptitude/ability. Even though the ACT Mathematics Usage Test may not have been the best measure of a student's mathematical aptitude/ability, it should suffice for use in this study considering the time constraints and limited availability of data.

Student Developmental Task and Lifestyle Assessment (SDTLA)

The Student Developmental Task and Lifestyle Assessment (Winston, Miller, & Cooper, 1999) is a multifaceted instrument designed to measure psychosocial student development. The current SDTLA instrument is in its fourth edition. Three major revisions have taken place since the instrument (originally called the Student Developmental Task Inventory or SDTI) was originally published in 1974 (Prince, Miller, & Winston, 1974). The scrutiny the SDTLA has received during its revisions strengthens its choice as an appropriate instrument to measure the moral/ethical and, more specifically, the psychosocial dimensions of student development. The theoretical work of Chickering and Reisser (1993), as presented in *Education and Identity*, was a major influence in developing the current form of the SDTLA. The seven developmental vectors postulated by Chickering (1969) and revised by Chickering and Reisser provide the basis from which the SDTLA was developed. Form 1.99 of the SDTLA is made up of 153 items that assess three developmental tasks and two scales. The three developmental tasks are defined by subtasks. For the purpose of the SDTLA, a developmental task can be defined as an interrelated set of behaviors and attitudes that society expects to be exhibited by students at a specific age in a given context. A subtask is a more specific component or part of a larger developmental task. A scale in the SDTLA is a measure of the degree to which individuals report possessing certain behavioral characteristics, attitudes, or feelings that may not be affected by the college experience.

The *Establishing and Clarifying Purpose Task* (PUR) is comprised of four subtasks: *Educational Involvement* (EI), *Career Planning* (CP), *Lifestyle Planning* (LP), and *Cultural Participation* (CUP). The *Developing Autonomy Task* (AUT) is comprised of four subtasks: *Emotional Autonomy* (EA), *Interdependence* (IND), *Academic Autonomy* (AA), and *Instrumental Autonomy* (IA). The *Mature Interpersonal Relationships Task* (MIR) is comprised of two subtasks: *Peer Relationships* (PR) and *Tolerance* (TOL). The two scales are the *Salubrious Lifestyle Scale* (SL) and the *Response Bias Scale* (RB).

Establishing and Clarifying Purpose Task (PUR)

This task is designed to measure to what degree students (a) have defined educational goals and are active, self-directed learners, (b) have organized knowledge about themselves and vocational opportunities into career plans and have begun to construct career goals, (c) have used personal, ethical, and religious values to develop a personal direction for their lives, and (d) have established cultural interests.

Educational Involvement Subtask (EI). Students who score high on this subtask have well-defined educational goals and plans. They are active learners and take the initiative to pursue educational experiences that match their perceived skills and abilities.

Career Planning Subtask (CP). High scores on this subtask indicate that students have an accurate understanding of their own vocational skills and abilities and how to use them to become successfully integrated into the work force. These students are aware of what steps need to be taken in order to be an active participant in their chosen career fields.

Lifestyle Planning Subtask (LP). This subtask measures how well students are using personal, ethical, and religious values to establish personal directions, future relationships/family plans, and educational objectives. Scores on this subtask were used as one of the measures of moral/ethical student development.

Cultural Participation Subtask (CUP). Students who score high on this subtask demonstrate a wide variety of cultural interests and are actively involved in activities that continue to develop and promote cultural involvement.

Developing Autonomy Task (AUT)

Students are evaluated as to how well they (a) are able to meet their own needs and take action on their own without reassurance, (b) can successfully integrate into and live in their environment without extensive direction or support from others, (c) manage their time in order to be productive in daily activities without outside guidance, and (d) act as responsible contributing members of their community, recognizing the interactive relationship between their environments and themselves.

Emotional Autonomy Subtask (EA). This subtask is designed to measure how well students have freed themselves from the need to be constantly reassured by others. They trust their own ideas and feelings and have enough self-confidence to no longer need continuous approval from others. Students who score high on this subtask have confidence in their abilities and are prudent risk-takers.

Interdependence Subtask (IND). Students who have high scores on this subtask are responsible citizens. They understand the importance of the relationship they have with their environments. They are actively involved in institutional and commnity activities.

Academic Autonomy Subtask (AA). This subtask is designed to assess how well students can deal with the ambiguity and difficulty of academic demands in college. High scores indicate the ability to devise and execute effective study habits and to accomplish academic objectives.

Instrumental Autonomy Subtask (IA). Higher scores on this subtask indicate that students are able to structure their lives and manipulate their environment in such ways that allow them to address daily needs and responsibilities without much outside help. These students are independent, goal-directed, and self-sufficient.

Mature Interpersonal Relationships Task (MIR)

This task assesses the extent to which students have open, honest, and trusting relationships with peers and show respect and acceptance of those who are culturally diverse.

Peer Relationships Subtask (PR). This subtask measures how well students can manage relationships with peers. Individuals show greater trust, independence, frankness, and individuality. Relationship skills have evolved to the point that friendships survive differences in activities, beliefs, and values.

Tolerance Subtask (TOL). Students' abilities to accept and respect different cultural backgrounds and beliefs are assessed. Students who score high on this subtask are open and accept other people as individuals, regardless of ethnic, racial, religious, or political differences.

Salubrious Lifestyle Scale (SL)

This scale measures the degree to which a student's beliefs match his/her lifestyle, especially in regards to good health and wellness practices. Scores on this scale was also used as a measurement of moral/ethical student development.

Response Bias Scale (RB)

A high score on this scale indicates that a student has attempted to portray himself/herself in a manner that is beyond realistic expectations. Scores higher than three indicate that the validity on the assessment is suspect and probably does not accurately describe the student. Winston, Miller, and Cooper (1999) suggest that students who score from four to six on this scale be eliminated from any analysis.

Reliability and Validity of the SDTLA

Table 5 gives the test-retest reliability and the internal consistency (Cronbach alpha coefficients) reliability estimates for each task, subtask, and scale score of the SDTLA. This helps in ascertaining if it is appropriate to use any of the task, subtask, or scale scores independently for analysis purposes (Winston, Miller, & Cooper, 1999). The normative sample of students used to calculate the reliability and validity estimates for each task, subtask, and scale score for the current version of the SDTLA came from a large group of students (n = 1822) enrolled at 32 colleges in the US and Canada. Even though the normative sample produced reliability estimates ranging from .93 to .62 (see Table 5 below), it must be remembered that these reliability coefficients are only estimates. Calculated values for reliability are sample specific and can vary from sample to sample (Crocker & Algina, 1986). Pedhazur and Schmelkin (1991) argue that the relevant reliability estimate is the one calculated from the sample used in the study under consideration. Therefore, as suggested by Thompson and Vacha-Haase (2000), this study will report both the reliability estimates from the normative sample (given in Table 5 below) as displayed in the *Preliminary Technical Manual for the Student Developmental Task and Lifestyle Assessment* (Winston, Miller, & Cooper, 1999) and the reliability coefficients calculated from the scores on the SDTLA obtained from the sample used in this study (also given in Table 5 below).

Table 5

Reliability Estimates for the SDTLA

Task/Subtask/Scale	Coefficient Alpha (Normative Sample)	Test-Retest (Normative Sample)	Coefficient Alpha (From This Study)
**Establishing and Clarifying Purpose Task* (PUR)	.81	.84	.87
Career Planning Subtask (CP)	.84	.89	.76
*Lifestyle Planning Subtask (LP)	.81	.80	.77
Educational Involvement Subtask (EI)	.82	.79	.81
Cultural Participation Subtask (CUP)	.76	.79	.72
**Developing Autonomy Task* (AUT)	.88	.81	.77
Emotional Autonomy Subtask (EA)	.71	.75	.61
Instrumental Autonomy Subtask (IA)	.62	.78	.62
Academic Autonomy Subtask (AA)	.77	.74	.73
Interdependence Subtask (IND)	.76	.80	.59
**Developing Mature Interpersonal Relationships Task* (MIR)	.76	.79	.65
Tolerance Subtask (TOL)	.74	.78	.65
Peer Relationships Subtask (PR)	.65	.73	.56
**Salubrious Lifestyle Scale* (SL)	.71	.77	.73
Response Bias Scale (RB)	.72	.93	.44

*These task, subtask, and scale scores are used as dependent variables in this study.

The reliability (coefficient alpha) estimates calculated from this studies' sample of 290 responses indicate that the variables (task and subtask scores of the SDTLA) used in this study have adequate reliability. Two of the task scores used in this study, the *Establishing and Clarifying Purpose Task* and the *Developing Autonomy Task* both produced sample specific reliability (coefficient alpha) estimates comparable to that reported from the normative sample (.87 and .77, respectively). The coefficient alpha reliability estimate for *Developing Mature Interpersonal Relationships Task* from the sample used in this study was calculated to be .65. That may be a little low (compared to the .76 calculated from the normative sample), but the difference in the two estimates may be attributed to the differences in the ages of the students used in the normative sample versus those used in this study. Chickering (1969) and Chickering and Reisser (1993) postulate that students advance to the fifth vector, *Freeing Interpersonal Relationships*, sometime during their junior or senior year of college. (Note: The *Developing Mature Interpersonal Relationships Task* from the SDTLA is based on Chickering and Reisser's fifth vector of psychosocial student development.) Since the students sampled for this study were all traditional, first-time, full-time freshmen that had been in the college environment less than eight weeks, it is highly unlikely that this variable will reach statistical significance when tested. Therefore, because of the moderate reliability coefficient alpha estimate of .65 calculated from the sampled used in this study, any statistically significant results that involve the *Developing Mature Interpersonal Relationships Task* score should be interpreted with great care.

The other two variables that come from the SDTLA and were used in this study are the *Lifestyle Planning Subtask* and the *Salubrious Lifestyle Scale.* Both produced sample specific coefficient alpha estimates that were very comparable to those produced from the normative sample. Several reliability estimates from the task, subtask, and scale scores of the SDTLA that were generated by the responses of the students used in this study were below the generally accepted cutoff of .70. However, none of those task, subtask, and scale scores were included as variables in this study (except for the *Developing Mature Interpersonal Relationships Task* score, which was discussed above).

Therefore, it appears that the reliability estimates calculated from the sample used in this study are sufficient for reliability generalization purposes.

Construct validity for the SDTLA was assessed by correlating each individual task and its accompanying subtasks with other scales that were designed to measure similar constructs. Validity of the *Salubrious Lifestyle* (SL) was estimated by correlating it with a generated group of items (Wellness Scale) thought to measure the same things as the SL scale. The SL was found to correlate with this Wellness Scale: $r = .54$ ($n = 119$, $p < .00l$). The *Response Bias* (RB) scale was correlated with the Marlowe-Crowne Social Desirability (SD) scale (Crowne & Marlowe, 1960) in order to assess its validity. The correlation between the SD and RB scales was reported as $r = .83$ ($n = 46$, $p < .01$). Any additional information regarding reliability or validity estimates can be obtained from the SDTLA technical manual (Winston, Miller, & Cooper, 1999).

American College Testing (ACT) Assessment

The other instrument used in this study to obtain data on students is the American College Testing (ACT) Assessment. The ACT program has long been recognized as a valid and reliable method of predicting future success at the post-secondary level (American College Testing Services, 1997). The ACT consists of four tests of educational development: English, Mathematics, Reading, and Science Reasoning. These tests are designed to “determine how skillfully students solve problems, grasp implied meanings, draw inferences, evaluate ideas, and make judgments in subject-matter areas important in college” (p. 2). The ACT assessment is designed to encourage students to acquire the skills necessary to perform complex college-level work and to integrate knowledge from a variety of sources. The ACT Assessment “may serve to aid high schools in developing in their students the higher-order thinking skills that are important for success in college and later life" (p. 2). These are the cognitive skills (referred to in Chapter 2) needed to enhance efficacy and self-concept beliefs, which develop the attributes necessary to move students along the cognitive, psychosocial, and moral/ethical dimensions of student development.

The ACT Assessment was revised and updated in 1989 in response to changes in high school curriculum and to expectations regarding the skills and knowledge that students need for college. The "Enhanced" ACT Assessment is comprised of four tests of educational development that include: (a) a 75-item English Test covering six elements of effective writing and yielding subscores in usage/mechanics (40 items) and rhetorical skills (35 items); (b) a 60-item Mathematics Test that provides subscores in pre-algebra/elementary algebra (24 items), intermediate algebra/coordinate geometry (18 items), and plane geometry/trigonometry (18 items); (c) a 40-item Reading Test measuring recall and reasoning comprehension with subscores in social studies/sciences (20 items) and arts/literature reading skills (20 items); and (d) a 40-item Science Reasoning Test that conveys science information in three different formats: representation (15 items), research summaries (18 items), and conflicting viewpoints (7 items). The fundamental idea underlying the development and use of these tests is to measure as directly as possible the skills needed to perform college-level work (American College Testing Services, 1997).

The hypothesis posited in this study is that the completion of rigorous, upper-level math courses correlates to enhanced cognitive skills (critical thinking, recall, decision-making, and problem-solving). Consequently, students with enhanced cognitive skills are able to develop efficacy and self-concept beliefs necessary to perpetuate key attributes needed in student development. For this reason, the ACT Assessment composite score measures a key variable in this study. One of the concerns of using ACT Assessment composite scores (or individual scores on the four tests of individual development) in this study relates to when each student actually took the ACT Assessment. The ACT is given five times a year on a national basis and students can take a "residual" ACT whenever they can schedule it. Not every student will take the ACT Assessment at the same time, nor will every student take it the same number of times. This characteristic of the participants involved in this study makes differential selection a threat to internal validity (Gay & Airasian, 2000). In order to best control for this confounding influence, only ACT Assessment composite scores from a national testing date will be used and the highest reported ACT Assessment composite score will be used for all students.

