ABSTRACT

Title of Document: AN EXAMINATION OF THE RELATIONSHIP BETWEEN PARTICIPATION IN ACADEMIC-CENTERED PEER INTERACTIONS AND STUDENTS' ACHIEVEMENT AND RETENTION IN MATHEMATICS-BASED MAJORS

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This mixed-method study employed quantitative and qualitative methods to examine the nature of first-year undergraduate students' experiences learning mathematics with peers through interactions that have an academic focus and how participation in these experiences (in and outside of math classrooms) relate to students' academic success in precalculus and calculus courses and their retention in mathematics- and science-based programs. Quantitative and qualitative results provided evidence that students have different experiences learning mathematics in-class and outside of class by race/ethnicity, gender, and ability (determined by students' first semester math course). Descriptive statistics and correlation analyses revealed that in both of these contexts first semester math course had the strongest relationship to students' level of participation in ACPIs. ANOVAs and multiple comparisons revealed differences in students' participation in in-class ACPIs by race/ethnicity and ability. Regression analyses revealed that the math course in which students enrolled for their first semester and for their second semester was predictive of students' math course grades during each of those semesters. Students' level of participation in ACPIs did not predict their academic achievement in mathematics or their retention in undergraduate math- and science-based programs after one year. Qualitative analyses resulted in the following assertions (1) When students struggle with learning mathematics their primary resource is the course text. (2) Students recognize the benefit of learning mathematics with other students both in- and outside of class, but they do not do it outside of class! and (3) Formally-organized, out-of-class interactions with undergraduates, TAs, faculty, and professors in math- and science-based programs have a strong influence in helping students to connect with others in these programs. Students report that this can influence their persistence in undergraduate math- and science-based programs. Results of this study provided information about students' learning experiences that can be valuable to undergraduate math and math education faculty and university administrators who are interested in improving undergraduate mathematics education.

AN EXAMINATION OF THE RELATIONSHIP BETWEEN PARTICIPATION IN ACADEMIC-CENTERED PEER INTERACTIONS AND STUDENTS' ACHIEVEMENT AND RETENTION IN MATHEMATICS-BASED MAJORS

By

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Dedication

This dissertation is dedicated to Keith, Winnifred, Suzzette, and Marvin. It was because of you that I believe that I can succeed in anything. Thank you for your eternal love, encouragement, and support. Thank you for the words of wisdom, for warm soup on a rainy day, and for some friendly competition. I love you.

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Out of Many, One People. (Jamaican Motto)

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CHAPTER ONE: INTRODUCTION

Current efforts to reform undergraduate mathematics education call for actively involving students in the learning process. Many initiatives promote discussions of mathematics content among peers during class to enhance students' understanding of course material. Other efforts seek to improve students' academic performance and retain students in math, science, engineering, or computer science programs by creating structured opportunities for students to interact in academic contexts outside of the classroom setting. Existing research considers a variety of ways that reform efforts can influence students' academic success; however, they have not examined the influence that learning math with peers has on students' academic success and retention in undergraduate mathematics-based programs. This study examined the nature of first-year undergraduate students' experiences learning mathematics with peers through interactions that have an academic focus and how participation in these experiences (in and outside of math classrooms) relate to students' academic success in pre-calculus and calculus courses and their retention in mathematics-based programs.

Statement of the Problem

The face of America is changing. "In 1998, only 72 percent of Americans were classified as White, non-Hispanic, and this population is older than all others…" (Gandara & Maxwell-Jolly, 1999, p. 5-6). Meanwhile, African Americans, Asian Americans, Latinos, and Native Americans comprise increasingly larger percentages of the US population. College enrollments reflect similar trends. The National Science Foundation (1996) reported that the decline of first-year, full-time undergraduate enrollment in colleges and universities during the period of 1980 to 1993 was primarily due to a drop in White, non-Hispanic enrollment during that period. However, "… the numbers of students in all racial/ethnic groups other than [W]hite, including foreign students on temporary visas continues to rise" (p. 2). Perna (2002) explains further, "Over the past decade, the number of African American and Hispanic undergraduates enrolled in colleges and universities nationwide has increased by 32% and 98% respectively, whereas the number of White undergraduates has declined by 1%" (p. 299).

At the time of these population shifts, scholars also noted discrepancies in educational attainment and income levels of racial/ethnic minorities relative to White, non-Hispanics (Ortiz-Franco & Flores, 2001; Takaki, 1994; Pavel, Swisher, & Ward, 1994). These discrepancies impede the United States from being able to realize the full intellectual potential of our citizenry.

> Until much higher percentages of students from underrepresented minority groups enjoy very high levels of educational success, it will be virtually impossible to integrate our society's institutions completely, especially at leadership levels. Without such progress, the United States also will continue to be unable to draw on the full range of talent in our population in an era in which the value of an educated citizenry has never been greater. (Gandara & Maxwell-Jolly, 1999, p. vii)

Such drastic shifts in demographic and educational trends require innovations that address the needs of this diverse population and enable our country to realize the full intellectual capital of its populace.

Today's workforce requires educated workers who can make informed decisions about technical matters and work with others to solve complex problems (National

Science Foundation [NSF], 1996). Literacy in math and science is critical in addressing the needs of a changing economy that relies more heavily on technology than ever before (Mathematics Association of America [MAA], 1998; NSF, 1996). The need for mathematicians, scientists, engineers, and computer scientists is expected to show continued growth from 2000 to 2010, with the greatest need being in computer specialist fields (Barton, 2002). However, the demand far exceeds current graduate enrollments in math- and science-based fields. Graduate enrollments in engineering, physical science, and mathematics peaked in 1992 and declined during the period from 1992 to 1997 (Barton, 2002). While graduate enrollments in computer science have increased during the period from 1990 to 1997, there has only been a five percent increase during that period. Moreover, while there was an increase of nine percent in undergraduate enrollments in the physical sciences, enrollments in engineering, computer science, and mathematics declined by 14%, 22%, and 26%, respectively during the period from 1987 to 1997 (Barton, 2002).

Colleges and universities play a particularly important role in supporting educational attainment and preparing students for professional careers. They serve a gate keeping function for many professions and play a particularly important role in preparing professionals in math- and science-based fields. Through their math and science programs colleges and universities hold the power to develop researchers and technologists who will lead this nation into the next era of scientific innovations and technological advances. Nevertheless, completion rates for many racial/ethnic minorities in undergraduate math, science, engineering, and computer science (MSEC) programs remain low – African Americans, Hispanics/Latinos, and Native Americans continue to be underrepresented in MSEC fields (Barton, 2003; National Center for Education Statistics, 2000; National Science Foundation, 1996; Seymour & Hewitt, 1997). Additionally, while the number of women in undergraduate MSEC programs is increasing, many leave these programs without completing a degree (Margolis & Fisher, 2002; National Center for Education Statistics, 2000; National Science Foundation, 1996; Seymour & Hewitt, 1997). "In 1995, women represented 51 percent of the U.S. population and 46 percent of the nation's labor force, but constituted only 22 percent of the [Science and Engineering] workforce" (National Center for Education Statistics [NCES], 2000, p. 6). And while the gender gap has narrowed, with women earning 34%, 37%, and 18% of the bachelors degrees awarded in 1996 in math and computer science, physical sciences, and engineering, respectively, a much smaller percentage of doctoral degrees in math and computer science (18%), physical sciences (22%), and engineering (12%) were awarded to women that year (NCES, 2000).

Research indicates that traditional pedagogical practices and the competitive nature of undergraduate MSEC programs greatly influence students' learning experiences and their decisions to persist in these fields (Linn & Kessel, 1996; Moreno & Muller, 1999; Nauta, Epperson, & Kahn, 1998; Seymour & Hewitt, 1997; Thompson, 2001). Undergraduate MSEC programs are known for being hard, elitist, unsupportive, and overly competitive. Students describe these programs as hard because of the volume of work required, the rapid pace for covering course material, and the illusiveness of the highly abstract, theoretical nature of concepts that always seem just beyond their intellectual grasp (Seymour & Hewitt, 1997). Students are further frustrated by the competition in MSEC programs. The tendency of faculty to grade on a curve discourages students from working together or discussing course material. Consequently, students spend great amounts of time studying in isolation in order to outscore and outperform their peers (Seymour & Hewitt, 1997). The use of curve grading fuels the competitive nature of MSEC programs and results in the loss of many talented students from the math and science pipeline with a disproportionate number of these students being racial/ethnic minorities and women (Seymour & Hewitt, 1997).

Features of socialization among students and between students and faculty can influence racial/ethnic minority students' learning experiences in undergraduate math- and science-based programs. According to Seymour and Hewitt (1997), racial/ethnic minorities in undergraduate MSEC programs who attended predominantly minority high schools often had strong peer relationships and supportive relationships with teachers and counselors who motivated them to continue in math and science. However, during undergraduate study racial/ethnic minority students often find that MSEC faculty do not provide the same type of support as high school teachers. This incongruity with students' high school experiences contributes to racial/ethnic minority students' views that MSEC faculty are unfeeling or discriminatory and influences their decisions to persist in MSEC programs (Seymour & Hewitt, 1997). In addition, low representations of racial/ethnic minority students in undergraduate MSEC programs cause many students to become separated from minority peers at the onset of choosing a MSEC major. This separation contributes to ethnic isolation because of the lack of a critical mass of students with whom racial/ethnic minority students can readily relate. Students are further alienated by peers within MSEC who tend to exclude racial/ethnic minorities from small group activities or labs (Frye-Lucas, 2003; Seymour & Hewitt, 1997).

Critics assert that prevailing pedagogical practices are problematic and tend to favor traditional, Anglo-Saxon, male students over women and racial/ethnic minorities (Alexander, Burda, & Millar, 1996; Margolis & Fisher, 2002; Seymour & Hewitt, 1997). MSEC faculty typically give considerably more attention to males in a variety of ways by making eye contact with males more frequently, calling on male students more often than female students, posing higher-order questions to males, and criticizing women more frequently (Fox & Soller, 2001; Kennedy & Parks, 2000; Linn & Kessel, 1996; Rosser, 1997). Additionally, the dominant lecture style that is characteristic of traditional pedagogical practices in MSEC – where teacher-student interactions dominate and student-student interactions are rare – tends to conflict with women's and racial/ethnic minorities' ways of learning and knowing (Alexander et al., 1996; Atwater, 1994; Becker, 1995; Mau & Letize, 2001; Rogers, 1992; Seymour & Hewitt, 1997). Moreover, traditional pedagogical practices evolved from an exclusively white and male context that values individual competition over collaboration and are based on motivational strategies understood by young men reared in that tradition, and its cues may be missed by students grounded in other traditions that value collaboration over competition (Alexander et al., 1996; Margolis & Fisher, 2002; Seymour & Hewitt, 1997). Adhering to these traditional pedagogical practices places an undue burden on women and racial/ethnic minorities to adhere to White, middle class values and reflects a commonly held belief among MSEC faculty that only a select group of students are able to succeed in these programs (Linn & Kessel, 1996; Nauta et al., 1998; Seymour & Hewitt, 1997; Thompson, 2001).

Like other MSEC fields, the dominant paradigm in mathematics education has been concerned with the transmission of a body of knowledge from teacher to pupil and the ability of instructors to explain material concisely and accurately takes precedence over what and how students learn (Gersting & Kuczkowski, 1977; Hoyles, 1985; Weissglass, 1993). Pedagogical reform efforts in undergraduate MSEC programs represent a new paradigm that is more student-centered and concerned about students' experiences in the learning process. In this paradigm, students engage in active-learning activities with peers that encourage them to think for themselves, make meaningful connections, engage in higher-order thinking, and develop new mental structures (Biggs & MacLean, 1969; Bonwell 1996; Bonwell & Eison, 1991; Meyers & Jones, 1993). Furthermore, students are expected to take more responsibility for and become actively involved in their own learning and the learning of their peers. Students become accountable to each other and learning becomes a personal and shared responsibility among students and between the teacher and the students. This is important because cooperative learning environments promote positive relationships among students and between students and faculty, support psychological adjustment, and promote higher academic achievement (Astin, 1993a, 1996, 1999; Johnson, Johnson, & Smith, 1991).

Many of the leading pedagogical reform movements are influenced by sociocultural theories of learning and feminist pedagogical perspectives. Sociocultural theories assert that cognitive development occurs within social and cultural contexts. Students gain knowledge by explaining their thinking to others or by attempting to resolve conflicts between their perspective and others' perspectives (Bauersfeld, 1995; Brown & Palincsar, 1989; Cobb, 2000; Hoyles, 1985; Miller, 1993; Rogoff, 1999; Yackel & Cobb, 1996). Proponents of incorporating sociocultural practices into the learning process promote the active involvement of students in learning and the use of peer interactions to facilitate learning. They contend that learning is provoked by external situations, a teacher, or more capable peers, and that development of new mental structures occurs as a result of trying to resolve differences between existing knowledge and new information (Kozulin, 1998; Wertsch, 1985). Reforms that integrate sociocultural practices into the learning process generally result in the use of cooperative learning techniques, such as small-group instruction or project/work groups, but may include the use of methods such as peer teaching and peer tutoring, group projects, group presentations, or other classroom practices that promote student-student discourse about academic content as well as student-teacher discourse.

Johnson et al. (1991) assert that in the old paradigm for higher education colleges focus on selecting only the best and the brightest students for admission and then filter out students who later reveal deficiencies in their knowledge base. However, the new paradigm calls for colleges to develop students' academic potential and transform them into more knowledgeable and committed individuals. Furthermore, this new paradigm calls for joint construction of knowledge and shared responsibility for learning among students and between faculty and students; students actively constructing, discovering, and transforming their own knowledge; cooperative instead of competitive or individualistic pedagogical methods; and faculty members who are adequately prepared and trained to teach. These changes reflect a belief that students experience more cognitive and psychological benefits from being more actively engaged in the learning process than from traditional practices that promote rote memorization (Johnson et al., 2001).

Proponents of feminist pedagogical perspectives applaud efforts to reform undergraduate MSEC programs based on sociocultural theories; however, they are concerned that efforts to incorporate sociocultural practices into the learning process seldom address social or political consequences of their innovative approaches (Mayberry, 1998; Zevenbergen, 1996). They assert that unless sociocultural practices consider gender, race, and class issues, the pedagogy resulting from these practices "work to sustain, rather than transform, the existing relations of power in science communities, and consequently maintain specific values, beliefs, and behaviors that impede progress toward achieving a more equitable and just society in which the science community would be far more diverse" (Mayberry, 1998, p. 444). Feminist scholars argue that rather than viewing students as needing to adhere to practices of the dominant culture, teachers must view students as having distinctive cultural identities and build upon their experiences to develop a firm foundation for learning (Bianchini, Cavazos, & Helms, 2000). To do this, teachers must be concerned with both *what* they teach and *how* they teach. They must develop strong relationships with their students, create opportunities for multiple interactions among class members, and engage students in group activities that demonstrate an awareness of race, class, and gender dynamics (Bianchini et al., 2000; Kellermeier, 1996; Lemke, 2001; Mayberry, 1998, Zevenbergen, 1996).

Feminist scholars are also concerned that traditional pedagogical practices are incongruent with women's ways of knowing and learning and do not promote the development of student autonomy. Becker (1995) states that women's ways of knowing mathematics – involving the shift from dependence to autonomy and from uncritical to critical – are different from men's ways of knowing. She asserts that the most marked difference between women's and men's ways of knowing occurs in the development of procedural knowing. Women are more often connected knowers and men are more likely to be separate knowers (this is analogous to inductive and deductive reasoning in mathematics, respectively). Becker argues that traditional lecture teaching methods support separate knowing and devalue connected knowing and create little opportunity for women to develop the participatory competence that would enable them to be self-assertive in math and science. Moreover, these practices disempower women and discourage them from developing their own voice (Mau & Leitze, 2001; Rogers, 1992). Mau and Letize (2001) assert that empowering curricula would place women in a position where they not only *could* participate but *would* participate in the articulation of meaningful mathematical understandings without fear of ridicule.

Reform in Undergraduate Math Education

Many efforts to reform undergraduate MSEC programs address concerns about the impact of traditional pedagogical practices or the competitive nature of these programs on students' learning. Reforms typically target students during the first two years of undergraduate study and often involve enhancements to course curricula that facilitate active-learning. Gateway courses for MSEC majors, such as pre-calculus and calculus, are often sites for curriculum enhancements that include incorporating technology, using problem-based activities to apply mathematical ideas in meaningful contexts, creating opportunities for students to make conjectures and construct proofs, and empowering students to develop autonomy (Ganter, 2001; Holton, 2001; Mau & Letize, 2001). Pedagogical reforms promote active learning by intimately involving students in their knowledge development through the critical analysis of course material;

discussion of ideas and problem-solving strategies with peers; justification of their reasoning to other students and to the instructor; and challenges to or questions of students' explanations (Couco, Goldenberg, & Mark, 1996; Davidson, 1971; Legrand, 2001; Millett, 2001; Wahlberg, 1997; Weissglass, 1993; Yackel & Cobb, 1996). While approaches to pedagogical reform vary, they attempt to move away from traditional ways of teaching and to engage students more actively in the learning process.

Some reform efforts establish additional supportive learning opportunities outside of the classroom that address many of the same concerns that students face in MSEC classrooms and foster behaviors that students can carry with them throughout their programs. University-sanctioned initiatives that typically target students in MSEC programs are concerned with attracting and retaining first- and second-year undergraduate students in these majors. These targeted programs seek to diminish the competitive learning environment by encouraging students to work together on homework, projects, and to prepare for exams. Many university-sanctioned initiatives also set up mentoring relationships among peers that can serve as academic resources and sources of encouragement and support for students to succeed in these programs and create opportunities for students to interact with faculty that believe in them and encourage them to do well. Additionally, these programs may provide supplemental instruction to strengthen students' academic skills and support cognitive development (College Board, 1999; Fries-Britt, 1998; Gandara & Maxwell-Jolly, 1999). Participating in these types of opportunities can positively influence academic achievement and program retention for first- and second-year students in general and for women and racial/ethnic minorities in particular because they provide students with both social and academic supports that can positively influence students' academic achievement and degree persistence (Alexander et al., 1996; Duncan & Dick, 2000; Eisenberg & Browne, 1973; Grandy, 1998; Lazar, 1993; Moreno & Muller, 1999; Treisman, 1985, 1992; Wheatland, 2000; Wine & Cooper, 1985; Zunkel, 2002).

The College Board (1999) notes that successful university-sanctioned programs address academic and social integration into undergraduate education by stressing scholastic excellence; supporting students' success early during undergraduate study; providing academic assistance to ensure that students develop a strong foundation for doing well in their majors; and by helping students build a strong support network consisting of academically-oriented peer groups and relationships with faculty. University-sanctioned initiatives that promote social and academic integration may be particularly important for the success and retention of women and racial/ethnic minorities attending predominantly white institutions and who enroll in MSEC programs because these students are more likely to feel isolated from their peers and unsure of their ability to succeed in these programs (Hurtado & Carter, 1997; Loo & Rolison, 1986; Smedley, Myers, & Harrell, 1993; Seymour & Hewitt, 1997; Thompson & Fretz, 1991; Weissman, Bulakowski, & Jumisko, 1998). Supportive programs create opportunities for students to become actively involved in the learning process by welcoming them into a community of learners who share similar goals and learning needs.

Rationale

The various strategies that utilize peer interactions to promote active learning in undergraduate mathematics education can be expected to impact students' academic success and persistence in different ways because of their differing structures and contexts. However, existing research has not examined the relative impact of these experiences on students' mathematics achievement and retention in undergraduate math- and science-based programs. Understanding relationships between first-year students' participation in various forms of active-learning opportunities and students' academic achievement and program retention is important because many students typically switch out of these majors during their first or second year of undergraduate study (Alexander et al., 1996; Duncan & Dick, 2000; Moreno & Muller, 1999; Seymour & Hewitt, 1997). Additionally, many reform efforts that incorporate active learning in undergraduate mathematics education target first- and second-year courses. Thus, there is a need to learn more about the experiences of first-year students in undergraduate math- and science-based programs. This includes understanding the quantity and quality of students' participation in active-learning opportunities and the relative impact of these experiences on the cognitive and affective development and retention of students in math-based majors.

This study examined the nature of students' experiences learning mathematics with peers through interactions that have an academic focus (academic-centered peer interactions, ACPIs), and how participation in these experiences in and outside of math classrooms (both formally and informally organized) relate to students' academic success in pre-calculus and calculus courses and their retention in math-based programs.

Theoretical Framework

This study was guided by Astin's theory of student involvement (Astin, 1993a, 1996, 1999) which defines involvement as "the amount of physical and psychological energy that the student devotes to the academic experience" in formal and informal contexts both in and outside the classroom (Astin, 1996, p. 518). This theory is particularly relevant to studies of the impact of active learning on students' academic success and program retention because active learning inherently requires students to invest physical and psychological energy in the learning process. Reform efforts that incorporate active learning opportunities in undergraduate math education seek to change the focus from faculty members' intentions for the undergraduate experience to students' lived experiences. Similarly, the theory of student involvement shifts the emphasis away from faculty content knowledge, university resources, and individualized instructional approaches to focus on what students actually do by examining how students invest their time and energy and understanding the effect that this has on important learning outcomes. Astin asserts that of the three forms of involvement that have the greatest influence on cognitive and affective outcomes, academic involvement; involvement with faculty; and involvement with peers, involvement with peers has the most powerful influence on students' academic and personal development (Astin, 1993a, 1996, 1999).

The theory of student involvement suggests that examining active involvement in the academic experience both in and outside of class can be useful in trying to understand factors that influence students' affective and cognitive development. In the context of the classroom, the theory suggests that pedagogical practices influence student learning. In particular, it emphasizes active inquiry arguing that "learning will be greatest when the learning environment is structured to encourage active participation by the student" (Astin, 1999, p. 522). Astin (1996) asserts that peer group interactions outside of the classroom can be influenced by formal programs organized by student affairs. Furthermore, Astin (1999) claims that the quality and quantity of these interactions are directly related to the amount of student learning. Thus, involvement theory suggests that the amount and frequency of participation in active learning activities as well as the structure and context (i.e., in class, formally organized out of class, informally organized out of class) influence students' learning and commitment to pursuing their degrees.

Research Questions

This study examined the extent to which students engaged in academic-centered peer interactions (ACPIs) both in and outside of class, the nature of these experiences, and how these experiences are related to students' mathematics achievement and retention in undergraduate math, physical science, engineering, and computer science programs. Specifically, this study explored the following research questions:

1. What was the nature of students' involvement in ACPIs (i.e., In what types of, with what frequency, and with whom were students participating in ACPIs? What role did ACPI experiences play in students' perceptions of their academic performance and decisions to persist in undergraduate MSEC programs?)?
2. Is there a statistically significant difference in the amount of time students spent involved in ACPIs when examined in terms of race/ethnicity, gender, and ability (determined by students' fall 2004 math course)? Does this vary by the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students)?
3. Is the amount of time students spent involved in ACPIs a statistically significant predictor of fall 2004 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved

(i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

4. Is the amount of time students spent involved in ACPIs a statistically significant predictor of spring 2005 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

5. Is the amount of time students spent involved in ACPIs a statistically significant predictor of retention of first-year students in MSEC programs from the fall 2004 to the fall 2005 semester (determined by fall 2005 major and course enrollment)? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

Significance of the Study

This research is significant because it increases our understanding of students' learning experiences during undergraduate mathematics education and explored how different ACPIs support active involvement in the learning of mathematics both in and outside of the classroom setting. The findings from this research can be used to inform university administrators, mathematicians, and mathematics educators about the nature of student involvement in ACPIs, and can be used to promote and support the academic success and persistence of diverse undergraduate students majoring in math-based programs at predominantly white institutions. Studying the population of first-year undergraduates in MSEC programs helps educators gain a better understanding of how to best facilitate the development of mathematical knowledge and academic success and persistence in undergraduate math-based programs.

Overview of the Method

The study sample included first time, full time, traditional-aged students majoring in any MSEC program and enrolling in pre-calculus or calculus for the fall 2004 semester. The total number of fall 2004 CMPS and ENGR first-time, full-time students was 734 (198 and 536, respectively). Of the 734 students, there were 118 females, 616 males, 470 Whites, 52 Blacks/African Americans, 20 Latinos(as)/Hispanics, 114 Asians/Pacific Americans, 3 American Indians, and 15 international students, and 16 whose race or citizenship status was unknown (University of Maryland [UM] Office of Institutional Research and Planning, September 16, 2004). There were a total of 1926 students enrolled in pre-calculus or calculus for the fall 2004 semester (UM Schedule of Classes, September 18, 2004). This number included all enrolled students regardless of their classification or major. Students who were not first time, full time, traditional-aged students in fall 2004 with a major in CMPS or ENGR and enrolled in a pre-calculus or calculus course were not included in this study.

Data Collection and Analysis

This study employed a mixed methods approach that involved both quantitative and qualitative data collection and analysis. According to Teddlie and Tashakkori (2003) a major advantage of mixed methods research is that it allows a researcher to answer research questions that other research methods cannot; "it enables the researcher to simultaneously answer confirmatory and exploratory questions, and therefore verify and generate theory in the same study" (p. 15). One method gives greater depth while the other gives greater breadth; thus, mixed methods research may provide results which can allow a researcher to make stronger inferences. Mixed methods research also provides the opportunity for presenting a greater diversity of divergent views that may lead to a reexamination of the conceptual frameworks and the assumptions underlying each of the quantitative and qualitative components (Teddlie & Tashakkori, 2003).

In the present study, three primary types of data were collected and analyzed. These included a survey, the *MSEC ACPI Experiences Survey*, that assessed students' experiences learning mathematics with others; focus group interviews that explored qualitative differences in students' learning experiences; and university data that provided information on students' academic performance prior to entering the university and during their first year at the university. The *MSEC ACPI Experiences Survey* was designed to capture information about student demographics (including age, gender, race/ethnicity) and participants' ACPI experiences during college (including the types of ACPIs in which students engage, who else participates, and the frequency of participating in these opportunities). This survey was web-based and administered during the spring 2005 semester to all study participants. Focus group interviews were conducted in April

2005 with a subset of participants from the larger study. The composition of the focus groups were determined in part after preliminary analyses of the fall 2004 data was completed. The focus group interviews explored the nature of students' ACPI experiences during the fall 2004 semester and the beginning of the spring 2005 semester. Students' SAT and ACT scores, declared major, mathematics course enrollment, and grades were collected from university records for the fall 2004 and spring 2005 semesters following the close of records for the spring 2005 semester. Students' declared major and course enrollment for the fall 2005 semester was also collected from university records after the official drop period for the fall 2005 semester.

Data analysis for this study was conducted in two phases. The first phase included a quantitative component that explored the nature of students' participation in ACPIs and the relationship between participation in ACPIs and students' mathematics achievement and retention in undergraduate MSEC programs. Descriptive statistics and correlation analyses were used to describe demographic characteristics of the study participants, the types of ACPIs in which students participated, the frequency of students' participation in ACPIs, and who students interacted with during ACPI experiences. Correlation analyses were also used to identify highly correlated variables and spurious relationships that may cause exaggerated relationships between variables considered in the analysis of variance (ANOVA) analyses and regression analyses.

ANOVA analyses (including multiple comparisons) and blocked hierarchical regression analyses were used to examine relationships between and among independent variables (race/ethnicity, gender, ability, and amount of time students spent involved in ACPIs, type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students), and type of persons that were involved in the ACPIs (i.e., undergraduate students, graduate students, professors)) and dependent variables (first-semester math course grades, second-semester math course grades, and retention of first-year MSEC students from the fall 2004 to the fall 2005 semester) considered in this study. ANOVA analyses were used to compare the mean amount of time students spent involved in ACPIs based on students' race/ethnicity, gender, and ability. Regression analyses were used to determine the relative role that the independent variables have in predicting the dependent variables. Variables measuring race/ethnicity, gender, and ability were included in the analyses to determine if different experiences have different effects for different types of students.

The second phase of data analysis involved a qualitative component that used two focus group interviews and an individual interview to explore students' sense of how participation in ACPIs influenced their academic achievement in mathematics and their decisions to persist in undergraduate MSEC programs.

Explanation of Key Terms

The following terms were used frequently in this study and are defined as follows:

- *Ability*: Study participants' math SAT scores were relatively high (ranging from 500 to 800); therefore, their level of mathematics knowledge was measured by the math course in which they enrolled for the fall 2004 semester.
- *Academic-centered peer interactions (ACPIs)*: Scholars noted that both social and academic interactions among students are critical aspects of undergraduate students' learning experiences (Pascarella & Terenzini, 1991); however, these interactions differentially influence students' academic success and retention in undergraduate

education. Liu and Liu (2000) noted a risk of oversocialization when students participate in too many social interactions too often. This can lead to lowered academic achievement and higher levels of departure from undergraduate study (Liu & Liu, 2000). Astin (1993a, 1996, 1999) found that while participating in academically-oriented activities with peers negatively influences students' social development, they are strongly and positively related to students' academic success and retention in undergraduate education. In order to distinguish these types of interactions from those that are more socially centered, I describe them as academic-centered peer interactions. These are interactions among peers that are organized primarily for an academic purpose.

- *Formally organized, university-sanctioned initiatives*: Non-required programs that are funded or provided by the institution to support students' academic success and persistence at the institution (e.g., Women in Science and Engineering, mathematics tutoring room, living-learning communities, undergraduate research experiences)
- *In-class ACPIs*: ACPIs that occur within the boundaries of the classroom and as part of normal course requirements. They include participation in student-student discourse during classroom or group discussions and student presentations of course content, individual or group work, homework problems, or projects to the class. Workshops or courses that students participate in that are optional or in addition to normally required course requirements are not considered *in-class ACPIs* (e.g., Emerging Scholars Program). These activities are considered *out-of-class ACPIs*.
- *Math-based majors - Mathematics, Physical Science, Engineering, and Computer Science (MSEC)*: Majors in the college of Computer Science, Mathematics, Physical

Science (CMPS) and the college of Engineering (ENGR) at the University of Maryland College Park.

- *Mixed-methods research* involves the use qualitative and quantitative data collection and analysis techniques in a single study in which data are collected concurrently or sequentially, are given priority, and involve the integration of the data at one or more stages in the process of research. (Creswell, Plano Clark, Gutman, & Hanson, 2003; Teddlie & Tashakkori, 2003).
- *Out-of-class ACPIs*: ACPIs that bring students together for an academic purpose outside of the formal classroom setting. They include tutoring, study groups, undergraduate research teams, learning communities, mentoring circles, discussion groups, project teams, or other academic-centered activities that occur outside the bounds of the formal classroom and bring students together to discuss mathematics content or apply mathematical ideas.
- *Peers*: Students who were enrolled in any undergraduate or graduate MSEC program during the fall 2004 to spring 2005 academic year. *Immediate peers* include only undergraduate MSEC students; graduate-level MSEC students (including most TAs) are considered *more advanced peers*. Research suggests that in addition to the benefits of interactions with immediate peers, interactions with advanced peers can influence students' self-efficacy beliefs and subsequently their academic success and persistence by creating opportunities for students to have vicarious learning experiences by observing future versions of themselves performing well (Silverman & Casazza, 2000). Such relationships are especially important for women pursuing

nontraditional careers since they are able to illustrate ways to handle multiple roles, for instance, those related to work and family (Nauta, Epperson, & Kahn, 1998).