Extensive work has been done in obtaining evidence for the reliability and validity of the ACT. The median score reliabilities for each of the four tests of educational development and the overall average composite score are reported to range from .86 to .96. The median SEMs (Standard Error of Measurement) for each of the four tests and the composite score are reported to range form .88 to 2.20. These scale score summary statistics were produced with examinee scores obtained from the five national ACT Assessment administrations during the 1995-96 academic year and were based on systematic samples of 2,000 examinees per administration (American College Testing Services, 1997).

Validity measures for the ACT are estimated three different ways: content validity, predictive validity, and construct validity. Establishing content validity is an ongoing process with the ACT, as test development procedures include an extensive review process. Detailed test specifications have been developed to ensure that each test is representative of current high school and college course work. Ways in which predictive validity assessments of the ACT have been conducted include establishing relationships between ACT Assessment scores and first-year college course grades and GPA, high school course grades and GPA, and course placement/admission decisions. Construct validity has been estimated by correlating ACT test scores with high school grades (American College Testing Services, 1997) and with other educational test, such as the Scholastic Aptitude Test (SAT). Correlations between SAT I and ACT scores are reported to range from .89 to .92 (Dorans, 1999). The ACT Assessment (the four tests and the composite score) has consistently demonstrated high reliability and validity (Passow, 1995). Any additional information regarding reliability or validity estimates for the ACT and its four tests of educational development can be obtained from the ACT Assessment Technical Manual (American College Testing Services, 1997).

Demographic Questionnaire

A brief questionnaire was attached to the SDTLA in order to obtain demographic and other information of interest related to the study (see Appendix E). The information requested included asking each student to identify his/her age, gender, ethnicity, self-reported high school GPA, last math class completed, and intended college major. In addition, the students were asked to supply a reason why they took their terminal mathematics class, how many leadership positions they held during high school, and the highest level of education for each parent.

Procedure

The researcher made a presentation in each of the 19 freshman orientation classes (that the instructors gave their permission) in order to explain the purpose of the study, encourage student participation, and answer any questions that students had about the study. A scripted protocol was used in order to ensure that all relevant areas of concern were addressed (see Appendix C). The instruments and pencils were provided to all students who, after hearing the protocol, indicated that they wanted to participate. Two copies of the informed consent were attached to each scantron answer sheet. Students who considered participating were asked to read the top copy and then, if willing to continue, tear it off and keep it as their copy. The students were asked to sign and date the second copy (still attached to the scantron answer sheet) that was kept as part of the researcher's records. This was done in order to enable the researcher to compile a list of students to be forwarded to the Registrar's Office. The Registrar at the institution where the study was conducted agreed to have his office produce copies of students' transcripts from the list provided by the researcher as mentioned above. By examining the copies of the students' transcripts, the researcher was able to identify which students met the sampling criteria previously described. Once those students were identified, each student's ACT Assessment composite score, gender, and last math course completed were obtained from his/her high school transcript. Information about each student's intended college major and ethnicity were self-reported on the demographic survey.

Research Design/Data Analysis

This study attempts to explore whether a relationship exists among the variables of interest. Therefore, the basic research framework from which this study was conducted was a correlational design. The focus of this project was to answer the four research questions posed at the beginning of this chapter. Other ancillary issues were addressed, depending upon the results obtained from the analysis of the data.

The first research question was designed to investigate the relationship between a student's terminal math course in high school and his/her general cognitive skill level (measured by using a student's ACT Assessment composite score). It is hypothesized that students who complete intensive, rigorous math classes beyond the traditional high school mathematics core of Algebra I, geometry, and Algebra II have enhanced/refined/ sharpened cognitive skills. These refined cognitive skills translate to better-developed critical thinking, problem solving, recall, and decision-making skills. These skills are needed in order for students to reach a level of attribute maturation necessary to advance along the psychosocial and moral/ethical dimensions of student development before college. If a significant relationship between the terminal math course a student completes in high school and his/her level of cognitive skills cannot be established, then the model presented in Figure 1 (page 40 in Chapter 2) may not be accurate as posited and the premise upon which this study is based needs to be revised.

If a significant relationship between a student's terminal math course in high school and his/her general cognitive skill level is established, then the focus of this study shifts to an evaluation of whether the terminal math course a student completes in high school has a significant relationship with the variables selected as measures of a student's psychosocial (research question #2) and moral/ethical (research question #3) student development. The dependent variables used are the *Mature Interpersonal Relationships* (MIR) *Task* score, *Developing Autonomy* (AUT) *Task* score, and *Establishing and*

Clarifying Purpose (PUR) *Task* score from the SDTLA (serving as measures of psychosocial student development – research question #2) and the *Lifestyle Planning* (LP) *Subtask* score and *Salubrious Lifestyle* (SL) *Scale* score from the SDTLA (measuring moral/ethical student development – research question #3). The other dependent variable (as hypothesized) was the ACT Assessment composite score (used for research question #1). The terminal mathematics course a student completed in high school (three groups/categories/levels: completion of the basic high school mathematics core through Algebra II – level 1, Algebra III, trigonometry, math analysis, statistics, or pre-calculus – level 2, or calculus – level 3) and gender (used for research question #4) were the independent variables used in this study.

Students completed the SDTLA during the first eight weeks of the fall 2005 semester. Therefore, history and maturation should not have been threats to internal validity. The most serious threat to external validity was selection-treatment interaction (Gay & Airasian, 2000). There is little doubt that the students sampled for this study differed on key characteristics (SES, parent's level of education, reading and math ability, etc.) depending upon what level of terminal math course they completed (level 1, level 2, or level 3 as previously described). The most serious issue in this study was how to control for those initial differences. The limited availability of the students to fill out questionnaires/surveys/assessments and confidentiality concerns made it nearly impossible to obtain data on SES and pre-high school math and reading ability (this information was not on their high school transcripts). Therefore, it was difficult to control for these initial differences in this study. It should be mentioned that the study conducted by Trusty and Niles (2003) did control for the background variables of SES, race/

ethnicity, eighth grade reading ability, and eighth grade mathematics ability. In the discussion and implications section of their paper, Trusty and Niles commented, “these strong effects of credits in intensive math courses were independent of the influences of eighth grade reading and math ability, gender, SES, and racial-ethnic group membership” (p. 103).

The key hypothesis in this study posits that completion of higher-level math courses correlates with enhanced cognitive skills. Students with more refined cognitive skills and abilities are believed to have more highly developed efficacy and self-concept beliefs which are necessary to perpetuate the attributes used to move further along the cognitive, psychosocial, and moral/ethical dimensions of student development. Intensive, upper-level courses may be of most benefit to students of moderate ability. Students of low ability will most likely not succeed; students of high ability will most likely succeed, but not receive the same degree of benefits because they will not have to work as hard to navigate through the disequilibrium/dissonance caused when struggling through intensive mathematics courses. This issue will be discussed further in Chapter 5.

A factorial multivariate analysis of variance (MANOVA) approach is appropriate for this study because univariate tests have no mechanism for addressing the correlations among the dependent variables. Multivariate analyses allow for the covariance of the dependent variables to be built right into the test statistics (Stevens, 2002). Figure 1 (page 40 in Chapter 2) gives a visual representation of the hypothesized relationships between cognitive, psychosocial, and moral/ethical student development. Cognitive skill development is the engine that drives growth along both the psychosocial and moral/ethical dimensions of student development. As stated in Chapter 2, Lawrence Kohlberg

(1969, 1971) and Douglas Heath (1968, 1977) connect moral/ethical development to cognitive development. Additionally, Chickering's psychosocial model (1969), later refined and updated by Chickering and Reisser (1993), postulates that psychosocial development is based on general tasks of identity resolution that require cycles of differentiation and integration that are stimulated by social interaction. Pascarella and Terenzini (1996) theorize that in order for students to be able to experience their own identities, self-concepts, and interactions with the outside world (environment), they must acquire various kinds of substantive knowledge and cognitive competence. Clearly, cognitive, moral/ethical, and psychosocial development are related. Therefore, the variables used in this study (ACT Assessment composite score or ACTCOMP for cognitive skill level, the *Lifestyle Planning* (LP) *Subtask* score and *Salubrious Lifestyle* (SL) *Scale* score from the SDTLA for moral/ethical student development, and the *Mature Interpersonal Relationships* (MIR) *Task* score, *Developing Autonomy* (AUT) *Task* score, and *Establishing and Clarifying Purpose* (PUR) *Task* score from the SDTLA for psychosocial student development) were speculated to be moderately to highly correlated. This presumption not only comes from the theorized relationships among the variables, but also from information found in the *Preliminary Technical Manual for the Student Developmental Task and Lifestyle Assessment* (Winston, Miller, & Cooper, 1999) which states "that most of the measures are moderately correlated with each other, as developmental theory suggests should be the case" (p. 26). This makes the choice of factorial multivariate analysis of variance (MANOVA) a logical research design for this study. Stevens (2002) argues that the objective of multivariate analysis is to "determine whether several groups differ on the average on a set of dependent variables" (p. 22).

Therefore, a factorial MANOVA was performed on the six dependent variables listed above to ascertain if statistically significant differences existed on the set of dependent variables according to a student's terminal math course completed (level of math) and gender. A factorial MANOVA design assessed multivariate significance for the independent variables of level of math (LVLMATH), gender (GENDER), and their combination or interaction. This helped to answer if the set of dependent variables differed according to the grouping variable that was the focus of this study (level of math or terminal math course completed). In addition, a factorial MANOVA design aided in interpreting which of the individual dependent variables chosen for this study contributed to multivariate significance according to the independent variable used as the focus in this study (level of math or terminal math course completed).

If the main effect of LVLMATH reaches multivariate significance on the set of dependent variables used in this study, then research questions #1, #2, and #3 can be answered by subsequently assessing the univariate tests of the individual dependent variables used to measure 1) cognitive skill level (a student's ACT Assessment composite score or ACTCOMP), 2) psychosocial student development (a student's *Mature Interpersonal Relationships* (MIR) *Task* score, *Developing Autonomy* (AUT) *Task* score, and *Establishing and Clarifying Purpose* (PUR) *Task* score), and 3) moral/ethical student development (a student's *Lifestyle Planning* (LP) *Subtask* score and *Salubrious Lifestyle* (SL) *Scale* score).

In order to answer research question #4, the focus shifts to evaluating gender as the second independent (grouping) variable in the factorial MANOVA design. The results of the factorial MANOVA will also be able to assess the relationship of GENDER and/or the combined relationships of LVLMATH X GENDER to the set of dependent variables used in this study. Again, if the main effect of GENDER and/or if the interaction effect of LVLMATH X GENDER reaches multivariate significance on the set of dependent variables used in this study, then the subsequent results of the univariate tests for each dependent variable will be used to determine if a relationship exists between GENDER and/or LVLMATH X GENDER to each of the individual dependent variables that represent cognitive skill level (ACT Assessment composite score or ACTCOMP), psychosocial student development(the *Mature Interpersonal Relationships* (MIR) *Task* score, *Developing Autonomy* (AUT) *Task* score, and *Establishing and Clarifying Purpose* (PUR) *Task* score), and moral/ethical student development (the *Lifestyle Planning* (LP) *Subtask* score and *Salubrious Lifestyle* (SL) *Scale* score).

The theory upon which this study is based implies that the completion of rigorous, intensive upper-level math courses relates to enhanced cognitive skills, which in turn, correlate with sharpened efficacy and self-concept beliefs which are necessary to perpetuate the attributes used to move further along the cognitive, psychosocial, and moral/ethical dimensions of student development. The question is whether students need to possess a high level of cognitive skills before they can even enroll in rigorous, intensive, upper-level math courses, or does the rigor of taking mathematics courses beyond the basic high school mathematics core of Algebra I, geometry, and Algebra II further enhance students' existing cognitive skills? The answer is, that to a certain degree, both theoretical positions have merit. The position taken in this study will not argue with the fact that most students who enroll in these advanced math courses have highly developed cognitive abilities/math skills before they enroll in such courses. These are the students who are most likely to take advanced math. The position taken in this study is that the completion of rigorous, intensive, upper-level math courses correlates to *sharpened* cognitive skills. Perhaps the critical thinking, recall, decision-making, and problem solving skills needed to successively navigate mathematics classes beyond the required basic high school math core require students to use more of their mental faculties than what they are accustom to using.

Why is this an important issue in this study? The use of a student's ACT Assessment composite score as a measure of cognitive skill level in this study implies that ACTCOMP is an outcome, or dependent variable (enhanced as a result of completing the higher level math courses discussed previously). It could just as easily be argued that ACTCOMP should be an input, or independent variable. A student's cognitive skill level could be viewed as an attribute that empowers student academic and social performance.

The first paragraph of this chapter stated that the purpose of this study is to explore a theoretically derived proposition based on the findings of Adelman (1999) and Trusty and Niles (2003). Both studies found statistical evidence that completing a math course beyond Algebra II greatly increased the probability that a student would persist and complete a college degree. Why? The theory explored in this study posits a relationship involving the benefits of completing tough, upper-level math courses. Not that completion of such courses makes a student "smarter," but that it relates to sharpening the cognitive skills that the student already possesses.

CHAPTER IV

RESULTS

The purpose of this study is to explore a theoretically derived relationship based on the findings of Adelman (1999) and Trusty and Niles (2003). Both studies found statistical evidence that completing a high school mathematics course beyond Algebra II (traditionally the last class taken in the basic high school mathematics core) was the greatest single predictor of bachelor's degree completion. The hypothesis posited in this study is that high school students who complete higher level math courses sharpen/ enhance their cognitive skills, which help develop attributes necessary for upward movement along the cognitive, psychosocial, and moral/ethical dimensions of student development. Students who are further advanced along these developmental dimensions are better prepared to meet and overcome the challenges and opportunities encountered during college.