- *Retention and persistence*: Retention and persistence are used interchangeably to describe the act of beginning in an undergraduate MSEC program during the fall 2004 semester and continuing to major in any MSEC program through the official drop period of the fall 2005 semester (students who switch to another MSEC program are classified as persisters).
- *Traditional-aged, first-year undergraduate*: A student who completed high school in the same year as initial enrollment in an undergraduate MSEC program.

Basic Assumptions

An important assumption made by the researcher is that the information students shared through the survey instrument and during focus group interviews was a true representation of their ACPI learning experiences.

Limitations of the Study

This study has the following limitations that may affect the ability to draw conclusions or infer results beyond the scope of the study.

- The study was limited to traditional-aged, first-year students majoring in mathematics, physical science, computer science, or engineering at one institution. Therefore, caution must be taken regarding the generalizabilty of the results to other student populations or other institutions.
- Because students were surveyed only once (early during the spring 2005 semester) about their ACPI learning experiences, it was assumed that the experiences that they report are a true representation of their typical learning experiences for both the fall

2004 and spring 2005 semesters. However, since students' ACPI participation habits may change through the academic year, this approach may be somewhat limiting.

- For the fall 2004 semester, Black/African American, Latino(a)/Hispanic, and American Indian students made up 18% of the all undergraduates but only 10% of first-year MSEC students. Of the 734 first-year MSEC students, 7.1% were Black/African American, 2.7% were Hispanic, 0.4% were American Indian, 15.5% were Asian/Pacific American, 64.0% were White, 2.0% were international students, and 8.2% were classified as race or citizenship status is unknown (UM Office of Institutional Research and Planning, September 16, 2004). The small numbers of racial/ethnic minority students limited the extent to which some quantitative analyses could be done and the conclusions that could be drawn about their experiences learning mathematics with peers and influences on their academic performance and program retention.

Summary

Previous research suggested that actively involving students in learning undergraduate mathematics through the use of academic-centered peer interactions positively influences students' academic success and persistence in their degree programs. However, existing studies had not considered the influence of ACPIs that occur in different contexts (in-class vs. out of class) or that have different structures (formally organized vs. informally organized) on the learning experiences of students. This study is significant because it described the nature of students' experiences learning math with peers both in and outside of the classroom and the relationship between these experiences and students' mathematics achievement and retention in undergraduate

MSEC programs from the beginning of their first semester through the fall semester of their second year. Furthermore, this study provided information that can be used to support the academic success and retention of first year students in MSEC programs and that can be used to enhance the learning experiences of particular groups of students. It filled gaps in the literature regarding the similarities and differences in students' learning experiences based on race/ethnicity, gender, ability, and who is involved in the ACPIs. The mixed methods approach provided multiple ways of examining students' learning experiences. The quantitative component provided information on the types and frequency of students' participation in ACPIs and their relationship to academic outcomes and the qualitative component provided an opportunity to examine the nature of students' learning experiences and the sense that they make of these experiences. The findings from this study can be valuable to undergraduate math and math education faculty and university administrators who are interested in improving undergraduate mathematics education.

CHAPTER TWO: LITERATURE REVIEW

Introduction

This chapter reviews the literature regarding actively involving students in the learning of undergraduate mathematics through the use of academic-centered peer interactions and its relation to students' mathematics achievement and retention in undergraduate math, physical science, engineering, and computer science programs in order to provide a foundation for the research in this study. This chapter gives an overview of these topics in its description of three facets of academic-centered peer interactions: in-class ACPIs, ACPI opportunities outside of class through formally organized, university-sanctioned programs, and ACPIs outside of class that are informally organized.

Active Learning

While there is no agreed upon definition of active learning, some scholars have discussed what it means for students to engage in active learning. Meyers and Jones (1993) assert that "(1) learning is by its very nature an active process and (2) different people learn in different ways" (p. 20). Active learning involves talking, listening, writing, reading, and reflecting. Talking clarifies students' thinking because it requires them to organize and structure their thoughts in a meaningful way so that they can communicate clearly (Meyers & Jones, 1993). Active listening involves listening attentively to others' comments and ideas, considering others' perspectives relative to one's own, and asking questions when something is unclear or confusing (Cobb, 2000; Meyers & Jones, 1993; Yackel & Cobb, 1996). Writing encourages students to engage in analytic and synthetic activities that help them to expand, modify, and create mental structures (Hobson, 1996; Meyers & Jones, 1993). Reading engages students in scanning, identifying, sorting, and prioritizing information as they try to connect ideas and make sense of what others think (Meyers & Jones, 1993). Silent reflection creates an opportunity to gather one's thoughts, mull over, sort, out, try to understand, and incorporate new information. This involves higher-level learning processes that lead to the creation of new mental structures or the incorporation of new information into existing mental structures (Meyers & Jones, 1993). These elements - talking, listening, writing, reading, and reflecting - all engage the brain in different thinking processes or operations that lead to the creation of new mental structures, and thus, are elements of active learning (Meyers & Jones, 1993).

Biggs and MacLean (1969) conceptualized active learning as having three major components which create opportunities for students to (1) think for themselves; (2) discover the order, pattern, and relations which are the essence of mathematics; and (3) develop necessary procedural skills. They assert that active learning opportunities must be situated in learning situations where students learn and apply mathematics in meaningful contexts. Moreover, in a classroom where active learning is encouraged, it is important for teachers to consider what a student knows, how the student understands the mathematical situation, and what facilitates the development of new understandings based on this knowledge.

Bonwell and Eison (1991) summarized the following characteristics of active learning:

- Students are involved in more than listening.

- Less emphasis is placed on transmitting information and more on developing students' skills.
- Students are involved in higher-order thinking (analysis, synthesis, evaluation).
- Students are engaged in activities (e.g., reading, discussing, writing).
- Greater emphasis is placed on students' exploration of their own attitudes and values. (p. 2)

They describe active learning as "anything that involves students in doing things and thinking about the things they are doing" (p. 2). Activities that engage students in active learning include the pause procedure (stopping for a few minutes during a lecture to allow students to summarize and synthesize information or to allow for discussions among students); short writes (time for students to rework their notes or summarize big ideas); the wait procedure (a chance for students to think and evaluate their ideas before answering a question); think-pair-share (the wait procedure followed by pair discussions and then larger group discussions); formative quizzes (used to keep students attention focused and to determine how students comprehend material); lecture summaries (forum for students to summarize lectures or share notes with peers); classroom assessment techniques (used to assess students' recall of information presented in the classroom); and group work (small groups of students working together on activities dealing with course content) (Bonwell, 1996; Bonwell & Eison, 1991, Bonwell & Sutherland, 1996; Ebert-May & Brewer, 1997). These activities actively engage students in their learning by involving them in doing things and in thinking about the things that they are doing.

Pedagogy that incorporates active learning represents a paradigm shift from focusing on what the teacher does to relay information to students to one that emphasizes students taking responsibility for their learning by asking questions, applying ideas in meaningful contexts, and considering other students' (or the teacher's) perspective relative to his or her own. Johnson et al. (1991) distinguish practices associated with the old and new paradigms of teaching for higher education. The old paradigm assumes that any expert can teach. Knowledge is transferred unidirectionally from faculty to students. Relationships among students and between faculty and students are impersonal and the educational environment fosters competition and individuality over cooperation. Students are passive vessels to be filled by faculty's knowledge. Institutions continually sort and classify students to select only the most intelligent students and filter out those who reveal cognitive deficiencies. The new paradigm assumes that teaching is complex and requires considerable training. Knowledge is jointly constructed by students and faculty. Students are active constructors, discoverers, and transformers of their own knowledge, and learning is a personal transaction among students and between faculty and students. Cooperative learning pedagogical techniques are used in the classroom and cooperative teams are formed among faculty (Johnson et al., 2001).

While pedagogical techniques involving cooperative learning are most often associated with active learning, conceptions of active learning do not imply that cooperative learning is the best or only way to engage students in active learning or that students cannot learn from traditional lecture methods. Instead, they assert that enhancing the lecture method by incorporating active learning activities can be an effective strategy for actively involving students in their learning.

For while developing teaching strategies that are less heavily based on the lecture method is certainly important, it is not the case that the lecture must be abandoned or that all faculty must begin using group work in their classes. What is important is for instructors to find approaches that fit their personal style of teaching and meet their educational objectives, while at the same time actively engaging students as they learn in the college classroom. (Bonwell & Sutherland, 1996, p. 4)

These perspectives are concerned with what students are thinking, learning, and doing in the classroom and leave the pedagogical method for promoting active involvement up to individual instructors.

Scholars tend to focus on active learning that occurs in the classroom context; however, students also engage in learning activities outside of class (such as studying, working on projects, conducting research, reading texts, etc.) that qualify as active learning. Hence, a broader conception of active learning must be used here to describe the types of experiences that students engage in (both in and outside of formal classroom settings) that are active in nature, help them to facilitate the development of new mental structures, and cause them to think about the things they are doing.

Educational Outcomes of Active Learning

Studies of active learning suggest that participating in active-learning opportunities may positively influence students' cognitive and affective development during undergraduate study and contribute to higher levels of commitment to persist in undergraduate study. Braxton, Milem, and Sullivan (2000) found that participating in active learning activities had both direct and indirect influences on educational outcomes for first-year students. Participating in class discussions had a direct and positive influence on social integration and students' institutional commitment and persistence. Social integration was composed of two measures: peer group interactions and out-of-class interactions with faculty. Engaging in higher-order thinking had a direct and positive influence on social integration, and social integration had a direct and positive influence on students' institutional commitment. Additionally, participating in class discussions and social integration indirectly influenced institutional commitment and students' intent to return to their institution after the first year. In contrast, knowledge-level exam questions indicative of passive learning had a direct and negative influence on institutional commitment and persistence.

Ebert-May and Brewer (1997) also considered the educational outcomes of active learning. They conducted a qualitative assessment of two traditionally-taught biology lecture courses that were redesigned to incorporate active-learning opportunities. Students in the redesigned courses reported having better learning experiences from participating in active-learning activities and enjoyed the opportunities for social interactions. They described the learning environment as friendly, nonthreatening, fun, and dynamic, and reported a sense of belonging and camaraderie among peers as a result of regular interactions and being able to learn from one another. Students in the redesigned course also felt that they would remember the course material for a longer period of time because it was repeated and presented in meaningful contexts. They were also pushed to work harder and pay attention in class because of the frequent responsibility of reporting to the class. The researchers noted that attendance was higher and students raised their hands much more often to answer questions in the redesigned courses as compared to the traditional courses.

These studies highlight the importance of creating opportunities for students to engage in active learning during undergraduate study. These opportunities can stimulate higher-order thinking, promote knowledge retention, encourage students to become responsible for their own and their peers' learning and influence their level of commitment to complete undergraduate study. These educational outcomes drive the need to incorporate active learning as a major component in the new paradigm for teaching and learning in higher education.

Active Learning in Undergraduate Mathematics Courses

Actively involving students in the learning process is a central feature of many efforts to reform the teaching and learning of undergraduate mathematics. In their recommendations for preparing K-12 math teachers, the Conference Board of the Mathematical Sciences (2001) discussed the importance of actively engaging pre-service teachers in the learning process. They identified active involvement as a goal of elementary and secondary mathematics education and claim that in order for teachers to do this in their own classrooms they need to have similar experiences in their college mathematics courses. The Mathematics Association of America also supports efforts to actively engage students in the learning of undergraduate mathematics. They developed *Quantitative Reasoning for College Graduates: A Complement to the Standards* (MAA, 1998) to address similar concerns about quantitative literacy as those raised for K-12 mathematics education by the National Council of Teachers of Mathematics (NCTM, 2000) in *Principles and Standards for School Mathematics*. In MAA's document, they describe the types of mathematical experiences that all undergraduate students should have as they develop quantitative literacy. MAA recommended that traditional lectures be replaced with more active, engaging experiences that require students to engage in teamwork, discussion, and writing about mathematics. The expectation of these reform efforts is that by actively involving students in the learning of mathematics students will be more academically successful and more likely to pursue degrees in math-based fields.

Few studies and some faculty observations explored the relationship between active involvement and learning outcomes in undergraduate mathematics courses. They considered the impact of the following activities on students' academic achievement in undergraduate mathematics courses and their attitudes toward the study of mathematics: engaging students in whole class discussions (Millett, 2001; Wahlberg, 1997); giving students short, turn-to-your-neighbor exercises (Cooper & Robinson, 2000); doing quick writes to help students synthesize information (Rosenthal, 1995); utilizing peer teaching or peer tutoring (Eisenberg & Browne, 1973; Hurley, 1982); centering instruction around problem- or project-based activities (Hilbert, Maceli, Robinson, Schwartz, & Seltzer, 1992; Kvam, 2000; Seltzer, Hilbert, Maceli, Robinson, & Schwartz, 1996); and using a variety of small-group cooperative learning methods that range from those that emphasize problem-solving (Bryant, 1998; Dancis, n.d.; Dees, 1991; Dennis, 2001; Gersting & Kuczkowski, 1977; Page, 1979; Quitadamo, 2002; Sasse, 1997; Valentino, 1988, Weissglass, 1993) to those that are more inquiry-oriented (Cohen, 1982; Davidson, 1970; 1971; Legrand, 2001; Loomer, 1976; McKeen & Davidson, 1975). This collection of studies and personal accounts supports the following assertions about the impact of active learning on undergraduate students' learning experiences in mathematics:

Pedagogical strategies that promote active learning help students think about what they are learning.

Scholars claim that writing about mathematics or orally communicating about mathematics helps students to use and understand the language of the profession and helps them synthesize course information (Cohen, 1982; Rosenthal, 1995; Wahlberg, 1997; Weissglass, 1993).

Students who engage in active-learning activities perform at least as well as students' who participate in traditional learning activities.

The body of research that examines the relationship between active-learning activities and student achievement suggests that these types of learning experiences have no detrimental effects on students' learning of undergraduate mathematics. In fact, in studies that compared the academic performance of students who experience cooperative-learning pedagogy to students who experience traditional pedagogy, the researchers either report no statistically significant differences in achievement scores of the two groups or that students in cooperative learning groups outperformed students in traditional learning groups (Bryant, 1998; Dees, 1991; Dennis, 2001; Eisenberg & Browne, 1973; Loomer, 1976; Millett, 2001; Valentino, 1988).

Similarly, research on peer tutoring and peer teaching suggests that learning math with peers can influence students' academic achievement. Hurley (1982) found that high-ability calculus students who were paired with low-ability students had significantly higher end-of-course grades than their low-ability peers but found minimal differences for students in other ability dyads. Eisenberg and Browne (1973) saw increases in test scores across the board for students in a lecture-recitation pre-calculus course as compared to students' test scores in the previous year's lecture-only course. Under the lecture-recitation format students attended recitation sessions in addition to lecture and were placed into groups of three or four to work through assignments. As the groups worked on assignments, upper-class undergraduate students monitored their progress and acted as peer tutors for the groups. Differing influences of peer tutoring on academic achievement found in these two studies may reflect the types of tutors being utilized. In Hurley's study the tutors were students in the same class whereas in Eisenberg and Browne's study the tutors were upper-class undergraduates. Future research needs to consider differential impacts of interactions with immediate peers and with more advanced peers on cognitive and affective outcomes.

Participating in cooperative-learning activities in math courses early during undergraduate study may increase students' ability to retain mathematical knowledge. Kvam (2000) and Roddick (1997) compared students' ability to retain knowledge gained in a cooperative-learning engineering statistics and a cooperative-learning calculus course, respectively, to students' knowledge retention from traditional versions of those courses. In each case the researcher found that students who experienced cooperative learning pedagogy had greater knowledge retention over time than their counterparts. These findings suggest that there may be longer-term influences of active-learning experiences on students' cognitive development.

Students' attitudes toward studying mathematics are enhanced by participating in active learning experiences.

Some researchers have examined the impact that active learning versus traditional learning environments had on students' attitudes toward studying mathematics and found more positive attitudes toward studying mathematics among students who participated in courses where active learning pedagogy was employed (Eisenberg & Browne, 1973; Davidson, 1970; Sasse, 1997; Valentino, 1988).

While some of the aforementioned studies and faculty observations considered active learning that students engage in independently (such as writing and reflecting about mathematics) or interactions with faculty (orally communicating about mathematics in classroom discussions involving student-teacher dialogue), active learning in undergraduate mathematics is often measured by students' engagement in activities that involve student-student (or peer) interactions (e.g., student-student discourse, small-group work, cooperative learning, and peer tutoring or peer teaching). This focus reflects the powerful role of peers in influencing students' learning and attitudes toward undergraduate study and has influenced the types of structured active-learning activities available to students outside of the classroom context.

Academic-Centered Peer Interactions

Peers play a very influential role in undergraduate students' learning experiences. Many of the active learning methods used in undergraduate mathematics involve students in discussing course material with immediate peers or more advanced peers (for example during tutoring sessions or when studying, doing homework, preparing for class, or working in groups) or applying mathematical ideas in meaningful contexts in conjunction with an immediate or more advanced peer (for example as part of a course project, interdisciplinary project, or an undergraduate research experience). While these interactions may have social components, they are situated in academic contexts and the primary purpose for students to interact in these contexts is academic. In order to distinguish such interactions from activities where peers come together for a primarily social purpose, I refer to them as academic-centered peer interactions (ACPIs). These are interactions among peers that are organized primarily for an academic purpose. Furthermore, ACPIs occur both in and outside of the mathematics classroom and may or may not be part of a formally organized effort.

Many studies of social and academic aspects of students' learning experiences in undergraduate education have identified faculty and peer interactions as significant factors in students' affective and cognitive development and are a source of influence on student persistence in higher education (Bank, Slavings, & Biddle, 1990; Berger & Milem, 1999; Fernandez, Whitlock, Martin, & VanEarden, 1998; Hurtado & Carter, 1997; Hurtado, Carter, Spuler, Dale, & Pipkin, 1994; Lee, 1997; Loo & Rolison, 1986; Milem & Berger, 1997; Pascarella & Terenzini, 1991; Smedley et al., 1993; Thompson & Fretz, 1991; Weissman et al., 1998). These studies suggest that higher levels of involvement with peers and with faculty in academic contexts positively influence cognitive and affective outcomes. Many of these studies pointed out that students from underrepresented groups – particularly women and racial/ethnic minorities – attending larger or majority White institutions may have more negative relationships with faculty and peers than other groups of students and often report feeling isolated or alienated from faculty and peers (Berger & Milem, 1999; Hurtado & Carter, 1997; Loo & Rolison, 1986;

Smedley et al., 1993; Thompson & Fretz, 1991; Weissman et al., 1998). Similar observations have been made in studies that examined students' experiences in math- and science-based programs across several institutions. Scholars note that the competitive nature of MSEC programs and the elitist attitude of many faculty and students fosters negative relationships among students and between students and faculty (especially during the first two years of undergraduate study), and negatively impacts students' academic success and persistence in these programs (Fries-Britt, 1998; Hagedorn, Siadat, Nora, & Pascarella, 1996; Linn & Kessel, 1996; Nauta et al., 1998; Seymour & Hewitt, 1997; Thompson, 2001).

The math, science, engineering, and computer science (MSEC) environment during the first two years of undergraduate study is seen by students and educational reformers as overly competitive and unfriendly toward students, especially toward women and racial/ethnic minorities (Fox & Soller, 2001; Kennedy & Parks, 2000; Linn & Kessel, 1996; Nauta et al., 1998; Rosser, 1997; Seymour & Hewitt, 1997; Thompson, 2001). Seymour and Hewitt (1997) conducted a longitudinal, qualitative study that explored students' learning experiences in undergraduate MSE (math, science, or engineering) programs at several institutions and found that many students reported that they were discouraged by fast-paced curricula, overwhelming workloads, low grades in first-year courses, curve-grading, lack of support from faculty and other advisors, and negative interactions with peers. More specifically, students described pedagogical practices that made understanding course material difficult, discouraged interactions with faculty, and fostered competition among peers. Unfortunately, when students turned to teaching assistants for the support and assistance they desired from faculty, they often encountered pedagogical styles and attitudes that were similar to those of faculty.

Seymour and Hewitt (1997) described the negative impact of the competitive nature of MSE programs on students' interactions with peers. "Curve-grading is the engine which drives the competitive atmosphere in early [MSE] classes. It is this, above all, which makes students fearful of sharing their work and their ideas…Curve-grading forces students to compete with each other, whether they want to or not, because it exaggerates very fine degrees of difference in performance" (p. 118). Moreover, "competition based on curve-grading distorts normal social interaction between students. It creates isolation, mutual suspicion, and promotes a grossly protective attitude to the acquisition of knowledge and skills" (p. 119). As a result, some students become intimidated, have lower self-confidence, or become unhappy, and leave the sciences; and those who stay often study in isolation and have little interaction with MSE faculty, teaching assistants, and peers beyond the classroom (Seymour & Hewitt, 1997).

The "weed out" tradition in MSEC programs contributes to students' departure from these fields. It is akin to practices of military academies or fraternities and is a test of both ability and character and is also similar to the sort and classify system described by Johnson et al. (1991). During the first two years of study in MSEC programs, students are continually being examined for cognitive defects and, if found, are "weeded out" to ensure that only the most intelligent students continue in these programs. Weed-out practices include direct comments by MSEC faculty and administrators that many students won't make it past the first year. "Look to the right of you, look to the left of you. Forty-percent of you won't be here next year" (Seymour & Hewitt, p. 123). The weed-out process becomes evident to students by the way the curriculum is structured, by faculty's pedagogical practices, and by assessment practices. Students note that "weed-out" classes are exceptionally hard and argue that faculty try to get students to fail on purpose (Seymour & Hewitt, 1997). Faculty's attitudes toward first- and second-year students are another aspect of the weed-out process. Students assert that MSEC faculty are indifferent, uncaring or unapproachable, and hostile toward students. Furthermore, MSEC faculty make academic help difficult to get by not holding office hours and by discouraging students to seek help for problems with comprehension (Seymour & Hewitt, 1997). These attitudes and practices negatively influence students' academic success and their persistence in MSEC programs.

Negative interactions with faculty, teaching assistants, and peers have a particularly detrimental impact on women and racial/ethnic minority students in undergraduate MSEC programs. Seymour and Hewitt (1997) described how the weed-out tradition used in courses during the first two years of undergraduate study has a disproportionately negative impact women and racial/ethnic minorities. They state that the loss of regular contact with an instructor who encourages students to believe in their ability to do math and science results in lowered self-confidence and exacerbates feelings of uncertainty about whether they *belong* in these programs.

Forcing students to compete for, or learn to do without, help and attention, was an important part of the problems reported by women and by men of color (as well as some white men). This arises because the system has evolved in an exclusively white and male context. It tests for qualities of character traditionally associated with 'maleness' in Anglo-Saxon societies and is based on motivational strategies understood by young men reared in that tradition. The cues are more likely to be missed, and the messages lost on students whose education was founded in different normative systems… Among many women and young men of color it produces feelings of rejection, discouragement and lowered self-confidence. (Seymour & Hewitt, 1997, p. 132)

Alexander et al. (1996) support this perspective by describing traditional calculus courses as not only being non-reflective of recent advances in our understanding of teaching and learning, but also being in conflict with the cultures of many underrepresented racial/ethnic groups. "Academic success is founded on independent work with emphasis on outperforming others. This is potentially conflictual for many ethnic minority students because of their collective sense of ethnic identity which is based on a different cultural conception of self and relationship to community" (p. 5). Thus, traditionally taught calculus courses add another layer of difficulty to the learning process for many women and students in historically underrepresented racial/ethnic groups.

While little research has examined students' learning experiences in undergraduate computer science programs, existing work suggests students' learning experiences in these programs are similar to their peers' learning experiences in MSE programs. According to Margolis and Fisher (2002), White males dominate undergraduate computer science programs, and these programs reflect Angle-Saxon traditions. Furthermore, students who where were not raised in these traditions are often faced with cultural and curricular practices, faculty-student interactions, and student-student interactions that are incongruent with their ways of knowing and learning. This incongruence results in isolation and alienation from faculty and peers, lowered self-confidence, loss of interest in computing, and the loss of many talented individuals before the end of their sophomore year. Margolis and Fisher (2002) highlighted the particular challenges women face in undergraduate computer science programs by stating that computing is claimed as a male territory very early.

Curriculum, teachers' expectations, and culture reflect boys' pathways into computing, accepting assumptions of male excellence and women's deficiencies in the field… By the time they finish college, most women studying computer science have faced a technical culture whose values often do not match their own and have encountered a variety of discouraging experiences with teachers, peers, and curriculum. Many end up doubting their intelligence and their fitness to pursue computing. (p. 4-5).

Both male and female faculty members show differential treatment in favor of male students: they remember male students' names more often, call on them more frequently, ask them more challenging questions, listen to and take their ideas more seriously, and give positive responses to them more often (Klawe & Leveson, 1995). These classroom practices contribute to women's negative experiences in computing and their departure from this field of study.

In addition to challenges in MSEC classroom settings, racial/ethnic minority students who attend predominantly White institutions are likely to contend with stressors that other students do not face (Loo & Rolison, 1986; Weissman et al., 1998). Minority stressors are influenced by historical legacies of exclusion that may be present in institutional policies and practices that favor a particular population; lack of structural diversity at the institution; perceptions of campus relations as being inhospitable to racial/ethnic minorities; and actual occurrences of racial/ethnic incidences on campus

(Hurtado, Milem, Clayton-Pedersen, Allen, 2002). These stressors influence racial/ethnic minority students' sense of belong and their social and academic adjustments at the institution (Hurtado & Carter, 1997; Hurtado et al., 2002; Loo & Rolison, 1986; Smedley et al., 1993).

Racial/ethnic minority students in undergraduate MSEC programs who attend predominantly White institutions are also likely to have more negative experiences with faculty and peers than White students have (Loo & Rolison, 1986; Weissman et al., 1998). They are often one of a very small number of racial/ethnic minorities in their classes and are more likely than other students to view faculty as unfeeling and insensitive and to feel alienated from their peers (Alexander et al., 1996; Seymour & Hewitt, 1997). Racial/ethnic minorities tend to experience ethnic isolation because of the lack of a critical mass of students with whom they can readily relate, and they frequently work in isolation because their peers exclude them from small group activities or labs (Frye-Lucas, 2003; Seymour & Hewitt, 1997). These experiences negatively influence racial/ethnic minority students' learning experiences and contribute to the loss of talented individuals from undergraduate MSEC programs (Alexander et al., 1996; Frye-Lucas, 2003; Seymour & Hewitt, 1997).

The aforementioned studies suggest that the nature of pedagogy in MSEC programs influence students' interactions with faculty, teaching assistants, and peers and subsequently impacts students' academic success and persistence in these programs. They also suggest that first-year students may have different experiences with faculty (professors), teaching assistants, and peers that result from the types of interactions they have with these persons. Distinguishing between students' relationships with professors and teaching assistants (often graduate students) is important because current trends show a shift in teaching responsibilities for first-year courses at larger institutions from professors to graduate students and to greater use of graduate or undergraduate student teaching assistants (Seymour & Hewitt, 1997; Shannon, Twale, & Moore, 1998). This shift is particularly important to this study because some scholarship suggests that positive interactions with students in graduate MSEC programs can facilitate undergraduate students' academic success and persistence in math-based programs.

Grandy (1998) conducted a national study on high-ability racial/ethnic minority students (having a math SAT score greater than 500) who majored in MSE programs and were academically prepared to become scientists or engineers to identify factors that contributed to their persistence in these fields. Persistence rates of American Indian, Black, Mexican American, and Puerto Rican students were monitored for five years after their enrollment in an undergraduate MSE program. Students were classified as having persisted if they remained committed to MSE programs or careers at the end of five years (i.e., they were working or studying MSE full-time or part time). Those who had earned a degree in MSE but were employed outside of MSE were not classified as having persisted.

Grandy (1998) identified minority support as a potentially influential factor in students' decisions to persist in MSE programs and careers; therefore, it was included in the statistical model. Minority support was measured by "the extent to which [students] had minority or female role models and advisors, the extent to which they had advice and support from advanced students of their own ethnic group, and the extent to which they had a dedicated minority relations staff" (p. 594). Other variables in the model included type of college attended (two-year or four-year), socioeconomic status, math/science achievement in high school and on the SAT, social development in high school, science ambition in college, importance of performing a service to the community, importance of job security and success, and gender. Grandy (1998) found that minority support had a positive relationship to students' retention in MSE fields and benefited males more than females. Students who made a commitment to MSE by their sophomore year were more likely to have benefited from having a minority role model, received advice and support from more advanced students within MSE, and interacted with faculty members who were dedicated to minority student relations. These results suggest that minority support can be an effective tool to promote MSE retention and commitment to careers in these fields.

In a qualitative study of minority students' transition into a community college Weissman et al. (1998) examined factors related to students' social and academic integration. Through the use of focus groups as forums for students to discuss their experiences among racial/ethnic peers, they found that Hispanic students had limited interaction with instructors outside of class. Instead, they were more comfortable seeking academic help from their friends or other students. Hispanic students also reported some discomfort when they were in classes where they were the only minority; they often felt that other students looked at them as being troublemakers and as being intellectually inferior. Fries-Britt's (1998) work has shown similar findings for high-achieving African American students. Hispanic students' feelings were exacerbated by pressures they felt to succeed in school because of the sacrifices their parent had made to give their children an opportunity to go to college so they could be more successful than their parents were.

The findings of this study suggested to Weissman, Bulakowski, and Jumisko that faculty should develop collaborative environments that promote peer support networks that draw on “students’ experiences and knowledge… [and] encourage students to persist in their studies while simultaneously meeting their social and academic needs” (p. 36).

A related national study by Hurtado et al. (1994) examined factors affecting the social and academic adjustment of second year Hispanic students at four-year institutions. Again, peer support was a significant predictor of students’ social and academic integration. They found that the opportunity to interact with racial/ethnic peers had a positive impact on Hispanic students’ adjustment. Moreover, there were important differences in the effect of varied types of peer interactions. Specifically, interaction with upper-class peers was positively associated with academic adjustment while interaction with immediate peers was only associated with positive levels of social adjustment. This suggests that interacting with advanced undergraduates, graduate students, and mathematics professors in MSEC is likely to influence students’ learning experiences in different ways.

In-Class vs. Out-of-Class Learning Experiences

Very little research considers relationships between in- and out-of-class experiences and how they relate to undergraduate students’ academic success. Moreover, no studies have examined relative influences of students’ in- and out-of-class learning experiences in undergraduate MSEC programs on cognitive and affective outcomes. Nevertheless, results from a number of existing studies suggest that understanding relationships between in and out-of-class learning experiences and cognitive and affective outcomes for students in math-based majors can provide useful information to university administrators, mathematicians, and mathematics educators about learning experiences that are unique to students in MSEC programs.