Math Ability

This study was designed as a correlational study which sought to determine if a relationship exists between the level of mathematics a student completes in high school and his/her level of cognitive, psychosocial, and moral/ethical student development. It would be remiss to not briefly discuss the role that math ability plays in a student's decision to pursue higher-level math classes.

Math ability influences math course taking (Hall & Ponton, 2005; Maple & Stage, 1991; Trusty, 2002). This is a pertinent part of the complex puzzle that is being investigated in this study. If math ability influences math course taking, then according to the theory postulated in this study, it would influence the benefits derived from completing rigorous, intensive upper-level math courses. This study argues that the demands and expectations of advanced math classes create cognitive dissonance and/or disequilibrium as students progress through such courses. Students then must call upon their refined/enhanced cognitive skills in order to restore cognitive balance. Students who are gifted (have more math ability) will most likely not develop as high a level of cognitive dissonance/disequilibrium as a result of taking intensive math classes. Therefore, according to the premise of this study, gifted math students would not receive the same level of benefits as students of lesser math ability.

Consequently, the sample of students used in this study was evaluated in regards to comparing their math ability to the level of advanced math they completed in high school. In this study, a student's math ability was measured using his/her ACT Mathematics Usage Test score or ACTM (American College Testing Services, 1997). The scores on the ACTM range from 1-36. In regards to ACTM, scores were grouped into low math ability (10-18), moderate math ability (19-24), and high math ability (25-36). This protocol was used in order to place an approximate equal number of subjects in each group: low (n = 99), moderate (n = 109), and high (n = 82). Table 6 presents a crosstabulation of the sample of students used in this study, ACTM X LVLMATH.

Table 6

The Relationship of Math Ability and Math Course Taking: Crosstabulation of ACTM X LVLMATH (n = 290)

	LVLMATH			
ACTM	1	2	3	Total
Low (10 - 18)	56	42	1	99
Moderate (19 - 24)	26	73	10	109
High (25 - 36)	2	47	33	82
Totals	84	162	44	290

Table 6 shows that in this study a student's math ability, as measured by his/her ACTM, has a relationship with the terminal math course he/she completed while in high school. Fifty-seven percent (56/99) of the students categorized as having low math ability completed only the basic high school core mathematics curriculum requirements. Seventy-six percent (83/109) of the students categorized as having moderate math ability completed an advanced math class at least one level beyond the basic mathematics core. Ninety-eight percent (80/82) of those students in the high math ability category completed at least one upper-level math class. Table 6 indicates that the results of this study should be interpreted with care.

Math Course Taking

How many students complete advanced math classes? According to *Report: U.S. Students More Prepared Academically Than 20 Years Ago* (2005), the percentage of high school graduates completing math courses beyond Algebra II or geometry increased from

26 percent in 1982 to 45 percent in 2000. If no more than 45 percent of students graduating from U.S. high schools are taking math courses beyond Algebra II and/or geometry, then perhaps the theory posited in this study can, at least partially, be used to explain the alarmingly high attrition rates for college students. If students do not take advanced math classes in high school, then not only are they most likely to require remediation in math during college (lack of academic preparation), but perhaps their lack of cognitive skill enhancement/refinement impairs the level of psychosocial and moral/ethical development they need to cope with the challenges and demands of college (lack of non-academic preparation). In order to investigate this aspect, Table 7 is presented to display the results of the crosstabulation of the 290 students who participated in this study arranged by LVLMATH X YRSMATH.

Table 7

Assessing the Potential Relationship Between Cognitive Disequilibrium/Dissonance and Math Course Taking: Crosstabulation of YRSMATH X LVLMATH (n = 290)

	LVLMATH			
YRSMATH	1	2	3	Total
2 (Sophomore Year)	4	0	0	4
3 (Junior Year)	61	46	2	109
4 (Senior Year)	19	116	42	177
Totals	84	162	44	290

The rate of participation in math courses beyond Algebra II and/or geometry in this study (206 out of 290, or 71 percent) was much higher than what was reported in

Report: U.S. Students More Prepared Academically Than 20 Years Ago (2005). However, 39 percent (113/290) of the students in this study chose not to take any math beyond their junior year. Sixty-five out of those 113 students (58 percent) who chose not to take math beyond their junior year did not take any math classes after completing Algebra II and/or geometry. Those interested in improving education in the U.S. need to find and to develop ways to improve participation in advanced math classes during high school. If for no other reason, a student's decision not to pursue advanced math beyond Algebra II and or/geometry while in high school, can limit his/her career choices (Maple & Stage, 1991; Singer & Stake, 1986; Trusty, 2002).

Is it possible that the intensity, demands, and rigors that students face while participating in advanced math classes play a part in their decision whether or not to take them? Perhaps students want to avoid the disequilibrium/dissonance created when challenged cognitively by upper-level math courses. The lack of experience and confidence in successfully navigating stressful situations may cause students to seek a more familiar and/or comfortable environment. This may help explain why, according to *Report: U.S. Students More Prepared Academically Than 20 Years Ago* (2005), 55 percent of the high school students surveyed during 2000 did not take math courses beyond Algebra II or geometry. The findings of Wieschenberg (1994), in part, may help support this belief. He found evidence that excluding math majors, avoidance of math is at an all-time high.

Preliminary Considerations

In accordance with the results of the normative sample reported in the *Preliminary Technical Manual for the Student Developmental Task and Lifestyle*

Assessment (Winston, Miller, & Cooper, 1999), moderate to high intercorrelations are expected among the variables that were chosen to measure psychosocial and moral/ ethical student development in this study. The hypothetical relationship between cognitive skill level, psychosocial, and moral/ethical student development posits that a student's ACT Assessment composite score or ACTCOMP (used to measure cognitive skill level), *Mature Interpersonal Relationships Task* (MIR) score, *Developing Autonomy Task* (AUT) score, *Establishing and Clarifying Purpose Task* (PUR) score (used to measure psychosocial student development), *Lifestyle Planning Subtask* (LP) score and *Salubrious Lifestyle Scale* (SL) score (used to measure moral/ethical student development) are all moderately to highly intercorrelated. The hypothesized relationships among the variables of interest in this study weighed heavily in choosing factorial multivariate analysis of variance (MANOVA) as the statistical technique to answer the research questions posed in this study.

Table 8 lists the zero-order correlations for the variables considered for use in this study. All correlations are calculated and tested for two-tailed significance based on this study's sample of 290 students. In this study, gender (GENDER) was coded as 1 = male and 2 = female. The students who participated in this project were grouped into three levels or categories according to the terminal math course they completed while in high school (LVLMATH). Level 1 (coded = 1) included the students who completed the basic high school mathematics core curriculum of Algebra I, geometry, and Algebra II. Level 2 (coded = 2) was comprised of the students who completed math classes one level beyond the basic high school mathematics core. This would include Algebra III, math analysis, pre-calculus, statistics, and trigonometry. The students who completed a second level of math class beyond the basic high school mathematics core (calculus) were placed in Level 3 (coded = 3). In addition, a subscore of the ACT, the ACT Mathematics Usage Test score (ACTM), was used to measure a student's math ability/skill.

Table 8

Zero-Order Correlations Among the Independent and Dependent Variables Considered For Use in This Study (n = 290).

Variable	GENDER	LVLMATH	ACTM	ACTCOMP	LP	SL	PUR	AUT	MIR
GENDER	1.00	-.04	-.11	-.01	.08	.17**	.03	.05	.08
LVLMATH		1.00	.60**	.55**	.21**	.14*	.21**	.25**	.05
ACTM			1.00	.87**	.31**	.09	.30**	.28**	.02
ACTCOMP				1.00	.33**	.13*	.31**	.32**	.04
LP					1.00	.25**	.85**	.59**	.15*
SL						1.00	.29**	.45**	.09
PUR							1.00	.65**	.18**
AUT								1.00	.31**
MIR									1.00

** Correlation is significant at the 0.01 level (two – tailed)
 * Correlation is significant at the 0.05 level (two – tailed)

The strong intercorrelation between ACTM and ACTCOMP (.869) indicates that trying to remove the effects of a student's math ability/skill (ACTM) from his/her general cognitive skill level (ACTCOMP) would be tenuous at best. This observation, along with moderate to high intercorrelations among the dependent variables that were used to measure psychosocial and moral/ethical student development, indicated that perhaps the best experimental design to apply when answering the research questions in this study would involve using multivariate analysis of variance or MANOVA. MANOVA is a mathematical model based on assumptions and all mathematical models are approximations to reality (Stevens, 2002). Violations of the assumptions can have serious effects on Type I and Type II error rates. Each assumption of MANOVA is now discussed in relation to the sample used in this study.

Independence

Random sampling is the best experimental design facet to use to combat violating the assumption of independence of the dependent observations used in MANOVA. The sampling method used in this study was cluster/convenience sampling. This could be a limitation of this study. However, Tables 2, 3, and 4 from Chapter 3 indicate that the sample of students who participated in this study was representative of the target population. In addition, each student filled out the demographic survey and completed the SDTLA without being unduly influenced by any other students. These factors signify that the assumption of independence was tenable.

Normality

Multivariate normality is difficult to completely characterize. First, normality on each of the dependent variables is a necessary, but not sufficient condition for multivariate normality to hold. Second, all pairs of dependent variables must be bivariate normal (Stevens, 2002). In this study, the raw scores for the *Mature Interpersonal Relationships Task* (MIR), the *Developing Autonomy Task* (AUT), the *Establishing and Clarifying Purpose Task* (PUR), the *Lifestyle Planning Subtask* (LP), and the *Salubrious Lifestyle Scale* (SL) were originally used. Stem and leaf plots of each dependent variable for each of the three levels of math (LVLMATH) demonstrated univariate normality problems. Scores on the SDTLA for each task, subtask, and scale are all given in both raw score and standardized score form. A stem and leaf plot assessment of the standardized scores of each dependent variable for each of the three levels of math indicated that the assumption of univariate normality for each dependent variable was tenable.

Using SPSS (version 14.0), skewness and kurtosis coefficients were then calculated for each dependent variable at each of the three levels of math used in this study. For a variable to be considered normally distributed, skewness and kurtosis should be equal to zero. The range for skewness was -.320 to .647 for all 18 items (six dependent variables X three levels of math). The range for kurtosis was -.661 to .709 for all 18 items. The skewness and kurtosis coefficients did not give reason to believe that the assumption of univariate normality was violated. Stevens (2002) reports that both univariate and multivariate tests are somewhat robust to violations of normality and that violations of the normality assumption produce only slight effects on Type I error rates and power due to the Central Limit Theorem.

The SPSS EXAMINE procedure was used to obtain the Shapiro-Wilk statistical test for each dependent variable for each of the three levels of math. The results indicated that one of the variables used to measure psychosocial student development, the *Mature Interpersonal Relationships Task* score, deviated from normality for each of the three levels of math. A final statistical test was conducted to assess the effect of including the *Mature Interpersonal Relationships Task* score in the factorial MANOVA model as originally hypothesized.

A factorial MANOVA, which included the *Mature Interpersonal Relationships Task* score, was conducted using the six dependent variables and level of math (LVLMATH) and gender (GENDER) as the independent or grouping variables, as described in Chapter 3. This was done in order to evaluate the results of the Box test: the test of homogeneity of covariance matrices. The results are presented in Table 9.

Table 9

Multivariate Test for Homogeneity of Covariance Matrices (Mature Interpersonal Relationships Task Score Included as a Dependent Variable, n = 290*)*

Homogeneity of Covariance:	Test Result	P – Value
Boxs M	147.406	
F with (105, 31658) DF	1.299	.022*
Chi – Square with 105 DF	136.870	.020*

*p < .05

The results show that the null hypothesis of equal (homogeneous) covariance matrices is rejected at the .05 level of significance. Stevens (2002) states, “It is very unlikely that the equal covariance matrices assumption would ever literally be satisfied in practice” (p. 270). Stevens goes on to advocate that the Box test may be rejected due to a lack of multivariate normality, not because the covariance matrices are unequal. Therefore, a second factorial MANOVA was run that omitted the *Mature Interpersonal Relationships Task* score to determine if its apparent departure from normality was a factor in rejecting the Box test. Table 10 presents the results of the Box test: the test of homogeneity of covariance matrices with the dependent variable represented by the *Mature Interpersonal Relationships Task* score omitted.

Table 10

Multivariate Test for Homogeneity of Covariance Matrices (Mature Interpersonal Relationships Task Score Excluded as a Dependent Variable, n = 290*)*

Homogeneity of Covariance:	Test Result	P – Value
Boxs M	98.302	
F with (75, 32817) DF	1.299	.087
Chi – Square with 75 DF	92.407	.084

Removing the dependent variable represented by the *Mature Interpersonal Relationships Task* score resulted in the Box test becoming non-significant (failure to reject the null hypothesis, $p > .05$). This result, in conjunction with the assessment of univariate and multivariate normality, suggested that the *Mature Interpersonal Relationships Task* score be dropped from the factorial MANOVA model.

The SDTLA is designed for young adult college students. The theoretical work of Chickering and Reisser (1993) as presented in the book, *Education and Identity,* was a major influence in guiding the creation and evolution of SDTLA. The seven developmental vectors postulated by Chickering are fundamental to the SDTLA. The *Mature Interpersonal Relationships Task* score of the SDTLA corresponds to vector five, *Freeing Interpersonal Relationships* of the psychosocial model of student development postulated by Chickering (1969) and Chickering and Reisser (1993). Chickering argues that, traditionally, college students progress through vector five during their junior and senior years. The students sampled for this study had attended college less than eight weeks. Although it would be interesting to explore how many of the students surveyed for this study scored well enough to demonstrate competence in vector five, it is highly unlikely that many of the 290 students sampled would have demonstrated that level of maturity after only eight weeks of college. As a result, the decision was made to eliminate the *Mature Interpersonal Relationships Task* score as a dependent variable measure of psychosocial student development from this study.