Based on evidence from an extensive review of studies on students' experiences in college by Pascarella and Terenzini (1991), Terenzini, Springer, Pascarella, and Nora (1995) conducted a study that explored the importance of students' (1) co-curricular experiences; (2) formal instructional experiences and classroom-related contacts with faculty members; and (3) out-of-class experiences with faculty, peers, and the formal co-curriculum. The researchers wanted to understand how and to what extent these experiences shaped students' interest in learning. The study was conducted with part-time and full-time, first-year students from various majors at one large, urban, research institution. They found that both class-related and out-of-class experiences made statistically significant unique and joint contributions to students' intellectual orientations. The researchers noted that while their learning experiences in class had a greater influence on students' year-end interest in academic learning, the number of hours students' spend studying outside of class was also a strong, positive predictor of students' year-end interest in academic learning. Furthermore, among out-of-class experiences the only statistically significant negative predictor of students' year-end interest in academic learning was the number of hours students spent socializing with friends. This finding is consistent with other research which cautions that certain kinds of or too much social interaction with peers can lead to oversocialization that distracts students from studying and has a negative influence on their academic achievement (Astin, 1993b; Liu & Liu, 2000). Terenzini et al. (1995) assert that in order to understand the relative importance of various and interrelated sources of influence on educational outcomes, future studies must consider both in- and out-of-class learning experiences (including the nature and quality of these experiences).

A national study by Whitt, Nora, Edison, Terenzini, and Pascarella (1999) examined the relationship between peer interactions both in- and outside of classroom settings and students' cognitive development during the first three years of college. The researchers' analysis of the first-year experience for students across a variety of majors revealed that course-related peer interactions (e.g., studying or discussing ideas or concepts with classmates, participating in groups discussions, explaining course material or experimental procedures to others, etc.) had significant positive effects on students' self-reported cognitive gains in thinking and writing skills, understanding of science, and academic preparation for a career. Non-course related interactions (e.g., talking about art, music, or theater; having serious discussions with others who have different political opinions or religious beliefs, etc.) had significant positive effects on self-reported gains in understanding the arts and humanities, understanding self and others, gains in writing and thinking skills, and gains in preparation for a career. Furthermore, "With one exception (science reasoning in the second year), *all* of the significant effects of peer interaction on objectively measured outcomes [e.g., CAAP reading comprehension, critical thinking, composite cognitive development] occurred at the end of the first year" (p. 72). The researchers concluded that "peers play a particularly important role in cognitive development in the first year of college" (p. 72) and assert that special attention should be given to create "opportunities for first-year students to engage with peers in a wide variety of educationally purposeful activities" (p. 72-73). Whitt et al.'s recommended that future studies examine students' learning experiences both in- and outside the classroom and consider what students are learning, how they are spending their academic time, who students are learning with, and what types of educationally purposeful interactions among peers have the greatest impact on students' cognitive and affective development. Thus, examining peer interactions both in- and outside of class can provide valuable information about the relationship between students' involvement in the learning process during undergraduate study and how they relate to cognitive and affective learning outcomes.

Active Learning through ACPIs Outside of Class

Formally Organized, University-Sanctioned ACPI Opportunities

A host of formally organized, university-sanctioned programs for students in math- or science-based majors exist at many institutions. These programs include opportunities for students to participate in learning communities, undergraduate research projects, internships, peer mentoring, tutoring, supplemental instruction, and other activities designed to support their success and persistence in a math- or science-based field. In order to identify characteristics of successful programs, the College Board evaluated a collection of formally organized, university-sanctioned initiatives whose shared objective was to increase the number of graduating minority students in undergraduate MSEC programs (Gandara & Maxwell-Jolly, 1999). The report identified five major areas as critical to success: (1) mentoring; (2) financial support; (3) academic support; (4) psychosocial support; and (5) professional opportunities. One aspect of successful programs that cut across three (mentoring, academic support, and psychosocial support) of the five major areas was the role that peers play in enhancing students' academic success and persistence. While the implementation of these programs varied, they typically included structured opportunities for students to interact with immediate or more advanced peers through mentoring, peer tutoring, organized study groups, or learning communities.

Supplemental Instruction

While a professor at the University of California, Berkeley, Uri Treisman designed what has been identified as one of the most successful formally organized, university-sanctioned programs designed to support first-year students' success and persistence in undergraduate math- and science-based majors (Asera, 2001; Treisman, 1985, 1992). Treisman recognized that calculus was a major barrier for many minority students seeking to enter math-based careers. He noted that while the Black students in his class were motivated and had a desire to succeed, they were often struggling to pass his course (Treisman, 1985, 1992). Treisman decided to look more closely at his students' learning experiences and found qualitatively different styles of studying math for the Black and Chinese students in his class. Black students tended to study in isolation, and had no sense of how they were performing relative to their classmates.

For the Black students [learning math] meant this: You wake up in the morning. You go to class. You take notes. You get your homework assignment. You go home. You do your homework religiously and hand in every assignment on time. You put in six or eight hours a week of studying for a calculus course, just what the teacher says, and what happens to you? You fail. (Treisman, 1992, p. 366)

In contrast, Treisman found that the Chinese students studied both independently and with their peers and supported one another's academic growth by sharing problem-solving strategies, quizzing one another, comparing answers, asking questions about things that were unclear, and sharing class notes. These students were very aware of were they stood in the class at all times. The Chinese students' approach to learning math was so different from the Black students' approach that Treisman wondered if learning math with peers could be used to promote academic success for the minority students in his class. He designed the Emerging Scholars Program to test this idea (Asera, 2001; Treisman, 1985, 1992).

The Emerging Scholars Program was designed to facilitate student success in calculus by capitalizing on the use of peer learning groups. Students of various backgrounds voluntarily participated in this program and attended supplemental instruction workshops that ran parallel to calculus lectures and recitation sections for the entire semester. In the workshops small groups of students worked together on challenging problems designed to strengthen their understanding of calculus content. Mathematics graduate students facilitated the sessions, monitored students' progress, and asked probing questions or provided hints for groups that were having trouble making progress. Emerging Scholars Program workshops were held throughout the week and ran for the duration of the semester and, thus, provided the opportunity for a learning community to develop among MSEC students. Additionally, frequent interactions with graduate student leaders allowed students to interact with peers who had already completed undergraduate MSEC programs and were continuing their studies in MSEC fields.

The Emerging Scholars Program at University of California, Berkeley was a success. Treisman found that as a result of participating in these workshops, African American and Latino students outperformed their peers (racial/ethnic minorities, Whites, and Asians) who did not participate in the Emerging Scholars Program. Additionally, workshop students were retained in their programs at higher levels than non-workshop students (Treisman, 1985, 1992). The Emerging Scholars Program was so effective in enhancing minority students' academic achievement and persistence in MSE programs that it has received a great deal of attention from those interested in enhancing the learning of undergraduate mathematics. Several institutions have applied aspects of this model in their first-year math courses to strengthen the academic achievement and promote the retention of traditionally underrepresented students (e.g., racial/ethnic minorities, women, students from rural areas) in math- and science-based majors (Alexander et al., 1996; Asera, 2001; Duncan & Dick, 2000; Moreno & Muller, 1999).

In addition to findings regarding the short-term benefits of participating in Emerging Scholars Programs (e.g., academic support during first-year math courses, retention in calculus and other first-year courses, and the development of academic-centered peer support networks), one study suggested that participating in an Emerging Scholars Program early during an undergraduate career can influence students' achievement in subsequent courses and persistence through degree completion. Bonsangue (1992) conducted a longitudinal examination of the impact of participating in an Emerging Scholars Program on students' success in math-based fields three years later. He found that compared to their counterparts, a higher percentage of workshop participants still enrolled in math-based majors had completed their math course requirements (91% compared to 58% for non-participants). Bonsangue also noted that non-workshop students took a full quarter longer to complete these requirements. Additionally, students who did not participate in the workshops were more likely to withdraw or be dismissed from the institution (forty percent of non-workshop students compared to only five percent of workshop students). These results suggest that participation in Emerging Scholars Program workshops may not only influence student success during the first-year of undergraduate study, but may also have residual benefits that carry through the duration of an undergraduate career.

Learning Communities

The use of learning communities in higher education has become increasing popular in recent years (Zhao & Kuh, 2004; Zunkel, 2002). While several models of learning communities exist, ranging from those that cluster students for two or more classes to those that include a residential component, they are structured in ways that help students make social and academic connections. Consequently, students become members of a community of students and faculty who provide social and academic supports that facilitate cognitive growth and identity development (Zhao & Kuh, 2004, p. 117). The opportunities students have to interact with immediate and more advanced peers can increase their involvement in the learning experience and subsequently influences their academic success and persistence in undergraduate study. Researchers note that various types of learning communities may influence students' learning experiences in different ways. For example, because students in residential learning communities have greater access to peers they tend to be more academically and socially integrated into the institution (Astin, 1999; Pascarella & Terenzini, 1991). Moreover, students who participate in academic-centered learning communities typically experience greater cognitive gains than students with other living arrangements (Pascarella & Terenzini, 1991; Terenzini, Pascarella, & Bliming, 1996; Tinto & Goodsell-Love, 1993).

These differences in cognitive gains are often attributed to high levels of social, emotional, and academic support from peers and faculty members.

Pike (1999) considered the effects of participation in three types of residential learning communities on first-year students' level of academic involvement and cognitive development. He discussed the importance of linking students' in-class and out-of-class experiences and asserted that residential learning communities provide unique opportunities for students to interact with peers from a variety of academic disciplines who are different from themselves. Each of the learning communities in the study were designed to facilitate students' cognitive and affective development by creating opportunities for students to participate in academic and co-curricular activities (i.e., service learning, career exploration, subject mastery workshops, recital rooms for music, or computer laboratories); course clustering; freshman interest groups; or living structures that place students who were pursuing similar degrees on the same floor. Pike hypothesized that these opportunities contributed to higher levels of involvement and integration in the institution, more interactions with faculty and peers, and greater cognitive gains than their counterparts who did not participate in the learning community. He found that students in residential learning communities were more involved, had more interactions with faculty and peers, were more academically and socially integrated into the institution, and had greater cognitive gains than did students in traditional residential halls. Moreover, among the variables considered, involvement in residence halls and interactions with faculty had the strongest positive relationship to intellectual development. Thus, participating in residential learning communities that have an academic focus and that create opportunities for ACPIs and interactions with faculty can influence students' cognitive development.

Zunkel (2002) examined relationships among retention, academic performance/success, self-efficacy, confidence, outcome expectations, and commitment for first-year undeclared engineering students who participated in a residential learning community. She found that students who participated in the residential learning community were retained at a higher rate than students who elected not to participate, and that retention was related to more positive levels of students' confidence, commitment, self-efficacy, and outcome expectations. Additionally, Zunkel noted that first semester grades had a bigger role predicting students' retention in engineering than participation in the learning community had. Despite this positive relationship between participation in the learning community and retention, the hypothesis that participation would be positively related to achievement was not supported. Zunkel found no significant differences in grade point averages for students who participated in the learning community and those who did not elect to do so. Although Zunkel's findings suggest that participation in the learning community did not directly affect students' academic achievement, learning communities may indirectly influence students' achievement because they can facilitate academic and social integration (Tinto & Goodsell-Love, 1993).

Fernandez et al. (1998) examined the impact of participation in a first-year pilot program on the academic achievement, retention, and satisfaction of under-prepared White and Hispanic first-year students attending a predominantly White, private university. The participants were members of a cohort of students who enrolled together in small groups in three required courses. They were assigned a faculty mentor (one of their instructors) with whom they would meet (along with their group members) for an hour each week. In these weekly sessions, faculty mentors helped students develop their verbal, study, and note-taking skills. The researchers found that students who participated in the pilot program had higher grade point averages and were retained at higher rates than their peers who did not participate. However, students expressed dissatisfaction with meetings with their faculty mentors and the influence of these interactions on their personal and academic growth. These findings suggest that the structure of faculty-student and student-student interactions may influence students' cognitive and affective development and satisfaction in different ways.

The Meyerhoff Scholars Program at the University of Maryland, Baltimore County was designed to increase the number of underrepresented minorities who pursue graduate and professional degrees in science and engineering by creating a learning community of high-ability (having relatively high SAT math scores and maintaining a B average) Black students. The program offers study groups, tutoring, academic advising, and mentoring by professionals in MSEC fields. Data gathered on students' first-year experiences revealed that students who participated in the Meyerhoff program had significantly higher grade point averages than African American students enrolled in MSEC programs in previous years who were not Meyerhoff scholars and were more likely than non-participants to complete a degree in MSEC. Fries-Britt (1998) reported that students in the Meyerhoff program enjoyed being members of a community of high-ability Black students with whom they could relate and seek academic and social support and felt a connection to their peers that diminished feelings of isolation. Additionally, meeting and studying with other talented Black students created a friendly competition that encouraged students to work harder.

Although findings are mixed on the relationship between participating in a learning community and educational outcomes, these studies suggest that there are some benefits to participating in learning communities. Further research needs to be conducted to gain an understanding of the aspects of learning communities that contribute to academic achievement and students' decisions to persist in their programs.

Undergraduate Research Experiences

Providing undergraduate MSEC students with the opportunity to participate in undergraduate research is designed to enhance students' learning experiences and develop students' knowledge and skills in professional aspects of these fields. Kardash (2000) considered the influence of science majors' participation in undergraduate research experiences with a faculty mentor and their research skills. By surveying the students at the beginning and end of the research experience and their faculty mentors at the end of the experience, Kardash found that participating in the undergraduate research experience helped to develop students' research skills. That similar results were found for males and females, particularly in the students' self-rating, is important because women tend to be less confident in their academic abilities than men (Linn & Kessel, 1996; Nauta et al., 1998; Thompson, 2001) and this lack of confidence is related to their decisions to continue pursuing MSEC degrees (Seymour & Hewitt, 1997; Thompson, 2001). While students in this study were juniors and seniors, some opportunities to participate in undergraduate research are available to interested MSEC students regardless of their academic classification, and participating in these types of opportunities may be even more important for first-year students because of the opportunity to interact with an advanced peer or professor in an educationally purposeful and supportive context.

"Bridge" Programs

The transition from high school to college is difficult for many students. Not only do students find themselves in an unfamiliar environment where there are many unfamiliar faces, they are also given responsibility for their own academic development. In addition, racial/ethnic minority students who attend a predominantly White institution are more likely than other students to feel alienated and isolated from their peers (Hurtado & Carter, 1997; Loo & Rolison, 1986; Smedley et al., 1993; Thompson & Fretz, 1991; Weissman et al., 1998). Moreover, majoring in an undergraduate MSEC program may be particularly challenging for women and students from traditionally underrepresented groups because of the lack of a critical mass of other minority group members with whom the student can become friends (Becker, 1992; Linn & Kessel, 1996; Seymour & Hewitt, 1997; Steele, James, & Barnett, 2002). This can be exacerbated by the fact that because of complex historical and social factors, African American students may be alienated from peers within their own racial/ethnic group who do not place the same value on academic success (Fries-Britt, 1998). Many university-sanctioned "bridge" programs address these challenges by targeting students from historically underrepresented groups. These programs are often designed to facilitate the transition from high school to the first year of college and seek to develop academic and social support networks of diverse groups of students.

Many institutions have formally organized, university-sanctioned bridge programs designed to help students transition into the undergraduate environment by supporting their success in early coursework and connecting them with other students pursuing degrees in similar fields. Santa Rita and Bacote (1997) examined the effects of a summer bridge program designed to increase the academic achievement, retention, and graduation of minority and low-income students across a variety of majors on their academic, personal, and social development. While the nature of the relationship between participation in the learning community and students' grade point averages was inconclusive, participation in the summer bridge program was positively related to persistence in undergraduate study through the fall semester of students' second year of study.

The University Transition Program is another bridge program that seeks to facilitate the academic success and program retention of traditionally underrepresented groups across a variety of majors (Lee, 1997). This program targets academically under-prepared first-year African American and Native American students and provides an array of special courses and counseling services designed to prepare students for long-term academic success. Additionally, this program assists students with the academic transition, physical transition, and emotional transition into university life. The program also provides students with help to understand how to navigate the university system, and exposes them to classes where active-learning pedagogical strategies are employed. Students expressed positive views of this program and appreciated the support it provided during their transition period.

Wheatland (2000) and Wine and Cooper (1985) examined the relationship between MSEC students' participation in summer bridge programs and their academic success and program retention. In both cases, the summer bridge programs were designed to facilitate transition into the university environment by providing students with instruction in math, science, English, and study skills. In addition, the summer bridge programs created opportunities for students to participate in group study and discussions with other participants and peer counselors. These discussions addressed topics such as self-confidence, navigating and succeeding in MSEC majors, and exploring MSEC careers. Wheatland's (2000) findings showed that bridge program participants had higher levels of academic achievement and were retained at higher levels after their first year of undergraduate study than non-participants. Similarly, Wine and Cooper (1985) found that all of the students who participated in the bridge program completed their first year of school; however, bridge students' levels of academic achievement were not significantly different than non-participants. These findings suggest that summer bridge programs may have some influence on students' academic achievement, but may have a greater influence on their retention in MSEC programs.

Results of studies of the relationship between participation in "bridge" programs and the academic success and persistence of traditionally underrepresented students suggests that these programs can provide social and academic supports that can contribute to students' success in ways that other programs or academic enhancements do not. Furthermore, the types of activities in which students participate and who they are interacting with are important and must be considered as researchers try to understand the relationship between these programs and cognitive and affective outcomes.

Informally Organized ACPIs

Very few studies consider learning experiences outside of class that are informally organized by students. However, the competitive nature of undergraduate MSEC programs may cause many students to study alone or to find only a few peers with whom they can provide mutual support as they progress through these challenging programs. Moreover, it is important to understand what students are doing outside of class to support their academic success (whether formally organized or not) because these activities can influence students' academic performance in class and their decisions to persist in MSEC programs.

Treisman (1985, 1992) developed the Emerging Scholars Program discussed earlier based on his observations of how his students were learning math outside of class and was able to utilize ACPIs to actively engage students in the study of mathematics in class. The Emerging Scholars Program resulted in increased student achievement and persistence in undergraduate MSEC programs, and the success of this program continues to influence efforts to reform undergraduate mathematics education across the country.

Cerrito and Levi (1999) explored the study habits of undergraduate students in Intermediate Algebra, College Algebra, and Pre-calculus courses to understand how much time students spent studying for math class. The "rule of thumb" suggests that students should spend two to three hours studying outside of class for every hour they spend in undergraduate math classes. However, the researchers found that most students claimed to spend somewhere between 20 minutes and one hour and 34 minutes studying outside of class for each hour they spent in class. While this is more than the amount of time students spent studying for other courses, it may not sufficient for developing a good understanding of undergraduate mathematics course material.

Lazar (1993) also considered differences in students' study habits outside of class based on the structure of their interactions with study group members and how they influence students' learning of mathematics. She found differing approaches and ways of interacting with group members in the all female study group compared to the all male study group that were considered in her study. The female group's negotiation of their roles resulted in a teacher-student dynamic for their study sessions where a student who was able to grasp the material in class more easily than the other group member took on the role of "teacher" during study sessions. This role involved using questioning to guide her peer's thoughts and problem-solving strategies and giving instructions on particular problems to work through for practice and how to study for the course. Lazar notes that these study sessions were very "teacher"-centered and restricted the "student's" thinking and creativity at times. However, the dynamics of this study relationship were not oppressive; the "teacher" cared very deeply about the success of her "student" (and friend), and while the study group structure occasionally created tense moments, both parties understood that the "teacher's" intention was to facilitate the "student's" academic success.

The all male study group was structured very differently. The male students worked on problems independently and then compared their results afterward. They were not very interested in the process of how their peers solved a problem, and measured their ability to solve a problem by the final result. The male students avoided displays of teacher-centeredness, and mutually assumed that if someone needed help he would speak up and tell the group. While the structure of these two study groups differed greatly, they both offered opportunities for students to engage in discourse about mathematics content and work through mathematical tasks within meaningful, academic and social contexts. In addition to looking at the intellectual and academic differences among group members, Lazar asserted that future studies should consider the social, cultural, and emotional ties between participants because they may influence the structure and dynamics of the study group and the resulting educational outcomes.

Summary

This chapter described literature addressing active involvement in the learning process through the use of academic-centered peer interactions both in- and outside the mathematics classroom and their relationships to academic achievement and retention in undergraduate math, physical science, engineering, and computer science programs. Active-learning is a central component of many efforts to reform undergraduate mathematics education and influences the type of pedagogy that students encounter in first-year math courses as well as the availability of opportunities that support student success in undergraduate MSEC programs. Academic involvement, interactions with faculty, and interactions with peers influence students' academic success and retention in undergraduate education, and are particularly important to consider when examining students' experiences in MSEC programs. The nature of students' experiences with the curriculum, with faculty, and with peers is likely to influence learning outcomes. Negative experiences can discourage students' success and program persistence while positive experiences can support students' achievement and degree attainment. Moreover, the activities that students engage in during class and outside of class jointly contribute to their cognitive and affective development; however, they may influence students' learning in different ways. There may be differential influences on cognitive and affective outcomes depending on the peers that students are interacting with as well as the type, structure, and frequency of those interactions. Thus, as Astin (1993a, 1996, 1999) has proposed, it is important to understand both the quantity and quality of students' experiences with faculty, immediate peers, and more advanced peers as we consider how students learn mathematics in different contexts.

CHAPTER THREE: METHOD

Introduction

This study examined the nature of students' participation in active-learning experiences with peers in different contexts (in class vs. out of class) and with different structures (formally organized vs. informally organized) and their relationship to student achievement in mathematics and retention in math-based majors.

Research Questions

The study explored the following research questions:

1. What was the nature of students' involvement in ACPIs (i.e., In what types of, with what frequency, and with whom were students participating in ACPIs? What role did ACPI experiences play in students' perceptions of their academic performance and decisions to persist in undergraduate MSEC programs?)?
2. Is there a statistically significant difference in the amount of time students spent involved in ACPIs when examined in terms of race/ethnicity, gender, and ability (determined by students' fall 2004 math course)? Does this vary by the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students)?
3. Is the amount of time students spent involved in ACPIs a statistically significant predictor of fall 2004 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally

organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

4. Is the amount of time students spent involved in ACPIs a statistically significant predictor of spring 2005 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?
5. Is the amount of time students spent involved in ACPIs a statistically significant predictor of retention of first-year students in MSEC programs from the fall 2004 to the fall 2005 semester (determined by fall 2005 major and course enrollment)? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

Overview of Method

This study employed a mixed methods approach that involved collecting and analyzing both quantitative and qualitative data using what Creswell, Plano Clark, Gutman, and Hanson (2003) referred to as a concurrent triangulation method design in which a researcher uses separate quantitative and qualitative methods in an attempt to confirm, cross-validate, or corroborate findings within a single study. Method triangulation involves the use of multiple research methods to capture multiple viewpoints and allow for a more complete, holistic, and contextual portrayal of a single phenomenon (Russell & Stage, 1992). It requires the researcher to "actively seek points of intersection so that both mutually supportive results as well as seeming contradictions are fully discussed" (Russell & Stage, 1992, p. 126). Method triangulation is typically used to improve the validity of research or assessment findings; however, it "can also be a strategy for enriching conclusions by contributing new, explanatory finds" (p. 127). In the present study quantitative and qualitative data collection was concurrent, data analysis was separate, and the integration and triangulation of quantitative and qualitative results occurred during interpretation (Chapters Four and Five). While a higher priority was given to the quantitative aspects of this research, the qualitative results were used to illuminate quantitative results and provide a more in-depth description of first-year MSEC students' learning experiences. A copy of the Institutional Review Board (IRB) approval is included in Appendix A.

The Role of the Researcher

Locating myself within the study is essential to the qualitative aspects of this research. Unlike purely quantitative work, qualitative research does not assume a state of objectivity where the researcher remains unbiased. I am a female of African descent and of Jamaican heritage who completed an undergraduate degree in a MSEC field and have pursued graduate study in mathematics education with a focus on undergraduate mathematics education. I have had a variety of ACPI experiences that have shaped my perspectives on the teaching and learning of mathematics and my understanding of how active learning can influence students' academic success and retention in undergraduate

MSEC programs. In the year before this study was conducted I spent some time visiting several calculus lecture and recitation sections that a majority of my participants would enroll in the following year so that I could gain a sense of how the courses were structured and the types of ACPI opportunities they afford students. I also interviewed two students (individually) in those sections that where on different ability levels to learn more about how their ACPI experiences shaped their learning of mathematics and influenced their decisions to continue pursuing a degree in a MSEC field. Those classroom visits and interviews provided some insights on the types of opportunities students have to discuss mathematics with professors, TAs, and other undergraduate students and influenced the types of questions posed to students on the *MSEC ACPI Experiences Survey* and during focus group interviews. While these experiences placed me in a unique position to relate to the terminology and situations that my study participants described, I had to be careful that I expressed their views and perspectives rather than my own. I did this by revisiting audio recordings of interviews and notes throughout the analysis process; seeking corrective feedback from experts who were not present during the focus groups, but who are knowledgeable about the study population, ACPIs, and the research methodology; and by cross-referencing qualitative findings with quantitative data.

Setting and Participants

This study was conducted at the University of Maryland College Park, a public, four-year, predominantly white institution with a relatively large undergraduate student enrollment. Of the approximately 25,000 undergraduate students enrolled at the university at the time that I gathered the data for this study, approximately 51% were male and 49% were female, 58% were White/Caucasian, 13% were Asian American/Asian, 12% were African American/Black, 6% were Hispanic/Latino(a), 0.3% were American Indian, and 2% were International students (University of Maryland (UM) Office of Institutional Research and Planning, September 16, 2004).

The initial population for this study was all first-time, full-time, traditional-aged students majoring in any MSEC program who enrolled in pre-calculus or calculus during the fall 2004 semester. The total fall 2004 CMPS and ENGR enrollment of first-time, full-time students was 734; there were 198 students enrolled in CMPS and 536 students enrolled in ENGR. Of the 734 students, there were 616 males, 118 females , 514 Whites/Caucasians, 114 Asian Americans/Asians, 52 African Americans/Blacks, 20 Hispanics/Latinos, 3 American Indians, 15 international students, and 16 whose race or citizenship status was unknown (UM Office of Institutional Research and Planning, September 16, 2004). Calculus is typically required for students with a major in the College of Computer Science, Mathematics, and Physical Sciences (CMPS) or the College of Engineering (ENGR); therefore, most first-year CMPS or ENGR students enrolled in either precalculus, calculus 1, calculus 2, or an advanced mathematics course (calculus 3 or higher) for the fall 2004 semester.

At the time of this study, the fall calculus 1 and spring calculus 2 courses at the University of Maryland required students to enroll in both a lecture and a recitation/discussion section. The lectures consisted of between 200 and 300 students and the recitation/discussion sections consisted of between 18 and 28 students. The lectures were typically taught by a professor using traditional methods of instruction and were held three times each week for a total of 150 minutes. The recitation/discussion sections were organized in a small-group format that was adapted based on Treisman's work with the Emerging Scholars Program (see Bryant, 1998; Treisman, 1985), taught by a TA who was trained to use this pedagogical model, and held twice a week for a total of 100 minutes. Calculus 2 courses offered for the fall semester and calculus 1 courses offered for the spring semester did not have the small-group format for recitation/discussion sections. The structure of these courses varied based on each TA's pedagogical style. Pre-calculus courses and courses beyond calculus 2 (calculus 3 or higher) consisted of between 25 and 35 students and did not have a recitation/discussion section. The pedagogy in these courses was determined by the faculty member who taught each course.

Procedures

The email addresses of 655 of the 734 first-time, full-time CMPS and ENGR students were available through university records. These email addresses were compiled into a listserve that was used to contact students and invite them to participate in this study. In February 2005 the researcher visited courses that first-year students were likely to be enrolled in for the spring 2005 semester (e.g., Calculus I, II, III, and Linear Algebra) to share information about the study and to inform students to expect an email invitation during the following week inviting them to participate in the study. During the next week students on the listserve received an email from the Associate Chair of Undergraduate Studies in the math department asking them to participate in the study (see Appendix B). This email included a hyperlink to a web page where students were asked to read and electronically sign an informed consent form to indicate that they were willing to participate in this study.

The consent form provided students with information about the purpose of the study and described the different data components that were involved. The consent form also informed students that as a result of completing the survey they would be entered into a lottery to receive one of 15 cash prizes of $50 each. Students “signed” the consent form by providing one of the following unique university identifiers: their University ID (UID), their Directory ID (LDAP), or their Student ID (UMID). By signing the electronic consent form, students gave permission to the researcher to access university records containing data about their academic background (such as math SAT or ACT scores and high school math GPA); fall 2004 major, math course enrollment, and math grades; spring 2005 math course enrollment and math grades; and fall 2005 major and course enrollment. A copy of the survey consent form is included in Appendix A.

Once students electronically signed the survey consent form, they were allowed to complete the electronic version of the *MSEC ACPI Experiences Survey* online (see Appendix C). Students were given 14 days to respond to the survey. The researcher monitored the survey response rates. After 14 days the listserve owner removed email addresses of students that had already responded or that were “bad” addresses, and a follow-up email was sent from the Associate Chair of Undergraduate Studies in the math department asking students who had not completed the survey to do so. Students were asked to complete the survey by March 20th, 2005.

At the end of the survey, participants were asked to indicate their willingness to participate in focus group interviews during April 2005. Students who agreed were included in the pool of participants who were invited to attend one of the focus group interview sessions.

The composition of focus group sessions were determined, in part, based on findings from preliminary analyses of the survey data. Preliminary descriptive analyses of the survey data were conducted to examine the types and frequency of students' participating in ACPIs. Summary statistics and crosstab analyses were used to identify trends in student responses that suggested possible differences in the students' learning experiences and the value they place on these experiences. These analyses suggested (1) differences in the frequency of participation in ACPIs by race/ethnicity; (2) differences in the types of activities in which male and female students participate; and (3) differences in the types and frequency of participation in ACPIs by fall 2004 math course. Based on these findings and the goals of this study, subsets of the participants were invited to participate in three mini-focus group interviews that were conducted in April 2005. The interviews posed a variety of questions about students' ACPI experiences during the fall 2004 semester and the beginning of the spring 2005 semester to explore the nature of students' learning experiences and the role they play in students' academic achievement and decisions to persist in MSEC. See Appendix C for the focus group interview protocol.

Eight students participated in focus group interviews and signed the focus group informed consent form (see Appendix A). The focus group consent form provided students with information about the purpose of the study and described the different data components that were involved. The focus group consent form also notified students that as a result of participating in a focus group they would be provided with a meal during the interview session.

University data were collected at two time points. Data about students' academic background; fall 2004 major, math course enrollment, and math grades; and spring 2005 math course enrollment and math grades were obtained from university records after all grades were submitted and closed for the spring 2005 semester (in June 2005). The second data collection period occurred after the official university drop period for the fall 2005 semester (in September 2005) and included fall 2005 major and math course enrollment.

Survey Instrument Development and Validity

The *MSEC ACPI Experiences Survey* was developed by the researcher using *Survey Monkey,* an online-research tool used to create professional, web-based surveys quickly and easily. The survey interface was a point-and-click environment, user-friendly, and could be navigated by respondents quickly and easily. The items included on the *MSEC ACPI Experiences Survey* were based on literature on active learning in undergraduate education that was discussed in Chapter Two. A copy of the *MSEC ACPI Experiences Survey* is included in Appendix C.

The *MSEC ACPI Experiences Survey* is partitioned into five sections: informed consent form, demographic characteristics and background information, career aspirations, learning experiences, and learning preferences. Most of the survey items were adapted from previously validated instruments. Items included in the demographic characteristics and background information section were adapted from the 2003 College Study Survey administered by the Higher Education Research Institute at the University of California at Los Angeles as part of an ongoing study of higher education conducted by the American Council of Education and the University of California at Los Angeles.