Homogeneity

Removing the *Mature Interpersonal Relationships Task* score from the study resulted in a non-significant Box test of equality of covariance matrices, as shown in Table 10. As a final assessment of the normality/homogeneity assumptions, Levene's test of equality of error variances was conducted on the data using SPSS. The results are presented in Table 11.

Table 11

Levene's Test for Univariate Homogeneity (n = 290)

Variable	DF	F	Significance
ACTCOMP	(5,284)	1.757	.122
Lifestyle Planning (LP)	(5,284)	.364	.873
Salubrious Lifestyle (SL)	(5,284)	.794	.555
Establishing & Clarifying Purpose (PUR)	(5,284)	.954	.447
Developing Autonomy (AUT)	(5,284)	1.504	.188

In regards to non-normality, all remaining dependent variables were determined to be non-significant at the .05 level. Stevens (2002) argues that the Levene test is robust against non-normality. The statistical results presented in Table 10 and Table 11 and the fact that 290 subjects participated in the study give reason to believe that the normality/homogeneity assumptions were tenable.

Results

A 2 X 3 factorial MANOVA was performed using SPSS. A student's ACT Assessment composite score (ACTCOMP) was used as the dependent variable measuring general cognitive skill level. A student's *Developing Autonomy Task* (AUT) score and *Clarifying Purpose Task* (PUR) score were used as dependent variables measuring psychosocial student development. The *Lifestyle Planning Subtask* (LP) score and the *Salubrious Lifestyle Scale* (SL) score were used as dependent variables measuring a student's level of moral/ethical student development. A student's gender (GENDER) and terminal math course completed in high school (LVLMATH) were used as the independent or grouping variables. GENDER was coded as 1 = male and 2 = female. Three different levels of terminal mathematics courses that students completed in high school were evaluated in the factorial MANOVA design (Level 1 = completion of the basic high school mathematics core curriculum of Algebra I, geometry, and Algebra II; Level 2 = completion of a math class one level beyond the basic high school mathematics core e.g., Algebra III, math analysis, pre-calculus, statistics, or trigonometry; Level 3 = completion of a second level of math class beyond the basic high school mathematics core, or calculus).

Multivariate and univariate tests results of the relationships described above are now displayed in Tables 12-17. The results are summarized here and then examined in detail as each research question is presented. The interaction between LVLMATH and GENDER was examined first and found to be non-significant (Tables 12 and 13). The main effect for gender was not significant in the multivariate test, though upon examination, there was a gender difference for the *Salubrious Lifestyle Scale* (Tables 14 and 15). The multivariate main effect of LVLMATH was significant; univariate test results were significant at $p < .10$ for all dependent variables in the analysis (Tables 16 and 17).

Table 12

Multivariate F-Tests of Significance: LVLMATH X GENDER (n = 290)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	P - Value
Pillai’s Trace	.04267	1.225	10.0	562.0	.271
Hotelling’s Trace	.04375	1.220	10.0	558.0	.275
Wilks' Lambda	.95772	1.223	10.0	560.0	.273
Roy's Largest Root	.02948	1.707	5.0	281.0	.133

Table 13

Univariate F-Tests of Significance: LVLMATH X GENDER (n = 290)

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	P - Value
PUR	128.84	27993.71	64.42	98.57	.653	.521
AUT	223.17	21526.36	111.56	75.80	1.472	.231
SL	440.01	28670.45	220.00	100.95	2.179	.115
LP	97.91	27154.25	48.95	95.61	.512	.600
ACTCOMP	41.23	4021.47	20.61	14.16	1.456	.235

Table 14

Multivariate F-Tests of Significance: GENDER (n = 290)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	P - Value
Pillai’s Trace	.01832	1.045	5.0	280.0	.391
Hotelling’s Trace	.01866	1.045	5.0	280.0	.391
Wilks' Lambda	.98168	1.045	5.0	280.0	.391
Roy's Largest Root	.01832	1.045	5.0	280.0	.391

Table 15

Univariate F-Tests of Significance: GENDER (n = 290)

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	P - Value
PUR	25.70	27993.71	25.70	98.57	.261	.610
AUT	45.73	21526.36	45.73	75.80	.603	.438
SL	416.83	28670.45	416.83	100.95	4.129	.043*
LP	91.38	27154.25	91.38	95.61	.956	.329
ACTCOMP	.64	4021.47	.64	14.16	.045	.832

* p < .05

Table 16

Multivariate F-Tests of Significance: LVLMATH (n = 290)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	P - Value
Pillai's Trace	.32422	10.873	10.0	562.0	.000***
Hotelling's Trace	.46470	12.965	10.0	558.0	.000***
Wilks' Lambda	.67991	11.914	10.0	560.0	.000***
Roy's Largest Root	.31093	25.359	5.0	281.0	.000***

***p < .001

Table 17

Univariate F-Tests of Significance: LVLMATH (n = 290)

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	P - Value
PUR	1513.68	27993.71	756.84	98.57	7.678	.001**
AUT	1620.16	21526.36	810.08	75.80	10.687	.000***
SL	589.95	28670.45	294.98	100.95	2.922	.055*
LP	1463.15	27154.25	731.57	95.61	7.651	.001**
ACTCOMP	1758.46	4021.47	879.23	14.16	62.092	.000***

*** $p < .001$, ** $p < .005$, * $p < .10$

Research Questions

Research Question # 1

"Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with general cognitive skill level?"

In order to answer research question #1, the main effect (relationship) of LVLMATH on the set of dependent variables used in this study was evaluated for multivariate statistical significance. The results indicate that the three groups of students (categorized by the level of high school math course completed) differed on the average on the set of dependent variables tested. All multivariate tests presented in Table 16 are significant at $p < .001$.

As explained in Chapter 3, it is first important to establish that there is a statistically significant relationship between the independent or grouping variable, level of math (LVLMATH), and a student's general cognitive skill level. Therefore, it is prudent to look at the univariate F-tests for each dependent variable to assess whether the variable used in this study to measure a student's general cognitive skill level, the ACT Assessment composite score (ACTCOMP), contributed to multivariate significance.

The results from Table 17 indicate that general cognitive skill level, as measured by ACTCOMP, contributed to multivariate significance according to the independent or grouping variable, the terminal math course a student completes in high school or LVLMATH ($F = 62.092$, $p < .00l$). Establishing a relationship between those students who complete intensive, upper-level math courses and their level of refined and/or enhanced cognitive skills is paramount to the premise of this study. This study is based on the hypothesis that those students who demonstrate advanced cognitive skills have better developed critical thinking, recall, decision making, and problem solving skills which enable them to advance to a level of attribute development that promotes upward movement along the cognitive, psychosocial, and moral/ethical dimensions of student development.

Research Question # 2

"Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with psychosocial student development?"

The SDTLA (Winston, Miller, & Cooper, 1999) is an instrument that primarily measures psychosocial student development. It is based on the work of Chickering (1969) and Chickering and Reisser (1993). The use of the SDTLA to assess a student's level of psychosocial student development is a strength of this study.

In order to assess the relationship between a student's terminal high school mathematics course (LVLMATH) and his/her level of psychosocial student development, again it is appropriate to evaluate the results of the univariate F-tests given in Table 17. The two dependent variables used in this study to measure psychosocial student development, the *Establishing and Clarifying Purpose Task* (PUR) score ($F = 7.678$, $p < .005$) and the *Developing Autonomy Task* (AUT) score ($F = 10.687$, $p < .00l$), were both statistically significant in contributing to overall multivariate significance according to the independent or grouping variable, LVLMATH. This indicates a relationship exists between the level of mathematics that a student completes in high school and his/her level of psychosocial student development.

Research Question # 3

"Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with moral/ethical student development?"

Due to the parameters under which this study was conducted (e.g., time constraints, lack of access to students, etc.) several proxy measures were used. The *Lifestyle Planning Subtask* (LP) score and *Salubrious Lifestyle Scale* (SL) score from the SDTLA were used as proxy measures of a student's moral/ethical development. Use of these variables is a limitation to this study. However, the *Preliminary Technical Manual for the Student Developmental Task and Lifestyle Assessment* (Winston, Miller, & Cooper, 1999) defines the *Lifestyle Planning Subtask* as assessing how well a student achieves "a personal direction and orientation in one's life that takes into account personal, ethical, and religious values, future relationships/family plans and vocational and educational objectives" (p.11). This would indicate that the use of the *Lifestyle Planning Subtask* score as a variable measuring moral/ethical student development has merit.

The other issue involving the use of the *Lifestyle Planning Subtask* score as a measure of moral/ethical student development centers around the fact that it is a part of the *Establishing and Clarifying Purpose Task* score that is being used to measure psychosocial student development. As explained in Chapter 3, the *Establishing and Clarifying Purpose Task* is comprised of four subtasks: *Educational Involvement, Career Planning, Lifestyle Planning,* and *Cultural Participation.* From an experimental design standpoint, including the *Lifestyle Planning Subtask* (used as a measure of moral/ethical student development) as a part of the *Establishing and Clarifying Purpose Task* (used as a measure of psychosocial student development) could be questioned.

However, two points need to be made regarding the use of the *Lifestyle Planning Subtask* score as a measure of moral/ethical student development. First, as illustrated in Figure 1 on page 40 of Chapter 2, the dimensions of cognitive, psychosocial, and moral/ethical student development are all interrelated. Dissonance and/or disequilibrium can arise when students find themselves in social situations in which their current moral/ethical beliefs are not sufficiently developed to allow appropriate responses and/or reactions. All of the student developments theorists discussed in Chapter 2 posit that cognitive growth is necessary to accommodate the new schema structures needed to resolve the dissonance and/or disequilibrium caused by unfamiliar/unanticipated situations. Perry (1970), Kohlberg (1969, l97l), and Douglas Heath (1968, 1977) connect moral/ethical development to cognitive development. Therefore, the simultaneous two-way relationships (as depicted in Figure 1, page 40, of Chapter 2) among cognitive, psychosocial, and moral/ethical development have a theoretical basis.

Second, to ensure that including the *Lifestyle Planning Subtask* as part of the *Establishing and Clarifying Purpose Task* would not confound the MANOVA results as presented in Table 16 and Table 17, a second factorial MANOVA was conducted. This second MANOVA used all of the same dependent variables and the same independent (grouping) variables that were used to generate the results in Table 16 and Table 17, except that the *Lifestyle Planning Subtask* score was removed from the *Establishing and Clarifying Task* score for each student. The results are presented in Table 18 and Table 19.

Table 18

Multivariate F-Tests of Significance (Lifestyle Planning Subtask Score Removed From the Establishing and Clarifying Purpose Task Score): LVLMATH (n = 290)

Test Name	Value	Approx. F	Hypoth. DF	Error DF	P - Value
Pillai’s Trace	.32409	10.868	10.0	562.0	.000***
Hotelling’s Trace	.46456	12.961	10.0	558.0	.000***
Wilks' Lambda	.68001	11.910	10.0	560.0	.000***
Roy's Largest Root	.31093	25.359	5.0	281.0	.000***

***p < .001

Table 19

Univariate F-Tests of Significance (Lifestyle Planning Subtask Score Removed From the Establishing and Clarifying Purpose Task Score): LVLMATH (n = 290)

Variable	Hypoth. SS	Error SS	Hypoth. MS	Error MS	F	P - Value
PUR	6404.62	150318.73	3202.31	529.29	6.050	.003**
AUT	1620.16	21526.36	810.08	75.80	10.687	.000***
SL	589.95	28670.45	294.98	100.95	2.922	.055*
LP	1463.15	27154.25	731.57	95.61	7.651	.001**
ACTCOMP	1758.46	4021.47	879.23	14.16	62.092	.000***

*** $p < .001$, ** $p < .005$, * $p < .10$

A comparison of Tables 16 and 17 to Tables 18 and 19 indicate very little difference in the factorial MANOVA results when the *Lifestyle Planning Subtask* score was included as a part of the *Establishing and Clarifying Purpose Task* score. It is, therefore, believed that the factorial MANOVA results presented in Table 16 and Table 17 are not affected in any substantive way as a result of this issue.

The univariate F-tests presented in Table 17 show that both of the dependent variables used in this study to measure moral/ethical student development, the *Lifestyle Planning Subtask* score ($F = 7.651$, $p < .005$) and the *Salubrious Lifestyle Scale* score ($F = 2.922$, $p < .10$) were statistically significant in contributing to overall multivariate significance according to the independent or grouping variable (LVLMATH). Again, this would indicate that a relationship exists between the level of mathematics a student completes in high school and his/her level of moral/ethical student development.

Research Question # 4

"Does gender have a statistically significant relationship with the scores that measure psychosocial and moral/ethical student development when evaluated alone (tested as a main effect) or in combination with completion of intensive mathematics courses beyond the basic high school mathematics core (tested as an interaction effect)?"

In order to address research question # 4, the focus of interpretation shifts from evaluating the relationship of LVLMATH with the scores that measure psychosocial and moral/ethical student development to evaluating the relationship of GENDER and/or LVLMATH X GENDER with the scores that measure psychosocial and moral/ethical student development. The same five dependent variables that were used when answering research questions # 1, # 2, and # 3 were used when answering research question # 4.

A factorial design enables the researcher to examine the joint, or combined effects (relationships), of the independent categorical variables with the dependent variables. This information cannot be obtained by running two separate one-way analyses, one for each of the independent variables (Stevens, 2002). A factorial design allows the researcher to assess the main effects (relationships) of LVLMATH and GENDER with the set of dependent variables used in this study and also to determine if the effect (relationship) that one independent variable has with the set of dependent variables remains the same for all levels of the other independent variable (i.e., the joint or combined effect/relationship).

The results presented in Tables 12 and 13 indicate that GENDER does not combine with LVLMATH to produce a statistically significant joint (combined) relationship with the set of dependent variables investigated in this study. The main effect (relationship) of LVLMATH with the set of dependent variables used in this study has been investigated and presented in answering research questions # 1, # 2, and # 3. It is practical to now evaluate whether or not the independent or grouping variable GENDER, by itself, has a statistically significant main effect (relationship) with the set of dependent variables used in this study. Tables 14 and 15 presented the multivariate and univariate F-test results of the one-way MANOVA where GENDER was used as the independent or grouping variable and ACTCOMP, PUR, AUT, LP, and SL were used as the dependent variables.

The results of the multivariate and univariate F-test displayed in Tables 14 and 15 indicate that the relationship of GENDER did not change (differ) on the average on the set of dependent variables tested. In Table 15, the univariate F-tests for the main effect (relationship) of GENDER showed that one of the dependent variables used to measure moral/ethical development, the *Salubrious Lifestyle Scale* (SL) score, reached statistical significance ($F = 4.129$, $p < .05$). In this study, females scored higher on the *Salubrious Lifestyle Scale* than males at all levels of high school mathematics classes completed (LVLMATH). This would indicate that as a whole, females in high school lead healthier lifestyles than their male counterparts. Newcomb, Huba, Chou, and Bentler (1988) reported small differences in drug and alcohol use among the high school students who participated in their study. The differences that did appear showed that males used cannabis (drugs such as marijuana) and alcohol more than females. Lenz (2004) found evidence that during their early college years, males were more prone to use tobacco products than females. These studies support the findings in Table 15 that infers gender differences when making moral/ethical lifestyle choices.

Discriminant Analysis

Descriptive discriminant analysis is an adjunct (post hoc) procedure conducted to further explore significant MANOVA findings. LVLMATH had a significant multivariate effect on the variables used in this study to measure cognitive, psychosocial, and moral/ethical development (research questions # 1, # 2, and # 3). Therefore, a descriptive discriminant analysis was conducted to determine which uncorrelated linear combination(s) of the dependent variables maximized group (LVLMATH) differences (Stevens, 2002). These uncorrelated linear combinations are called discriminant functions (DF's) and can be used to name and interpret which combination(s) of dependent variables best explain how the groups (LVLMATH) in this study differ. Since there were three groups (LVLMATH) and five dependent variables used in this study, a maximum of two discriminant functions (DF's) were possible (the minimum of the number of dependent variables or one less than the number of groups). In order to interpret the discriminant functions, both the standardized coefficients and the structure matrix (the zero-order correlations of the dependent variables with the discriminant functions) should be evaluated. The structure matrix is used to name the discriminant function(s) and the standardized coefficients are used to determine which, if any, variables are redundant (Stevens, 2002). Only one discriminant function was significant ($\Lambda = .68161$, $F = 11.956$, $p = .000$, $R_c = .558$).

Table 20 presents the standardized canonical discriminant function coefficients and the structure matrix results from the discriminant analysis performed to determine which linear combination extracted from the ACT Assessment composite score (ACTCOMP), *Developing Autonomy Task* (AUT) score, *Establishing and Clarifying Purpose Task* (PUR) score, *Lifestyle Planning Subtask* (LP) score, and *Salubrious Lifestyle Scale* (SL) score best maximized group (LVLMATH) differences.

Table 20

Standardized Discriminant Function Coefficients and Structure Matrix

Variable	Standardized Discriminant Function Coefficients	Structure Matrix
PUR	.008	.321
AUT	.139	.385
SL	.097	.207
LP	-.036	.321
ACTCOMP	.952	.982

Table 20 indicates that only one dependent variable, ACTCOMP, is necessary to explain group (LVLMATH) separation. This is the variable used in this study to measure cognitive skill level. The interpretation given here is that cognitive skill is what separates the groups and that the differences in the rigor/intensity of the math courses in each group (Level 1 = completion of the basic high school mathematics core curriculum of Algebra I, geometry, and Algebra II; Level 2 = completion of a math class one level beyond the basic high school mathematics core e.g., Algebra III, math analysis, pre-calculus, statistics, or trigonometry; Level 3 = completion of a second level of math class beyond the basic high school mathematics core, or calculus) help to explain the differences in critical thinking, decision making, problem solving, and recall skills. The differences in the refinement/enhancement of these skills influence variations in efficacy, ability, and confidence constructs that result in different levels of attribute development. Critical thinking, the ability think logically and abstractly, and the skill to organize and synthesize information are all enhanced in the course of completing higher lever math courses.

Other Findings

Perhaps the most controversial aspect of the hypothesis upon which this study is based centers around the relationship between math course taking and cognitive/math skills. Does cognitive/math skills influence which math courses a student takes in high school or does completing difficult math courses further enhance/sharpen/develop cognitive skills? The most likely answer is that both suppositions have merit. Trusty and Niles (2003) acknowledged the influence of the 8th grade math ability on math course taking. "Early math ability did have an influence on math course-taking in high school. That is, students with higher ability tended to finish more intensive math courses" (p. 103). This study will not argue against such an assumption.

This study does argue that the completion of advance math courses refines critical thinking, decision making, problem solving, and recall skills that are necessary for enhanced attribute development. The demands and challenges that students face during their college years require that attributes such as achievement, conscientiousness, coping, discipline, goal setting, locus of control, motivation, performance, persistence, resiliency, and time-on-task be highly developed. Perhaps the best way to evaluate the benefits of completing intensive upper-level math courses in high school is to find students of comparable intellectual ability and track developmental differences between those who take advance math classes and those who do not. This would entail conducting a longitudinal type of study, the type of which was not possible to perform under the conditions that existed for this study.

It is postulated that completion of advanced math courses would be of most benefit to students of middle skill levels. Students of low skill levels will most likely not succeed; students of high skill levels will most likely succeed but not receive the same degree of benefits because they will not have to work as hard to navigate through the disequilibrium/dissonance experienced while completing such courses. In order to find just such evidence in this study, an attempt was made to categorize ACTCOMP (a continuous variable) into three groups. In this project, a student's cognitive skill level was measured using his/her ACT Assessment composite score or ACTCOMP (American College Testing Services, 1997). The scores on ACTCOMP range from 1-36. It was the researcher's desire to group the ACTCOMP scores of the 290 students used in this study into low, middle, and high skill level categories. The ACTCOMP cognitive skill level categories were grouped using 13-19 as representing the lowest skill level, 20-24 for the middle skill level, and 25-35 for the highest skill level. This grouping placed an approximate equal number of participants in each group: lowest (n = 91), middle (n = 119), and highest (n = 80).

How does the level of math a student completes in high school relate to his/her scores along the dimensions of psychosocial and moral/ethical student development according to his his/her cognitive skills? A table of descriptive statistics was constructed that listed the means, standard deviations, and sample sizes for each variable used to measure psychosocial and moral/ethical development in this study, categorized by the level of math each student completed within each of the three cognitive skill level groupings. Table 21 presents the results.

Table 21

Descriptive Statistics for the Variables Used to Measure Psychosocial and Moral/Ethical Student Development, Categorized by Level of Terminal Math Course Completed (LVLMATH) *Within Each Cognitive Skill Level* (ACTCOMPGRP) *Grouping* (n = 290)

Variable	ACTCOMPGRP	LVLMATH	Mean	SD	N
AUT	Lowest (13 - 19)	1	43.37	8.64	53
		2	44.95	8.12	36
		3	57.96	4.41	2
	Middle (20 - 24)	1	49.00	9.91	28
		2	47.02	8.19	81
		3	47.57	8.00	10
	Highest (25 - 35)	1	48.17	6.51	3
		2	50.31	8.50	45
		3	54.11	8.40	32
PUR	Lowest (13 - 19)	1	42.75	9.00	53
		2	43.79	7.04	36
		3	56.94	8.04	2
	Middle (20 - 24)	1	47.68	9.88	28
		2	46.07	10.70	81
		3	47.26	6.15	10
	Highest (25 - 35)	1	49.46	3.00	3
		2	48.77	11.02	45
		3	52.78	10.40	32
SL	Lowest (13 - 19)	1	46.24	10.61	53
		2	51.51	10.70	36
		3	58.16	2.29	2
	Middle (20 - 24)	1	48.87	10.35	28
		2	48.49	11.02	81
		3	47.69	6.58	10
	Highest (25 - 35)	1	60.85	5.71	3
		2	50.38	8.93	45
		3	53.05	8.90	32

Table 21 (Cont.)

Variable	ACTCOMPGRP	LVLMATH	Mean	SD	N
LP	Lowest (13 - 19)	1	45.12	8.96	53
		2	46.03	8.60	36
		3	58.94	2.77	2
	Middle (20 - 24)	1	50.00	10.91	28
		2	48.71	9.84	81
		3	51.26	8.88	10
	Highest (25 - 35)	1	54.03	5.20	3
		2	51.05	10.31	45
		3	54.61	10.11	32

*Note: All task, subtask, and scale scores generated from the student responses on the Student Developmental Task and Lifestyle Assessment (SDTLA) were reported in both raw score and standardized score form. In this study, only the standardized scores from the SDTLA were used for analysis purposes. The process of converting a raw score into a standardized score is done in two steps. First, from each raw task, subtask, and scale score generated in this study, its corresponding mean score is subtracted [obtained from the normative sample provided in the *Preliminary Technical Manual for the Student Developmental Task and Lifestyle Assessment* (Winston, Miller, & Cooper, 1999)] and the resulting difference is then divided by the corresponding standard deviation (also obtained from the normative sample). Second, the result from the first step is then multiplied by 10 and added to 50. The standardized scores produced from the sample of students used in this study should be evaluated against a mean of 50 and a standard deviation of 10 for each task, subtask, and scale score.

Within the lowest cognitive skill level grouping, the mean scores did increase from LVLMATH 1 to 2 for each of the four variables examined. Other comparisons were not as favorable. The differences in sample sizes within each cognitive skill level grouping and level of math category may be a contributing factor in the lack of consistency in the increase of scores. Eighty-four students were classified as having completed only the courses required in the basic high school mathematics core curriculum of Algebra I, geometry, and Algebra II. There were 162 students who took a math class one level beyond the basic mathematics core curriculum and 44 students who took a math course that was two levels above the basic mathematics core (calculus). Possibility other variables not included in this specific analysis are confounding results.

Regardless of the reasons, the results presented in Table 21 did not support the argument that completion of advanced math courses would be of most benefit to students of moderate ability.

Summary

Some ancillary findings were presented at the beginning of Chapter 4. First, the results presented in Table 6 indicated that in this study, math ability did relate to math course taking as reported in earlier studies conducted by Hall and Ponton (2005), Maple and Stage (1991), and Trusty (2002). Second, the results from Table 7 indicated that many students who have the opportunity and the capability to take advanced math classes did not do so. In this study, the percentage of students not participating in higher-level math courses was not as high as what was reported in *Report: U.S. Students More Prepared Academically Than 20 Years Ago* (2005). Still, 39 percent (113/290) of the students in this study chose not to take any math beyond their junior year. Sixty-five out of those 113 students (58 percent) who chose not to take math beyond their junior year did not take any math courses after finishing Algebra II and/or geometry.

Statistical tests of the MANOVA assumptions (independence, normality, and homogeneity of covariance) indicated that one of the variables first used to measure psychosocial student development, the *Mature Interpersonal Relationships Task* (MIR) score, created problems related to normality/homogeneity of covariance. This was revealed through the Shapiro-Wilk statistical test of univariate normality and stem-and-leaf plots for each of the dependent variables originally entered into the factorial MANOVA design. Removal of the *Mature Interpersonal Relationships Task* score from the design changed the results of the homogeneity of covariance test, the Box Test, from significant (p = .022) to non-significant (p = .087). The resulting factorial MANOVA design was evaluated using LVLMATH and GENDER as the independent or grouping variables and ACTCOMP, PUR, AUT, LP, and SL as the dependent variables. The new factorial MANOVA design appeared to be tenable as far as the model assumptions of independence, normality, and homogeneity of covariance matrices was concerned.

MANOVA results indicated that the three groups of students tested, categorized by the terminal math course completed in high school (LVLMATH), did indeed differ on the set of dependent variables (multivariate significance) used in this study. Univariate tests indicated that all five of the dependent variables used in the final MANOVA design contributed to multivariate significance according to a student's terminal math course completed in high school (LVLMATH). Therefore, the interpretation given here is that affirmative answers to the first three research questions are tenable. Completion of intensive mathematics classes beyond the basic high school mathematics core does appear to have a significant relationship with general cognitive skill level (research question # 1) and also a significant relationship with the scores that measure psychosocial student development (research question # 2), and moral/ethical student development (research question # 3).

GENDER did not appear to have a statistically significant relationship with the scores that were used to measure psychosocial and moral/ethical student development. Multivariate and univariate tests of significance gave no indication of a GENDER X LVLMATH joint (combined) effect (relationship). Multivariate tests to establish the existence of a relationship between GENDER and the set of dependent variables tested in this study were non-significant. The univariate tests of GENDER with the set of dependent variables indicated that only one variable used to measure moral/ethical student development, the *Salubrious Lifestyle Scale,* was significant from a statistical standpoint (p = .043). This would perhaps indicate that when considering the sample of students selected in this study, it is possible that freshmen female students adhere to a healthier lifestyle than their male counterparts. Otherwise, the answer to research question # 4 was that gender does not appear to have a relationship (either individually or jointly) with the scores that measure psychosocial and moral/ethical student development when evaluated in combination with completion of intensive math courses beyond the basic high school mathematics core.