Items adapted from the College Student Survey request information about students' sex, age, racial/ethnic background, year of graduation from high school, parents' education level, current living situation, major, highest degree intended, and likelihood to continue pursuing a degree in their current program.

Items included in the career aspirations section were adapted from a longitudinal, qualitative study conducted by Seymour and Hewitt (1997) on students' experiences in undergraduate MSE programs. These items are based on factors that Seymour and Hewitt identified as greatly influencing undergraduate students' decisions to switch from a MSE major to a major outside of these fields. Using a likert scale of "Critical," "Very Influential," "Some Influence," and "Not Influential at All" study participants were asked to rate how influential 25 items were in their consideration to switch to a major outside MSEC.

The learning experiences section included items soliciting information on ACPI experiences in class and formal and informal ACPI experiences outside of class. Items on ACPI experiences in class were adapted from a study by Ruland (1999) that examined how various factors in the classroom environment influence students' critical thinking ability. Many of the factors identified by Ruland include activities that promote active learning through the use of peer interactions that pertain to the present study. For each of the 13 items in this section, students were asked to indicate the frequency – "Not at All," "About Once a Month," "Once or Twice a Week," "Three or More Times a Week" – in which particular active-learning activities occurred during the calculus or pre-calculus course they were enrolled in during the fall 2004 semester.

The 11 items on formal and informal ACPI experiences outside of class were developed based on studies that examined the relationship between participation in out-of-class, university-sanctioned programs on students' learning experiences in undergraduate MSEC programs (Alexander et al., 1996; Cerrito & Levi, 1999; Duncan & Dick, 2000; Fries-Britt, 1998; Gandara & Maxwell-Jolly, 1999; Grandy, 1998; Moreno & Muller, 1999; Seymour & Hewitt, 1997; Thompson, 2001; Treisman, 1992, 1995; Zunkel, 2002) and Astin's work on the impact of student involvement in various types of activities on cognitive and affective outcomes (1984, 1993a, 1996, 1999). These studies inquired about students' level of participation in particular active-learning activities and who they were involved with in these activities (e.g., professors, advanced students, and immediate peers). The items in this section asked students to indicate the frequency – "Not at All," "About Once a Month," "Once or Twice a Week," "Three or More Times a Week" – of their participation in particular activities. They were also presented with an identical set of items and asked to identify whether they engaged in these activities alone, with another undergraduate student, a graduate student, or a professor.

The final section of the survey, ACPI preferences, was adapted from an instrument used by Cabrera, Crissman, Bernal, Nora, Terenzini, and Pascarella (2002) to measure the relationship between students' learning preferences and their level of participation in particular activities during college. The items in this section ask students to indicate their level of agreement – "Strongly Disagree," "Somewhat Disagree," "Neutral," "Somewhat Agree," "Strongly Agree" – with six statements about their preferences for learning with other students.

Survey Pilot Test

Due to the fact that the *MSEC ACPI Experiences Survey* was adapted from existing instruments in order to meet the objectives of this study, Creswell (1994) stated that it becomes important to reestablish instrument validity and reliability. In addition, Gall, Borg, and Gall (1996) encourage researchers to carry out a thorough pretest of the questionnaire before using it in the main study. Therefore, the survey was piloted to test the research methodology, data collection procedures, and to ensure that the items were clear and concise.

Mangione (1995) and Gall et al. (1996) suggested selecting a sample of 10-20 individuals similar to the population from which the researcher plans to draw his/her respondents for the main study. A panel of nine professionals working in math- and science-based fields and 11 graduate students in mathematics or mathematics education were identified and asked to complete the survey and provide feedback about the clarity of the survey instrument, any unclear instructions, ambiguous wording, confusing questions, or questions that were too difficult or sensitive to answer. In January 2005 panel members received an email providing information about the study asking them to participate in the pilot test of the instrument. Participants were expected to complete the survey and provide feedback within seven days of receiving the email.

Results of the Survey Pilot

Of the 20 persons on the panel, five professionals and eight graduate students participated in the survey pilot. Results indicated that some of the instructions needed to be made more noticeable and the wording of some items needed to be clarified. Participants also expressed concern about the length of the survey and suggested combining some items and removing others. The researcher used spacing and titles to clarify instructions on the survey, changed the wording of items to be more clear and concise, and combined or removed items to shorten the length of the survey. After making appropriate revisions to the *MSEC ACPI Experiences Survey* the instrument was reviewed by the Associate Chair of Undergraduate Studies in the mathematics department and resubmitted to the researcher's dissertation chair who then made final suggestions for the improvement of the instrument.

Factor Analyses

The Statistical Package for the Social Sciences (SPSS) Graduate Pack Version 12.0 for Windows was used to conduct exploratory factor analyses to investigate whether the initial scales used in the *MSEC ACPI Experiences Survey* (formally organized ACPIs in-class, formally organized ACPIs out-of-class, informally organized ACPIs out-of-class) were the most appropriate groupings of items for use in this study and to establish construct and instrument validity. Pett, Lackey, and Sullivan (2003) contend that exploratory factor analysis can be used for instrument development to assess construct validity and explore the underlying dimensions of the constructs of interest.

An unconstrained factor analysis of the 24 items in the learning experiences section of the *MSEC ACPI Experiences Survey* revealed 10 factorial structures. These results were based on a principal components method of extraction using a Varimax rotation. The 10-factor structure converged in 20 iterations, which indicated that the items did not fit clearly into the original subscales. To determine if the three subscales would replicate, the Varimax rotation was constrained to three factors. The three factors converged in five iterations. To obtain an adequate factorial structure for all three factors, items were retained on a factor if their loading was greater than or equal to 0.400 (in absolute value). PrjWork, "Students worked in groups on projects to be turned in for a grade or extra credit;" PrjInf, "Working on math- or science-based research projects;" IEExpInf, "Participating in math- or science-based internship or externship experiences," and EventsInf, "Attending math, science, engineering, or computer science lectures/seminars/social events" were removed on this basis, and the remaining 21 items were used to define the factors. Nonetheless, CareerInf, "Discussing careers in math, science, engineering, or computer science," and MeetingInf, "Attending math, science, engineering, or computer science lectures/seminars/social events," loaded > 0.400 on multiple factors. Item analyses were conducted to determine the most appropriate placements of these items. Item analyses revealed that both CareerInf and MeetingInf resulted in a higher reliability score when included with factor three, and their removal from factor two had only a minor impact on the reliability score for factor two; thus, both items were retained on factor three. The three factors identified did replicate the original subscales after these adjustments.

Reliability Analyses

All instruments are subject to measurement error. According to Pett et al. (2003), "The reliability of an instrument refers to the extent to which scores on an instrument are free from this measurement error" (p. 174). There are two types of measurement error that contribute to the reliability of an instrument, systematic (nonrandom) error and random error. Systematic error "is often the result of miscalibration of an instrument or problems with the underlying construct being measured. Random error, on the other hand, is inconsistent and not predictable given similar repeated measures of an instrument under the same respondent conditions" (Pett et al., 2003, p. 174). The strongest negative effect of systematic error is on the validity of the instrument (i.e., the extent to which the instrument measures what it intends to measure). Random errors have an inverse affect on the reliability of an instrument – the lower the random error, the higher the reliability.

Reliability analyses were conducted to determine the extent to which scores on the instrument were free from measurement error. Cronbach's coefficient alpha measure of reliability represents the portion of total variance in a given scale that can be attributed to a common source (Pett et al., 2003). Cronbach's coefficient alphas were calculated for each of the factors and revealed that all three factor subscales are valid and are generalizable for this study population. Cronbach's coefficient alpha was .876 for In-Class ACPIs; .818 for Formally Organized Out-of-Class ACPIs; and .710 for Informally Organized Out-of-Class ACPIs.Therefore, at least 87.6%, 81.8%, and 71.0% of the variance of the total scores on each subscale, respectively, can be attributed to reliable or systematic variance. Table 1 shows the factor subscales, items, loadings, and Cronbach's coefficient alphas for each factor subscale.

Table 1
Factor Analysis

Factor and Item Descriptions	Loading
In-Class ACPIs (Frequency of occurrence in fall 2004 Precal, Cal 1, Cal 2, or Cal 3+)	
Students listened to and evaluated each others' ideas, solutions, or points of view	.704
Students were challenged to defend, extend, clarify, or explain how they derived their answers or ideas	.672
Students were expected to "investigate" or "discover" mathematical principles and ideas	.640
Students worked together to explore new ideas/concepts through problems or examples	.682
Students shared strategies for approaching or solving a problem	.686
Students justified their reasoning in a problem or steps in a proof	.617
Students discussed connections between mathematical ideas/concepts	.738
Students worked together to evaluate or construct proofs or make conjectures/propositions	.597
When students were working together, they were encouraged to admit confusion and ask questions	.645
Students taught a particular mathematical idea to the class	.401
Students directed questions to each other about mathematical ideas/concepts	.652
Students put individual or group work on the board for classmates to examine or comment on	.555
Cronbach's Coefficient Alpha	.876

Factor and Item Descriptions	Loading
Formally Organized Out-of-Class ACPIs (Frequency of occurrence as part of a formally organized, university-sanctioned out-of-class opportunity)	
Reviewing math coursework or working on homework problems	.492
Working on supplemental math problems	.710
Working on math- or science-based research projects	.654
Tutoring or mentoring students for a math- or science-based course	.463
Receiving supplemental instruction or tutoring for math or science-based courses	.524
Discussing how to succeed in math- or science-based majors	.655
Reading math, science, engineering, or computer science textbooks	.466
Discussing careers in math, science, engineering, or computer science	.690
Participating in math- or science-based internship or externship experiences	.669
Attending meetings for math, science, engineering, or computer science organizations	.652
Attending math, science, engineering, or computer science lectures/seminars/social events	.453
Cronbach's Coefficient Alpha	.818

Factor and Item Descriptions	Loading
Informally Organized Out-of-Class ACPIs (Frequency of occurrence as part of a informally organized out-of-class opportunity)	
Reviewing math coursework or working on homework problems	.521
Working on supplemental math problems	.433
Tutoring or mentoring students for a math- or science-based course	.525
Receiving supplemental instruction or tutoring for math or science-based courses	.527
Discussing how to succeed in math- or science-based majors	.665
Reading math, science, engineering, or computer science textbooks	.651
Discussing careers in math, science, engineering, or computer science	.480
Attending meetings for math, science, engineering, or computer science organizations	.412
Cronbach's Coefficient Alpha	.710

Coding of Independent and Dependent Variables

Independent Variables

The independent variables that were considered in this study included race/ethnicity, gender, ability (determined by fall 2004 math course), amount of time students spent involved in ACPIs, type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students), and type of persons with whom they were involved in the ACPIs (i.e., undergraduate students, graduate students, professors). Race/ethnicity was measured by a series of dichotomous variables (No = 0; Yes=1): White/Caucasian, Asian American/Asian, African American/Black, Hispanic/Latino, and Other Race/Ethnicity. Gender was coded as Male=0 and Female=1. Students' ability was measured by their fall 2004 math course using a series of dichotomous variables (No = 0; Yes=1): pre-calculus (Precal (MATH 115, 115B)), calculus I (Cal 1 (MATH 140, 140B, 140H, 140U)), calculus II (Cal 2 (MATH141, 141H)), and calculus III+ (Cal 3+ (CalcIII+ (MATH 240, 241, 241H, 246, 246H, 340, 341)). Students were asked to indicate how frequently particular ACPIs - occurred in class and out of class (as part of a formally organized, university-sanctioned activity or as part of an informally organized activity) using the following scale: "Not at All" = 0; "About Once a Month" = 1; "Once or Twice a Week" = 2; and "Three or More Times a Week"=3. The factor analysis resulted in the creation of three variables: FInClass, FOutFormal, and FOutInformal that were composite representations of in-class ACPIs, formally organized, out-of-class ACPIs, and informally organized out-of-class ACPIs. Students were also asked to indicate which of the out-of-class ACPIs they engaged in alone, with another undergraduate, with a graduate student/TA, or with a professor. Each students' responses were summed and four new variables were created to represent the number of ACPIs students did by themselves (ACPI_S), with another undergraduate (ACPI_U), with a graduate student or TA (ACPI_G), or with a professor (ACPI_P). A description of each independent variable is included in Table 2.

Table 2
Coding of Independent Variables

Variable		Variable Levels
Race/Ethnicity		No = 0, Yes = 1
White/Caucasian		
Asian American/Asian		
African American/Black		
Hispanic/Latino		
Other Race/Ethnicity		
Gender:		Male=0
Male		Female=1
Female		
F04MathCat:		No = 0, Yes = 1
PreCal (MATH115,115B)		
Calc 1 (MATH140,140B,140H,140U)		
Cal 2 (MATH141,141H)		
Calc 3+ (MATH240,241,241H,246,246H,340,341)		
Please indicate how frequently the following activities occurred during the Pre-Calculus or Calculus course (lecture and recitation) you took DURING THE FALL 2004 SEMESTER.		
ListEval	Students listened to and evaluated each others'ideas, solutions, or points of view	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Explain	Students were challenged to defend, extend, clarify, or explain how they derived their answers or ideas	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Discover	Students were expected to "investigate" or "discover" mathematical principles and ideas	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
PrblmEx	Students worked together to explore new ideas/concepts through problems or examples	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3

Variable		Variable Levels
Strategy	Students shared strategies or approaching for solving a problem	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Just	Students justified their reasoning in a problem or steps in a proof	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Connect	Students discussed connections between mathematical ideas/concepts	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Proof	Students worked together to evaluate or construct proofs or make conjectures/propositions	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Question1	When students were working together, they were encouraged to admit confusion and ask questions	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Teach	Students taught a particular mathematical idea to the class	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
Question2	Students directed questions to each other about mathematical ideas/concepts	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
BoardWork	Students put individual or group work on the board for classmates to examine or comment on	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
PrjWork	Students worked in groups on projects to be turned in for a grade or extra credit	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3

Variable		Variable Levels
Please indicate the frequency with which you participate in the following activities as part of a formally organized, university sanctioned opportunity or as part of an informally organized, academic-centered opportunity.		
ReviewF ReviewInF	Reviewing math coursework or working on homework problems	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
SuppF SuppInF	Working on supplemental math problems	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
PrjF PrjInF	Working on math- or science-based research projects	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
TutMenF TutMenInF	Tutoring or mentoring students for a math- or science-based course	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
SIF SIInF	Receiving supplemental instruction or tutoring for math or science-based courses	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
SucceedF SucceedInF	Discussing how to succeed in math- or science-based majors	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
ReadingF ReadingInF	Reading math, science, engineering, or computer science textbooks	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
CareerF CareerInF	Discussing careers in math, science, engineering, or computer science	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
IEExpF IEExpInF	Participating in math- or science-based internship or externship experiences	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
MeetingF MeetingInF	Attending meetings for math, science, engineering, or computer science organizations	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3

	Variable	Variable Levels
EventsF EventsInF	Attending math, science, engineering, or computer science lectures/seminars/social events	Not at All = 0 About Once a Month = 1 Once or Twice a Week = 2 Three or More Times a Week = 3
ACPI Factors FInClass	ListEval Explain Discover PrblmEx Strategy Just Connect Proof Question1 Teach Question2 BoardWork	
FOutFormal	ReviewF SuppF PrjF TutMenF SIF SucceedF ReadingF CareerF IEExpF MeetingF EventsF	
FOutInformal	ReviewInf SuppInf TutMenInf SIInf SucceedInf ReadingInf CareerInf MeetingInf	