Following the statistically significant results indicating that LVLMATH relates to the set of dependent variables used in the factorial MANOVA design, a descriptive discriminant analysis was conducted to identify which uncorrelated linear combination(s) of dependent variables best describe the differences among the groups of students examined in this study (according to LVLMATH). Only one discriminant function was significant. Interpretation of the standardized discriminant function coefficients and the structure matrix indicated that only one dependent variable, ACTCOMP, was responsible for maximizing group separation. Therefore, according to the hypothesis of this study, cognitive skill levels separate the groups and are enhanced/sharpened as a result of completing intensive, upper-level math courses in high school. These enhanced/ sharpened cognitive skills enable students to advance along the dimensions of psychosocial and moral/ethical student development.

The last statistical analysis reported here in Chapter 4 involved looking at the relationship between math course taking and cognitive/math skills. An important aspect of this study involves trying to determine if a relationship exists between the level of math a student completes in high school and his/her scores that measure psychosocial and moral/ethical student development according to his his/her cognitive skill level. Table 21 was constructed that listed the means, standard deviations, and sample sizes for each variable used to measure psychosocial and moral/ethical student development in this study, categorized by the level of math each student completed within each of three cognitive skill level groupings (lowest, middle, and highest). The results did not support the hypothesis given earlier in this study that rigorous, intensive, advanced math classes should be of greatest benefit to students in the middle cognitive skill level.

CHAPTER V

DISCUSSION

Summary

This study was designed to explore a theoretical relationship between the terminal math course a student completes in high school and his/her level of cognitive, psychosocial, and moral/ethical student development. Adelman (1999) and Trusty and Niles (2003) both conducted longitudinal studies that used national probability samples of students. Both studies produced statistical evidence that the highest level of mathematics a student completes in high school was the strongest contributing factor in completing a bachelor's degree. More than any other individual variable tested, intensive, upper-level math courses had a greater influence on degree completion than other academic resources, SES, gender, or ethnicity. Why? What benefits do students derive from completing rigorous math courses that enable them to adapt to the challenges of college and obtain a degree?

The hypothesis upon which this study is based posits that during the process of completing advanced math classes, students sharpen/enhance their problem solving, critical thinking, decision making, and recall skills. These skills need to be highly developed in order for students to generate a level of attribute growth (e.g., achievement, conscientiousness, coping skills, discipline, goal setting, locus of control, motivation, performance, persistence, resiliency, time-on-task, etc.) necessary to advance along the dimensions of cognitive, psychosocial, and moral/ethical student development.

Because of the moderate to high intercorrelations hypothesized to exist among the dependent variables used in this study to measure cognitive, psychosocial, and moral/ethical development, multivariate analysis of variance (MANOVA) was chosen as the experimental design that would best answer the research questions of this study. Those research questions are now reproduced below.

1. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with general cognitive skill level?

2. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with psychosocial student development?

3. Among traditional, incoming freshmen, does completion of intensive mathematics courses beyond the basic high school mathematics core have a statistically significant relationship with moral/ethical student development?

4. Does gender have a statistically significant relationship with the scores that measure psychosocial and moral/ethical student development when evaluated alone (tested as a main effect) or in combination with completion of intensive mathematics courses beyond the basic high school mathematics core (tested as an interaction effect)?

Discussion

In the process of determining if the assumptions of the factorial MANOVA conducted in this study were tenable, one of the variables that was chosen as a measure of psychosocial student development, the *Developing Mature Interpersonal Relationships Task* score from form 1.99 of the Student Developmental Task and Lifestyle Assessment or SDTLA (Winston, Miller, & Cooper, 1999), was eliminated. As a result, the *Establishing and Clarifying Purpose Task* (PUR) score and the *Developing Autonomy Task* (AUT) score from the SDTLA were used in the factorial MANOVA design to measure psychosocial student development. The *Lifestyle Planning Subtask* (LP) score and the *Salubrious Lifestyle Scale* (SL) score from the SDTLA were the variables used in this study to measure moral/ethical student development. A proxy measure, the ACT Assessment composite score (ACTCOMP), was selected to assess a student's cognitive skill level.

The factorial MANOVA results from Chapter 4 produced statistically significant results that would point toward answering research questions # 1, # 2, and # 3 in the affirmative. The multivariate F-tests from the factorial MANOVA design indicated that the three groups of students (categorized by the level of high school math course completed: Level 1 = completion of the basic high school mathematics core curriculum of Algebra I, geometry, and Algebra II; Level 2 = completion of a math class one level beyond the basic high school mathematics core e.g., Algebra III, math analysis, pre-calculus, statistics, or trigonometry; Level 3 = completion of a math class a second level beyond the basic high school mathematics core, calculus) differed on the average on the set of dependent variables tested. The univariate F-tests for each of the five dependent variables tested were all statistically significant. These results indicate that the terminal math course a student completes in high school has a meaningful relationship with his/her cognitive skill level and, in addition, also relates to his/her level of psychosocial and moral/ethical student development.

In regards to research question #4, multivariate tests of significance indicated that males and females (GENDER) did not differ on the average on the set of dependent variables tested. This analysis included looking individually at the relationship of GENDER with the scores that were used to measure psychosocial and moral/ethical student development and the joint (combined) relationships of GENDER and LVLMATH with the scores that were used to measure psychosocial and moral/ethical student development. This is a somewhat, but not totally unexpected result. As part of his longitudinal study, Adelman (1999) introduced the background variables of SES, race, gender, parenthood prior to age 22, and the developed construct of “educational anticipations” into a logistic regression model that was designed to predict bachelor’s degree completion in college. In Adelman’s study, both race and gender showed virtually no relationship with degree completion. Despite the apparent evidence that race and gender had no significant relationship with degree completion, Adelman included these background variables in his logistic regression model hoping to find some sort of statistical evidence of their contribution to degree completion. Adelman (1999) commented:

> It is not surprising that race and sex fall out of the model, no matter how generous a statistical selection criterion was used. If these variables failed to meet statistical selection criteria at a stage of student history prior to college attendance and in the course of constructing ACRES, their chances of playing any role after the student group has been winnowed to 4-year college attendees is dim indeed. (p. 62)

Race and gender played a similar role in the study conducted by Trusty and Niles (2003). In summarizing their findings, Trusty and Niles commented on the effects that completing intensive, upper-level high school math courses had on bachelor's degree completion. "These strong effects of credits in intensive math courses were independent of the influences of eighth grade reading and math ability, gender, SES, and racial-ethnic group membership" (p. 103).

It is important to remember that in both the Adleman (1999) and the Trusty and Niles (2003) studies, gender was treated as pre-college background characteristics, just as it was in this study. This literature supports the statistical results presented in this study indicating that gender may not have a significant relationship with cognitive, psychosocial, and moral/ethical development.

However, conflicting evidence can be found indicating that gender should relate to various dimensions of student development. In discussing the results from the normative sample in the *Preliminary Technical Manual for the Student Developmental Task and Lifestyle Assessment*, Winston, Miller, and Cooper (1999) state that for freshmen, women scored equal to men on two subtask and one scale score of the SDTLA. On the other eleven task, subtask, and scale scores of the SDTLA, women scored higher than men. This indicates that gender should have made a difference in evaluating the variables used in this study to measure psychosocial and moral/ethical student development. Results of the univariate tests of GENDER with the set of dependent variables used in this study did indicate that females had significantly higher scores on the *Salubrious Lifestyle Scale* than what males did.

In addition, if the hypothesis under which this study was conducted is tenable, then students who complete upper-level, intensive math courses in high school have refined/enhanced cognitive skills, which help develop attributes necessary for upward movement along the cognitive, psychosocial, and moral/ethical dimensions of student development. The students who are more likely to take such advanced math courses are those who demonstrate higher achievement in mathematics. In her meta-analysis of mathematics achievement studies, Friedman (1989) observed that in five of seven studies, 12th grade boys outperformed l2th grade girls, with the two remaining studies showing no difference. Halpern and LaMay (2000) found that with regard to scores on standardized mathematics achievement tests, boys tended to score higher than girls. These studies would point toward gender differences in math ability and achievement, which according to the theory posited in this study, should produce higher scores for males than females on variables measuring psychosocial and moral/ethical student development.

Discriminant Analysis

Stevens (2002) argues for a discriminant analysis to be performed as an adjunct procedure following significant MANOVA results. The standardized canonical discriminant function coefficients and the structure matrix results from the descriptive discriminant analysis conducted in Chapter 4 indicate that the measure of general cognitive skill level used in this study, ACTCOMP, was sufficient to explain how the groups of students differed, according to the highest level of mathematics course they completed while in high school. Those results are interpreted to mean that cognitive skill level is what separates the groups and that the differences in the intensity of the math courses in each group correspond to the differences in critical thinking, decision making, problem solving, and recall skills. The differences in the refinement/enhancement of these skills relate to differences in efficacy, ability, and confidence constructs that result in varying levels of attribute development. Critical thinking, the ability think logically and abstractly, and the talent to organize and synthesize information are all skills developed in the course of completing higher lever math courses.

It might be of benefit to review how cognitive skills are posited to be related to various aspects of student development and how, in this study, the level of mathematics a student completes in high school is hypothesized to relate to cognitive skill level. According to Kohlberg (1969, l972, l975) and Perry (1970), the moral/ethical dimension of student development is affected by cognitive ability/skill. Smith (1978) postulates that moral/ethical student development is governed by rule, decision-making, and problem solving strategies that are based on one's level of cognitive ability/skill and are affected by changes in cognitive schema as a result of organizing and integrating social experience. Parker, Widick, & Knefelkamp (1978) advocate that the psychosocial component of student development pertains to how one chooses to act, behave, and respond in various social situations which are influenced by the challenges and responses offered by members of society and the environment. Chickering (1969) and Erickson (1963) believe that in order for students to advance along the psychosocial dimension, they must continue to develop and grow cognitively. This would indicate that as a result of working through the challenges and rigors of advanced math courses, the resulting growth in cognitive ability/skill equips students with the attributes necessary to progress along the psychosocial aspect of student development. Kohlberg (1972) and Piaget (1964) theorize that cognitive growth will not occur unless one's interaction with environmental and social situations creates a state of mental discord that requires cognitive organization of a new set of schema structures. These new schemas must be sufficient in giving guidance to resolving the discord created by the environmental/social situation. In order to work through the dissonance to balance sequence of cognitive activity, an individual must be first presented with a social/environmental situation that creates disequilibrium. The theory upon which this study is based advocates that the mental processes needed to restore cognitive balance after encountering disequilibrium/ dissonance are developed/refined/sharpened as students work through the requirements and intensity of advanced math courses. As a result of working through the disequilibrium/dissonance to balance process when trying to cope with the attention and care required from upper-level math courses in high school, students develop the skills/constructs/attributes necessary to score higher along the dimensions of psychosocial and moral/ethical student development before entering college. The development of these skills/constructs/attributes better equip students to cope with the challenges faced during their college years.

Math Ability

This study was designed as a correlational study which sought to determine if a relationship exists between the level of math a student completes in high school and his/her level of cognitive, psychosocial, and moral/ethical development. It would be remiss to not briefly discuss the role that math ability plays in a student's decision to pursue higher-level math classes.

Math ability influences math course taking (Hall & Ponton, 2005; Maple & Stage, 1991; Trusty, 2002). This is a pertinent part of the complex puzzle that is being investigated in this study. If math ability influences math course taking, then according to the theory postulated in this study, it would influence the benefits derived from completing rigorous, intensive, upper-level math courses. This study argues that the demands and expectations of advanced math classes create cognitive dissonance and/or disequilibrium as students progress through such courses. Students then must use/develop refined/enhanced critical thinking, problem solving, recall, and decision making skills during the course of completing advanced math classes in order to restore cognitive balance. Students who are gifted (have more math ability) will most likely not develop as high a level of cognitive dissonance/disequilibrium as a result of taking intensive math classes. Therefore, according to the premise of this study, gifted math students would not receive the same level of benefits as students of lesser ability.

Consequently, Table 6 in Chapter 4 was constructed to evaluate the sample of students used in this study in regards to comparing their math ability to the level of advanced math they completed in high school. In this study, a student's math ability was measured using his/her ACT Mathematics Usage Test score or ACTM (American College Testing Services, 1997). The scores on the ACTM range from 1-36. The ACTM scores were grouped into low math ability (10-18), moderate math ability (19-24), and high math ability (25-36). This placed an approximate equal number of participants in each group: low (n = 99), moderate (n = 109), and high (n = 82). Table 6 showed that in this study, a student's math ability as measured by his/her ACTM, related to the terminal math course he/she completed in high school. Fifty-seven percent (56/99) of the students categorized as having low math ability finished only what was required to complete the basic high school mathematics core curriculum. Seventy-six percent (83/109) of the students categorized as having moderate math ability completed at least one upper-level math course beyond the basic high school mathematics core. Ninety-eight percent (80/82) of the students in the high math ability category completed at least one advanced math class. Table 6 indicates that the results of this study should be interpreted with care.

Math Course Taking

Is it plausible that the intensity, demands, and rigors that students face while participating in advanced math classes play a part in their choice whether or not to take them? Maybe students want to avoid the disequilibrium/dissonance created when challenged cognitively by upper-level math courses. The lack of experience and confidence in successfully navigating stressful situations may cause students to seek a more familiar and/or comfortable environment. This may help explain why, according to *Report: U.S. Students More Prepared Academically Than 20 Years Ago* (2005), 55 percent of the high school students surveyed during 2000 did not take math courses beyond Algebra II or geometry. This supposition is supported, in part, by Wieschenberg (1994) who found evidence that excluding math majors, avoidance of math is at an all-time high. Therefore, it was of interest to investigate the distribution of the students used in this study according to the level of math a student completed in high school and the number of years he/she took math classes.

The sample of students who participated in this study exhibited a much higher rate of participation in math courses beyond Algebra II and/or geometry (71 percent or 206/290). However, an interesting statistic found in Table 7 of Chapter 4 revealed that 39 percent (113/290) of the students in this study chose not to take any math beyond their junior year. Sixty-five out of those 113 students (58 percent) who chose not to take math beyond their junior year did not take any math courses after finishing Algebra II and/or geometry. Stakeholders, customers, and responsible parties interested in improving education in the U.S. need to find and to develop ways to improve high school student participation in advanced math classes. If for no other reason, the choice a student makes not to pursue advanced math beyond Algebra II and or/geometry while in high school, limits his/her career choices (Maple & Stage, 1991; Singer & Stake, 1986; Trusty, 2002).

The Relationship of Cognitive Skill and the Level of Terminal High School Math Class Completed

According to the theory posited in this study, within each cognitive aptitude/skill level grouping the mean scores for each variable measuring psychosocial and moral/ ethical student development should increase as students take higher levels of math (LVLMATH). The results presented in Table 21 of Chapter 4 do not completely support this assertion. In this study, a student's cognitive skill level was measured using his/her ACT Assessment composite score or ACTCOMP. The ACTCOMP scores range from 1-36 (American College Testing Services, 1997). As was done with ACTM scores, the ACTCOMP scores were grouped into three categories: lowest (10-18), middle (19-24), and highest cognitive skill level (25-36). This was also done in order to place an approximate equal number of participants in each group: lowest (n = 91), moderate (n = 119), and highest (n = 80). Within the lowest cognitive skill level grouping, the mean scores did increase from LVLMATH 1 to 2 for each of the four variables examined. Other comparisons were not as favorable. Perhaps the differences in sample sizes within each cognitive skill level grouping and level of math category was a contributing factor in the lack of consistency in the increase of scores. There is the possibility that other variables not included in this specific analysis are confounding results. Regardless of the reasons, the results presented in Table 21 did not support the argument that completion of advanced math courses would be of most benefit to students classified in the middle skill level.

Issues Faced When Trying to Isolate the Effect of Terminal Math Course Completed on Various Dimensions of Student Development

One point about this study needs to be clarified. Figure 1 (page 40) represents a model that postulates a hypothesized relationship between the terminal math course a student completes, his/her enhanced/refined cognitive skill level, and his/her level of psychosocial and moral/ethical student development. This project was designed as a correlational study, not one that sought to find statistical evidence of a cause and effect relationship. In order to do that, control variables would traditionally be introduced into an experimental design in order to isolate the effect that a student's terminal math class has on cognitive, psychosocial, and moral/ethical developmental. Access to the sample of students used in this study was limited. In addition, the parameters under which this study was conducted made it unreasonable to be able to collect the demographic and background data needed as controls (e.g. SES and pre-high school math and reading skill).

The research presented here is intended to explore the possible benefits/results of completing intensive, upper-level math courses and to offer a possible explanation as to why the studies conduct by Adelman (1999) and Trusty and Niles (2003) found that more than any other individual factor, finishing a course beyond the basic high school mathematics core curriculum had the strongest single influence on bachelor's degree completion. In reporting their results, both Adelman (1999) and Trusty and Niles (2003) posited about the influence of completing advanced math classes on degree completion, but never offered any kind of possible explanation why.

Maybe a regression approach that utilized an Attribute-Treatment Interaction technique (Pedhazur, 1997) would be a better experimental design to use to assess the relationship between the completion of rigorous math classes and the benefits to students of average skill levels. The terminal math class completed would act as the treatment variable. Instead of using a student's ACT Assessment composite score as a proxy measure of general cognitive ability/skill level, a more appropriate measure of general intelligence such as the Wechsler Abbreviated Scale of Intelligence or WASI (Weschsler, 1999) could be used.

The ATI regression approach is used when one variable is categorical (level of math) and one is continuous (WASI score). It would be of interest to see how each separate level of the treatment variable, the terminal math course completed, interacts with students of varying intellectual ability/skill level. Pehazur (1997) recommends that when a statistically significant interaction between a continuous and a categorical variable is detected, the Johnson-Neyman procedure should be employed to determine regions of significance. This would allow for a more thorough investigation of the main effects of intelligence and level of math, their interaction effect, and proportion of variance accounted for.

Because of the conditions under which this study was conducted, an ATI regression approach was deemed inappropriate. First, the treatment effect (level of math course completed) should be administered to all participants at the same time. In this study, some students took a math course as juniors, but not during their senior year. Other students took various math courses during both their junior and senior years. Second, all subjects should be assessed along the dimension of intelligence at the same time. In this study, a student's highest ACT Assessment composite score was used as a measure of his/her general cognitive ability/skill level, regardless of when the ACT Assessment was taken.

Implications

The purpose of this study was to explore a theoretically derived proposition based on the findings of Adelman (1999) and Trusty and Niles (2003). If students who complete math courses beyond Algebra II (traditionally the last class required in the basic high school mathematics core) have a greater chance to complete a college degree, what is it about taking upper-level math courses that enables them to do so? This study found statistical evidence that completing advanced math courses relates strongly to advancement along the cognitive, psychosocial, and moral/ethical dimensions of student development. This is a complex puzzle with many small, but very influential pieces. Trying to address the influential aspects of why students choose to take math classes beyond what is required to graduate from high school is outside the scope of this study. This project was designed to explore the potential related benefits of completing upper-level math courses. A student's ability, interest, achievement, self-concept, and perceived usefulness of mathematics all play a role in a student's decision to take intensive, rigorous, upper-level math courses (Hall & Ponton, 2005; Maple & Stage, 1991; Middleton & Spanias, 1999; Schreiber, 2002; Singer & Stake, 1986; Trusty, 2002). According to the results presented in this study, students who complete advanced math courses demonstrate advancement along the cognitive, psychosocial, and moral/ethical aspects of student development.

What attributes are most developed as a result of completing rigorous, intensive math courses? Achievement, conscientiousness, coping skills, discipline, goal setting, locus of control, motivation, performance, persistence, resiliency, and time-on-task are the attributes offered in this study as being developed/enhanced/refined as a result of working through the cognitive disequilibrium/dissonance to balance process created by the challenges and demands of completing advanced math classes. Dickinson and Butt (1989) advocate that success in mathematics is a powerful influence on motivation to achieve and that time-on-task is often used as an index of motivation. Students in high school face time-on-task issues when working through tough math courses. In a study of the relationship between students' attributions of success (locus of control) in mathematics in 8th grade and their subsequent achievement in math in 11th grade, Meyer and Fennema (1985) found that attribution of success in 8th grade was the most consistent correlate to achievement (or lack of) in the 11th grade. Hagedorn, Siadat, Nora, and Pascarella (1997) found that studying mathematics generally requires long uninterrupted periods. If this is true, then students need attribute development in the areas of achievement, discipline, conscientiousness, resiliency, persistence, and coping skills in order to complete their assigned task(s). In a study focusing on mathematical achievement, Nora, Cabrera, Hagedorn, and Pascarella (1996) found that a variety of factors such as math ability, persistence, anxiety, attitudes, backgrounds, and exposure to mathematics (i.e., number and kind of math classes taken) were explanatory factors of mathematics achievement. As discussed in several different parts of this paper, the key to linking advanced math to various aspects of student development lies in the development/refinement/enhancement of critical thinking, problem solving, recall, and decision making skills.

Data has been collected indicating that over 60 percent of students who take trigonometry, precalculus, or calculus classes in high school earn a bachelor's degree in college. Students taking trigonometry had a 62 percent degree completion rate. Students who finished pre-calculus earned bachelor's degrees approximately 75 percent of the time. Those completing calculus had an 83 percent bachelor's degree completion rate (National Center for Educational Statistics, 2003). Prior research has clearly established a link between the completion of advanced math classes in high school and success in college.

Suggestions for Further Research

1. It would be beneficial to replicate this study with a couple of modifications. A better measure of a student's cognitive ability/skill level, such as the Weschsler Abbreviated Scale of Intelligence or WASI (Weschler, 1999) could be administered to the participants. The WASI is short, taking only about 15-20 minutes to administer. It also may be advisable to consider giving two shorter versions of the Student Developmental Task and Lifestyle Assessment or SDTLA (Winston, Miller, & Cooper, 1999), form 2.99 and form 3.99. Usage of these two forms would still give an accurate assessment of a student's level of psychosocial and moral/ethical student development. The downside(s) of using forms 2.99 and 3.99 instead of form 1.99 (which was used in this study) is that forms 2.99 and 3.99 do not score the *Developing Mature Interpersonal Relationships Task* (which eventually was removed from the experimental design of this study), the

Salubrious Lifestyle Scale, or the *Response Bias Scale.* A regression approach, using an Attribute-Treatment Interaction technique (Pedhazar, 1997) could then be applied that could assess the main effects of intelligence and level of math, their interaction effect, and proportion of variance accounted for. In addition, regions of significance could be identified. There could be another possible benefit to using a better measure of general cognitive ability/skill level (such as the WASI). By using the WASI and a student's score on the ACT Mathematics Usage Test (as a measure of a student's math ability), it may be possible to isolate the effect that the level of math a student completes in high school has on cognitive, psychosocial, and moral/ethical development *after* controlling for math ability. A regression approach would also permit entering other background variables into the model. This would not only allow for testing the incremental variance accounted for as each predictor is entered into the model, but also determine the unique contribution of each predictor variable (Pedhazar, 1997).

2. Another suggestion for further research involves using Figure 2 (page 50) as a theoretical basis for measuring the differences in construct and attribute development among students who complete different levels of advanced math, according to varying degrees of cognitive ability/skill level. This could involve using structural equation modeling (SEM) or path analysis. The use of SEM or path analysis as an experimental design would allow for an analysis of the hypothesized cause and effect relationships posited in Figure 2 (page 50). Development of such a structural model would take time, perseverance, and patience. Model testing of the causal relationships among the latent and/or manifest variables would most likely take several attempts before a parsimonious model could be developed that would adequately explain the direct and indirect effects

among both the latent and manifest variables theorized in Figure 2 on page 50 (Hoyle, 1995; Pedhazur, 1997).

3. Perhaps the best approach to use in examining the theory offered in this project is to conduct a longitudinal study, as was done by Adelman (1999) and Trusty and Niles (2003). One of the main keys in helping to determine how beneficial advanced math courses are in promoting various aspects of student development is to see how the completion of rigorous math classes affects student development after controlling for math ability. Conceivably, this would entail beginning the study in early elementary school. Students could be assessed for both cognitive and math aptitude/skill level. Then incremental changes in both could be measured as they progressed through school. Another benefit to a longitudinal approach is that it would most likely be easier to obtain accurate date on background characteristics (e.g. parent's level of education, SES, leadership experiences, reading ability, etc.) that could be used as control variables in attempting to isolate the effect of advanced math on the dimensions of student development.

4. The last suggestion for further research presented here may be as important, if not more important, than any of the others. The constructs and attributes listed in Figure 2 (page 50) can be very difficult to measure. Maybe a key in deciphering the complex puzzle presented in this project is to let the students themselves discuss their perceptions about the benefits of completing upper-level math courses. This would entail conducting a qualitative study that could focus on just how students deal with the disequilibrium/ dissonance created when they are engaged in advanced math. One important advantage of using some sort of qualitative approach is that an in-depth assessment of the benefits of

completing intensive math classes could be directed toward students of moderate to low cognitive and/or math aptitude/skill level. Maybe an experimental design that incorporated both qualitative and quantitative aspects would be a more desirable approach than either one individually.

Suggestions for Further Practice

Discovering how to empower students with the tools and skills necessary to successfully navigate the challenges and opportunities presented by college is a worthy goal of social science. Future generations will be affected by the quality of education that can be provided. It is the responsibility of college administrators, educators, and policymakers to develop criteria that will identify those students most able to grow and flourish during college. Why is it important to develop criteria to identify the students best able to successfully complete college? The cost of education is skyrocketing and more and more, taxpayers and policymakers are demanding explanations of student persistence, transfer, and completion rates (Colbeck et al., 2003). How does this relate to this study? Adelman (1999) and Trusty and Niles (2003) found that completion of rigorous math courses beyond Algebra II greatly enhanced a student's likelihood of degree completion (academic preparation). This study has found statistical evidence that finishing advanced math classes in high school relates to higher levels of pre-college student development (non-academic preparation). Therefore, the recommendations for further practice are:

1. Consider requiring all college-bound students to complete at least one class beyond the basic high school mathematics core curriculum of Algebra I, geometry, and Algebra II (a college entrance requirement).

2. Offer more practical application courses in high school that require math skills such as statistics, math analysis, and discrete math. Students have been found to be more motivated to be engaged in math if they perceive its usefulness and the benefits of its applications (Hall & Ponton, 2005; Middleton & Spanias, 1999).

3. Put more emphasis on teaching traditional mathematical concepts using an approach that requires problem solving, critical thinking, and decision-making skills. The National Council of Teachers of Mathematics (NCTM) gives data analysis and probability as one of its *Content Standards.* The NCTM also lists problem solving and reasoning and proof among its *Process Standards* (NCTM, 2000). In this study, enhanced development/ refinement of problem solving, critical thinking, decision making, and recall skills are postulated to improve the self-efficacy, ability, concept, and confidence beliefs needed to promote the attributes required to advance along the cognitive, psychosocial, and moral/ethical dimensions of student development.

Summary

The aim of this study was to determine if a relationship exists between the levels of mathematics a student completes in high school and his/her level of cognitive, psychosocial, and moral/ethical student development. Because of the hypothesized moderate to high intercorrelations among the variables chosen to measure cognitive, psychosocial and moral/ethical development, a factorial MANOVA approach was chosen as the statistical design that could best answer the research questions posed at the beginning of this chapter. The results of the factorial MANOVA conducted did, indeed, indicate that students who complete advanced math courses in high school have enhanced/refined cognitive abilities and scored higher on the variables used in this study to measure psychosocial and moral/ethical student development. According to the theory posited in this study, the enhanced/refined/sharpened cognitive ability/skill levels developed as a result of completing intensive upper-level math classes in high school promote the critical thinking, problem solving, decision making, and recall skills needed for a level of attribute development that would advance pre-college psychosocial and moral/ethical development.

Conclusion

The question that must now be addressed is what has this study accomplished? The answer is simply that, perhaps, this study has produced enough evidence to warrant pursuing further research in this area. Perhaps the most significant contribution that this project has to offer is that it is the first known study to attempt to tie the benefits of an aspect of academic preparation in high school (advancement in mathematics) to non-academic preparation (student development). If further studies are conducted along the line of research presented here and similar results are found, the implications of the benefits derived from having all college-bound students complete advanced math courses before entering college are significant.

The implications and ramifications of this research are left for each individual reader of this project to determine. Questions pertaining to the results of this study are numerous. Is the teaching of advanced math a key to equipping at-risk students in high school with the coping skills they need to successfully integrate into society? If so, is it reasonable to postulate a relationship between the level of mathematics achievement and those students who commit suicide in high school? If this apparent link between completing intensive math courses in high school, advanced levels of cognitive, psychosocial, and moral/ethical student development, and completion of a bachelor's degree in college is sound, then how do we in education create learning environments that entice students to enroll and persist in these difficult, hard to master math classes? Could it be that unlocking the key to this entire sequence is not found during a student's high school years, but much earlier? Should our best high school math teachers teach the upper-level math classes, or would their skills be better served by helping students in lower level classes? What about the concept of social promotion? Should students be promoted through each grade of elementary school, regardless of their performance in any and all subjects? There is no doubt about the importance of developing social skills during elementary years, but should social growth take precedence over academic development? This study was designed to investigate a small, but significant piece of a very complex puzzle. Social scientists should make it a priority to continue to study other pieces of this puzzle and conduct research to determine how best to put them together.

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Appendix A

Institutional Review Board Approval

Oklahoma State University

Oklahoma State University Institutional Review Board

Date:	Thursday, September 29, 2005
IRB Application No	ED0627
Proposal Title:	Exploring the Relationship Between High School Coursework in Mathematics and Precollege Student Development
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved Protocol Expires: 9/28/2006

Principal Investigator(s

Mark Tippin
512 Cherryvale Road
Edmond, OK 73003

Laura Barnes
700 N. Greenwood Main H
Tulsa, OK 74016

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

Appendix B

Institutional Review Board Approval

Southwestern Oklahoma State University

SWOSU
Southwestern Oklahoma State University
Department of Psychology

August 26, 2005

Mark Tippin, Associate Professor of Business
School of Business

Re: "Exploring the Relationship Between High School Coursework in Mathematics and Precollege Student Development"

Dear Mr. Tippin,

The Protection of Human Subjects Committee, through expedited review, has approved your research entitled: "Exploring the Relationship Between High School Coursework in Mathematics and Precollege Student Development."

It is the responsibility of the researcher to notify the committee and submit any modifications to the study protocol prior to implementation. It is also the responsibility of the researcher to submit an annual report if the study extends past a year and a final report upon completion of the protocol. **IRB FORM # HS-3** is provided on the SWOSU web site for your use in completing annual and final reports. For institutional compliance and auditing purposes, you are required to maintain all records pertaining to your conducted research including any informed consent forms for three years after completion of the research. For funded research, consult the time required for retention of records by the funding agency. (SWOSU disposition policies should be used when disposing of research records.).

The committee wishes you much success with the study and applauds you for undertaking such an ambitious work.

Sincerely,

Michael Wolff, Ph.D.

Michael Wolff, Ph.D.
Chair, PHSC

cc: Dr. Larry McKee, Associate Dean, School of Business
Dr. Ken Rose, Dean, College of Professional and Graduate Studies
Office of Sponsored Programs

Apendix C

Script for Protocol

Script for Protocol

My name is Mark Tippin, Assistant Professor of Business here at SWOSU. I am a doctoral student at Oklahoma State University working on my dissertation. The purpose of my dissertation study is to investigate the relationship(s) between the math course work that a student completes in high school and his/her preparation for both the academic and non-academic aspects of college.

The results of this research study are intended to help improve a student's preparation for college. Students who are better prepared have greater chances for success in college. In order to assess both types of student preparation, I am asking 1) that each student fill out a survey that will take approximately 30 minutes to complete and 2) that each student allow me to obtain their ACT scores and GPA from their high school transcript.

Any and all information gathered for this study will be strictly confidential. That means that all data will be reported in aggregate form only. I will be the only one who can match any of the information obtained to your name. Your participation is totally voluntary. You must be at least 18 years of age in order to participate. There will be no penalty of any kind for those students who do not wish to participate. For those of you who decide to participate, I ask that you read the consent form and sign the two copies of it that are attached to each scantron answer sheet. You will need to sign both copies and keep the top copy of the consent form for your own records. You will **not** put your name on the scantron answer sheet. This is to help protect the confidentiality of your responses on the survey. After all of the surveys have been completed, I will code the scantron answer sheets so that I will be the only one who can match the information on your high school transcripts to your responses on the survey. This information will be kept secured at all times and will be destroyed within two years after the study has been completed.

Your participation is extremely important, since the accuracy of the results of any research study is always critical. I would greatly appreciate your assistance, and want to thank you for your time. If you have questions of any kind, please feel free to ask me.

Appendix D

Informed Consent

INFORMED CONSENT

I, _________________________________(please print your name), hereby authorize or direct **MARK TIPPIN**, Assistant Professor of Business at Southwestern Oklahoma State University, or assistants of his choosing, to perform the following treatment or procedure.

This study is entitled ***Exploring the Relationship Between High School Coursework in Mathematics and Precollege Student Development.***

This study involves research and is being conducted through Southwestern Oklahoma State University and is sponsored by Oklahoma State University. It is being conducted by Mark Tippin, Assistant Professor of Business at SWOSU and doctoral student in the OSU College of Education.

The purpose of this research is to explore the relationship(s) between the last mathematics course that a student completes in high school, his/her ACT scores, and his/her high school GPA and the level(s) of his/her precollege student development.

I authorize the release of my high school academic records, as described in the paragraph above, to be used in this study. The information I provide will be kept confidential. No identifying information will be provided as a part of any reporting of the data or results of this study. All data will be kept in a locked file cabinet in the project director's office (Mark Tippin). Only the project director will have access to the data used in this study. The data will be kept on file for a period of two (2) years and will be reported only in aggregate form. The SWOSU and OSU Institutional Review Boards (IRB's) have the authority to inspect consent records and data files to assure compliance with approved procedures.

The only procedure that directly requires time and effort on behalf of each student entails completion of the SDTLA assessment tool (Student Developmental Task and Lifestyle Assessment – Form 1.99). Participation in this study will take approximately 30 minutes. There are no known risks associated with this project which are greater than those ordinarily encountered in daily life.

This study will be of benefit to any party connected with higher education that is interested in improving retention and graduation rates. Ultimately, the results of this study are designed to improve/enhance the opportunites for students to obtain a college education.

I understand that participation is voluntary and that I will not be penalized in any way if I choose not to participate. I also understand that I am free to withdraw my consent and end my participation in this study at any time without penalty after I notify the study's director (Mark Tippin).

For any questions related to the study at Southwestern Oklahoma State University, I may contact Mark Tippin (mark.tippin@swosu.edu) at (580)774-3706 or for information on subjects' rights contact Dr. Michael Wolff (michael.wolff@swosu.edu), Protection of Human Subjects Committee Chairman at (580)774-3720. For any questions related to the study at Oklahoma State University, I may contact Dr. Laura Barnes (lbarnes@okstate.edu), Associate Professor of Educational Studies, at (918) 594-8517 or for information on subjects' rights contact Dr. Sue Jacobs, IRB Chair, 415 Whitehurst Hall, (405)774-1676.

I have read and fully understand the consent form. I sign it freely and voluntarily. I realize that my signature indicates that I have agreed to participate in this study according to the terms stated above and allow Mr. Mark Tippin to have access to my high school academic records. A copy of this form has been given to me. I also understand that I must be at least 18 years of age in order to participate in this study and sign this consent form.

Date:____________________ Signature:___________________________________(Please do not print)

I certify that I have personally explained this document before requesting that the participant sign it.

Signed:_______________________________ Project director or authorized represenitive

Appendix E

Demographic Survey

Demographic Questionnaire

Please do **not** use your Scantron sheet for this section. Mark your answers directly on this sheet. Check the box that best answers each question. If none of the answers apply, please write your answer(s) in the blank(s) marked **Other**. Thank you!!!

1. Your age ____________ (those under 18 years of age should **not** fill out any part of the surveys)

2. Your gender: Male Female

3. High School GPA _______________

4. Your ethnicity:
   - Black or African American
   - Hispanic, Latino/a, or Mexican American
   - Asian American or Pacific Islander
   - Native American
   - White or Caucasian/European
   - Bi-racial or multiracial
   - Other____

5. Last mathematics course taken in high school:
   - Algebra I
   - Geometry
   - Algebra II
   - Precalculus
   - Trigonometry
   - Math Analysis
   - Statistics
   - Calculus

Other____

6. Why did you take your last math class as marked in # 5 above?

   - It was required
   - My parents encouraged me to do so
   - My high school counselor encouraged me to do so
   - Mathematics directly relates to (is a necessary part of) my intended college major
   - I thought it would help me for college

Other____

____

7. What is your intended major? **(If you are not sure, write Undecided)**

____

8. During high school, how many leadership positions did you hold? These positions had responsibilities that were vital to the success of the organization. (Class officer, scout leader, club officer, team captain, church group leader, etc.)

____

9. Parent's highest level of education:	Mother:	High School Some College College Graduate Some Grad School أ Graduate Degree	Father:	High School Some College College Graduate Some Grad School أ Graduate Degree

For questions #10 through #14, circle the response that <u>best</u> describes your attitude/feeling about what is being asked. <u>PLEASE CIRCLE ONLY ONE RESPONSE FOR EACH QUESTION ASKED.</u> Thank you!!!!!!!!!!!!!!!!!!

10. Compared to other students, I rate my math ability as being:

5 4 3 2 1

very low … very high

11. Compared to other classes, I rate my ability to do well in a math class as being:

5 4 3 2 1

very low … very high

12. I believe that math ability is something you are either born with or not.

5 4 3 2 1

strongly disagree … strongly agree

13. How much effort do you expect to have to put forth in a math class to be successful?

5 4 3 2 1

maximum … minimum

14. If I work hard enough, I can be successful in a math class.

5 4 3 2 1

strongly agree … strongly disagree

VITA

Mark Theron Tippin

Candidate for the Degree of

Doctor of Philosophy

Dissertation: EXPLORING THE RELATIONSHIP BETWEEN HIGH SCHOOL COURSEWORK IN MATHEMATICS AND PRE-COLLEGE STUDENT DEVELOPMENT

Major Field: Educational Psychology

Specialization: Research, Evaluation, Measurement, and Statistics

Biographical:

Education: Bachelor of Science in Mathematics Education, University of Central Oklahoma, May 1978. Bachelor of Science in Accounting, University of Central Oklahoma, May 1985. Masters of Management, Southern Nazarene University, December 1996. Anticipate completing the requirements for the Doctor of Philosophy degree in Educational Psychology, with specialization in Research, Evaluation, Measurement, and Statistics, at Oklahoma State University in May, 2006.

Experience: Assistant Professor of Business at Southwestern Oklahoma State University, 1999 to present; High School Math Instructor, Edmond Public Schools, 1985 to 1999; Accountant with Sohio Petroleum Company, 1980-1985; High School Math Instructor, Putnam City Public Schools, 1978 to 1980.

Professional Memberships: Phi Kappa Phi Honor Society, September, 2004.

Name: Mark Theron Tippin Date of Degree: May, 2006

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: EXPLORING THE RELATIONSHIP BETWEEN HIGH SCHOOL COURSEWORK IN MATHEMATICS AND PRE-COLLEGE STUDENT DEVELOPMENT

Pages in Study: 177 Candidate for the Degree of Doctor of Philosophy

Major Field: Educational Psychology

Scope and Method of Study: This was a correlational study that was designed to determine if a relationship exists between the terminal level of mathematics course a student completes in high school and his/her level of pre-college student development. Because of the hypothesized moderate to high intercorrelations between the variables that were chosen to measure psychosocial and moral/ethical student development, a factorial multivariate analysis of variance (MANOVA) was performed that used level of math (LVLMATH) and gender (GENDER) as the independent or grouping variables. From form 1.99 of the Student Developmental Task and Lifestyle Assessment (SDTLA), the *Establishing and Clarifying Purpose Task* (PUR) score and the *Developing Autonomy Task* (AUT) score were used to measure psychosocial student development. The *Lifestyle Planning Subtask* (LP) score and the *Salubrious Lifestyle Scale* (SL) score from the SDTLA were used to measure moral/ethical student development. A proxy measure, the ACT Assessment composite score (ACTCOMP), was selected to assess a student's cognitive skill level.

Findings and Conclusions: The multivariate F-tests from the factorial MANOVA design indicated that the three groups of students differed on the average on the set of dependent variables tested. The univariate F-tests for each of the five dependent variables tested were all statistically significant. These results indicate that the terminal math course a student completes in high school has a meaningful relationship with his/her cognitive skill level and, in addition, also relates to his/her level of psychosocial and moral/ethical student development. Multivariate tests of significance indicated that males and females (GENDER) did not differ on the average on the set of dependent variables tested. This analysis included looking individually at the relationship of GENDER with the scores that were used to measure psychosocial and moral/ethical student development and the joint (combined) relationships of GENDER and LVLMATH with the scores that were used to measure psychosocial and moral/ethical student development.

ADVISER'S APPROVAL: Dr. Laura Barnes