Variable		Variable Levels
Please indicate with whom you participate in the following activities as part of a formally organized, university sanctioned opportunity or as part of an informally organized, academic-centered opportunity.		
Reviewing math coursework or working on homework problems		No=0; Yes=1
ReviewS	By Yourself	
ReviewU	With another CMPS or ENGR Undergraduate	
ReviewG	With a CMPS or ENGR Graduate Student	
ReviewP	With a CMPS or ENGR Professor	
Working on supplemental math problems		No=0; Yes=1
SuppS	By Yourself	
SuppU	With another CMPS or ENGR Undergraduate	
SuppG	With a CMPS or ENGR Graduate Student	
SuppP	With a CMPS or ENGR Professor	
Working on math- or science-based research projects		No=0; Yes=1
PrjS	By Yourself	
PrjU	With another CMPS or ENGR Undergraduate	
PrjG	With a CMPS or ENGR Graduate Student	
PrjP	With a CMPS or ENGR Professor	
Tutoring or mentoring students for a math- or science-based course		No=0; Yes=1
TutMenS	By Yourself	
TutMenU	With another CMPS or ENGR Undergraduate	
TutMenG	With a CMPS or ENGR Graduate Student	
TutMenP	With a CMPS or ENGR Professor	
Receiving supplemental instruction or tutoring for math or science-based courses		No=0; Yes=1
SIS	By Yourself	
SIU	With another CMPS or ENGR Undergraduate	
SIG	With a CMPS or ENGR Graduate Student	
SIP	With a CMPS or ENGR Professor	
Discussing how to succeed in math- or science-based majors		No=0; Yes=1
SucceedS	By Yourself	
SucceedU	With another CMPS or ENGR Undergraduate	
SucceedG	With a CMPS or ENGR Graduate Student	
SucceedP	With a CMPS or ENGR Professor	

Variable		Variable Levels
Reading math, science, engineering, or computer science textbooks		No=0; Yes=1
ReadingS	By Yourself	
ReadingU	With another CMPS or ENGR Undergraduate	
ReadingG	With a CMPS or ENGR Graduate Student	
ReadingP	With a CMPS or ENGR Professor	
Discussing careers in math, science, engineering, or computer science		No=0; Yes=1
CareerS	By Yourself	
CareerU	With another CMPS or ENGR Undergraduate	
CareerG	With a CMPS or ENGR Graduate Student	
CareerP	With a CMPS or ENGR Professor	
Participating in math- or science-based internship or externship experiences		No=0; Yes=1
IEExpS	By Yourself	
IEExpU	With another CMPS or ENGR Undergraduate	
IEExpG	With a CMPS or ENGR Graduate Student	
IEExpP	With a CMPS or ENGR Professor	
Attending meetings for math, science, engineering, or computer science organizations		No=0; Yes=1
MeetingS	By Yourself	
MeetingU	With another CMPS or ENGR Undergraduate	
MeetingG	With a CMPS or ENGR Graduate Student	
MeetingP	With a CMPS or ENGR Professor	
Attending math, science, engineering, or computer science lectures/seminars/social events		No=0; Yes=1
EventS	By Yourself	
EventU	With another CMPS or ENGR Undergraduate	
EventG	With a CMPS or ENGR Graduate Student	
EventP	With a CMPS or ENGR Professor	
Number of ACPIs participated in with: self, other undergraduate, graduate student, professor		
ACPI_S	By Yourself	
ACPI_U	With another CMPS or ENGR Undergraduate	
ACPI_G	With a CMPS or ENGR Graduate Student	
ACPI_P	With a CMPS or ENGR Professor	

Dependent Variables

The dependent variables included in this study (Table 3) were fall 2004 math course grades, spring 2005 math course grades, and retention of first-year MSEC students from the fall 2004 to the fall 2005 semester (measured by students' fall 2005 major and enrollment in CMPS or ENGR courses). Study participants' fall 2004 and spring 2005 math course grades were obtained from university records and coded: A = 4, B = 3, C = 2, D = 1, and F = 0. Fall 2004 to fall 2005 retention was measured by two variables that included fall 2005 major and fall 2005 course enrollment. Students were considered to have been retained in MSEC from fall 2004 to fall 2005 only if they met both of the following criteria: (1) were listed as a CMPS or ENGR major in university records and (2) were enrolled in a CMPS or ENGR course for the fall 2005 semester.

Table 3
Coding of Dependent Variables

Variable	Variable Levels
Fall04 Math Grade (F04GradeCat)	A = 4 B = 3 C = 2 D = 1 F = 0
Spring05 Math Grade (S05GradeCat)	A = 4 B = 3 C = 2 D = 1 F = 0
Fall05 Math Course Category (F05CourseCat)	CMPS=0 ENGR=1
Fall05 Major Category (F05MajorCat)	CMPS=0 ENGR=1
Fall04-Fall05 Retention	No=0; Yes=1

Data Analysis

This study involved two phases of data analysis that examined both quantitative and qualitative data. The first phase of data analysis involved descriptive statistics, correlation analyses, analysis of variance (ANOVA) analyses (including multiple comparisons), and blocked hierarchical regression analyses. Descriptive statistics provided a profile of study participants and allowed the researcher to examine patterns and trends in students' participation in academic-centered peer interactions (ACPIs) both in and outside of the mathematics classroom. Correlation analyses provided information about the bivariate relationships between and among the variables under consideration. ANOVA analyses were used to compare the mean amount of time students spent involved in ACPIs by race/ethnicity, gender, and ability. Multivariate analyses provided information about the relationship between participation in ACPIs and educational outcomes (i.e., fall 2004 and spring 2005 math course grades and fall 2004 to fall 2005 retention). The Statistical Package for the Social Sciences (SPSS) Graduate Pack Version 12.0 for Windows was used for all statistical analyses.

The second phase of data analysis examined results from two focus groups and an individual interview that explored students' sense of how participating in ACPIs influenced their academic achievement in math and their decisions to persist in undergraduate MSEC programs. Focus group and interview analyses added a qualitative dimension to supplement and illuminate the findings from the quantitative results in the first analysis phase.

Data Analysis Phase One

The phase one analyses addressed research questions one through five and involved descriptive statistics, correlation analyses, ANOVA analyses, and multivariate analyses. Summary statistics were conducted to provide a profile of study participants' demographic characteristics and academic background. Crosstab and correlation analyses were conducted to examine the types and frequency of students' participation in ACPIs and with whom students engaged in ACPIs and addressed the first research question. Since one of the concerns of this study was whether ACPI experiences and their relationship to math grades and program retention differs by students' race/ethnicity, gender, and ability, comparisons were made across these dimensions. Pearson correlations were calculated for all of the variables in the model to examine the bivariate relationships among variables to identify highly correlated variables, and to note any spurious relationships that may cause exaggerated relationships in the ANOVA and multivariate analyses.

ANOVA, and multivariate analyses were conducted to examine relationships between race/ethnicity, gender, and ability and ACPI experiences. ANOVA analyses were used to address the second research question and compared the means of two or more groups of the independent variables on the dependent variables to determine if group means were statistically significantly different from each other. Three ANOVA analyses were conducted to examine relationships between independent variables and dependent variables. The first ANOVA analysis involved one-way ANOVAs and multiple comparisons. Powell (2002) asserted that while the one-way ANOVA answers the question of whether to believe that a set of group means are equal, it usually provides too little information that is relevant for answering researchers' questions concerning differences among group means. Multiple comparisons can be used to determine whether pairs of means are statistically significantly different from each other. Therefore, multiple comparisons were used to examine the mean amount of time students spent involved in ACPIs using pairwise comparisons based students' race/ethnicity. The second ANOVA analysis involved a one-way ANOVA to compare the mean amount of time students spent involved in ACPIs using pairwise comparisons based on students' gender. The third ANOVA analysis involved one-way ANOVAs and multiple comparisons to examine the mean amount of time students spent involved in ACPIs using pairwise comparisons based students' ability (determined by students' fall 2004 math course).

The multivariate analyses addressed research questions three, four, and five and were conducted using Astin's (1993b) Input-Environment-Output (I-E-O) model for studying college impact. This model addresses the non-random assignment of students (inputs) to programs (environments) and eliminates input bias by separating the environmental effects on student outcomes from the input effects. The I-E-O model controls for the effects of input variables and then determines if the environmental variables or intermediate outcomes add anything to the prediction of the dependent variable (Astin & Astin, 1992). Input variables, environmental variables, and intermediate outcomes are entered in the regression analysis in "blocks" according to their sequence of occurrence. After each block of variables has been entered, the relationship between the predictor variables and outcome variables are examined and explained.

In the present study, the researcher was interested in measuring the relationship between participation in ACPIs on students' fall 2004 and spring 2005 math course grades and fall 2004 to fall 2005 MSEC program retention. The I-E-O model was employed using blocked hierarchical regression analyses. Two, three, or four blocks of predictors (inputs, environmental variables, and intermediate outcomes) were entered into the regression equation to determine whether participation in ACPIs added meaningfully to the prediction of the outcome variables. Pedhauzer (1997) notes that blocked hierarchical regression analysis is particularly useful in applied settings where the researcher wants to determine whether the R^2 change for blocks entered at later stages of the analysis add meaningfully to the prediction of the criterion being measured. The first block of input variables included the characteristics of students as they enter the university environment: demographic variables (i.e., race/ethnicity, gender, ability (fall 2004 math course)) and SAT math score. Environmental variables were entered in two blocks. One block included students' fall 2004 math course enrollment and the next block included students' ACPI experiences learning mathematics with peers both in and outside math class (this included the context and structure of ACPI experiences as well as the frequency of students' participation and who students' interacted with during ACPIs). Intermediate outcomes are environmental events that a student exerts some control over that occur somewhere between initial entry to the college and assessment of an educational outcome (Astin, 1991). Two blocks for the intermediate outcomes of fall 2004 math grade and spring 2005 math course enrollment were included in the analysis of spring 2005 student achievement, and three blocks for the intermediate outcomes of fall 2004 math grade, spring 2005 math course enrollment, and spring 2005 math course grades were included in analyses of fall 2004 to fall 2005 program retention. The final block consisted of outcome variables: students' fall 2004 math course grades, spring 2005 math course grades, and fall 2004 to fall 2005 program retention, respectively. Conceptual models for predicting students' fall 2004 math course grades, spring 2005 math course grades, and fall 2004 to fall 2005 MSEC program retention are included in Appendix D.

After all quantitative data were collected and merged individual identifiers were removed form the data set. Students' data were grouped for reporting and presentation and neither student names nor other personally identifiable information were included. All electronically collected data was password protected for access and SSL encrypted during transfer. Physical forms of data were kept in locked storage, and only the researcher had access to the data.

Data Analysis Phase Two

The qualitative component of the study addressed research question one and involved two mini-focus group interviews and one individual interview that allowed study participants to provide insights regarding their ACPI experiences learning mathematics with peers by responding to questions and describing their experiences in their own words. The interviews also allowed the researcher to examine the qualitative nature of students' involvement in ACPIs, the value they place on these experiences, and how students think these experiences influence their academic success and decisions to continue pursuing a degree in a MSEC field. The mini-focus group interview is a group interview of approximately four to six people that is structured to facilitate talk among participants about a particular topic of interest. It is particularly useful when the topic to be explored is general and the researcher is interested in hearing multiple perspectives on the topic (Bogdan & Biklen, 2003). Three mini-focus group interviews were planned to be conducted in April 2005. The first focus group consisted of four female students and the second focus group consisted of three male students. Only one female student showed up for the final focus group session; therefore, two mini-focus groups and one individual interview were conducted. The interview questions employed a semi-structured technique that helped participants focus on the topic of interest, but also allowed for participants to shape the discussions based upon their interests and experiences. Each interview lasted approximately ninety minutes. The researcher took written notes during the interviews. All interviews were also audio taped and transcribed. See Appendix C for the focus group interview protocol.

The data gathered during the interviews were analyzed inductively. Before beginning the data analysis the researcher listened to the audio tapes, read through the transcripts, and reviewed the field notes several times to be reminded of the whole conversations and of what things were said and where they are located on the transcripts. The researcher then used the "long table" approach described by Krueger (1998) to identify themes and categorize results. Students' responses to the same questions in the interview protocol were merged into a master transcript. The researcher looked for themes that arose across interviews and categorized them based on students' descriptions of their experiences learning math with peers in and outside the classroom setting and with different persons. The master transcript was then cut up and participants' quotes were sorted into the following categories: math course structures and how questions are handled in class, experiences with formally-organized programs, informal learning resources outside of class, informal interactions with other students outside of class, interactions with professors and teaching assistants (TAs), and factors influencing students' decisions to continue pursuing a degree in MSEC. The researcher completed the qualitative analysis by reading through the data with respect to the categories and looked for recurring themes mentioned by students within and across categories. The researcher then developed assertions that offered a synthesis of the interview data.

Table 4 provides a summary of the research questions and analysis methods that were used to explore these questions.

Table 4
Summary of Research Questions and Analysis Procedures

Research Question	Analysis Methods
1. What was the nature of students' involvement in ACPIs (i.e., In what types of, with what frequency, and with whom were students participating in ACPIs? What role did ACPI experiences play in students' perceptions of their academic performance and decisions to persist in undergraduate MSEC programs?)?	Descriptive Analysis; Correlation Analyses; Qualitative Analyses
2. Is there a statistically significant difference in the amount of time students spent involved in ACPIs when examined in terms of race/ethnicity, gender, and ability (determined by students' fall 2004 math course)? Does this vary by the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students)?	ANOVA Analyses
3. Is the amount of time students spent involved in ACPIs a statistically significant predictor of fall 2004 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability; (b) the type of ACPIs in which students were involved ; or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?	Blocked Hierarchical Regression Analyses
4. Is the amount of time students spent involved in ACPIs a statistically significant predictor of spring 2005 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability; (b) the type of ACPIs in which students were involved; or (c) who else was involved in the ACPI?	Blocked Hierarchical Regression Analyses
5. Is the amount of time students spent involved in ACPIs a statistically significant predictor of retention of first-year students in MSEC programs from the fall 2004 to the fall 2005 semester? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability; (b) the type of ACPIs in which students were involved; or (c) who else was involved in the ACPI?	Blocked Hierarchical Regression Analyses

CHAPTER FOUR: RESULTS OF QUANTITATIVE ANALYSES

The purpose of this study was to examine the extent to which students engaged in academic-centered peer interactions (ACPIs) both in and outside of class, the nature of these experiences, and how these experiences are related to students' mathematics achievement and retention in undergraduate math, physical science, engineering, and computer science programs. Chapters Four and Five report the quantitative and qualitative results of the study, respectively. Quantitative results from the phase one analyses are presented in Chapter Four by research question and consist of descriptive statistics that provide a profile of study participants and their level of participation in in-class, out-of-class formal, and out-of-class informal ACPIs. ANOVA analyses (including multiple comparisons) and regression analyses examined relationships between and among the independent and dependent variables and are also discussed in Chapter Four. Qualititative results (discussed in Chapter Five) comprised the second analysis phase and addressed research question one.

Descriptive and Correlation Analyses

Research Question 1

1. What was the nature of students' involvement in ACPIs (i.e., In what types of, with what frequency, and with whom were students participating in ACPIs? What role did ACPI experiences play in students' perceptions of their academic performance and decisions to persist in undergraduate MSEC programs?)?

Of the 655 first-time, full-time CMPS and ENGR students who were invited to participate in this study, a total of 202 (31%) completed the *MSEC ACPI Experiences Survey*. Summary statistics and crosstabulation analyses were conducted to provide a profile of study participants and the types and frequency of students' participation in ACPIs. Appendix E includes the descriptive statistics and Pearson's correlations for all study variables. As Table 5 indicates, 68.8% (139) of the study participants were males and 31.2% (63) were females. There were 59.9% (121) Whites/Caucasians, 22.3% (45) Asian Americans/Asians, 5.9% (12) African Americans/Blacks, 6.4% (13) Hispanics/Latinos, and 5.4% (11) other race/ethnicity. Approximately eight out of ten students in the sample lived in some form of on-campus housing during the spring 2005 semester.

Table 5
Demographic Characteristics of Study Participants

	Frequency	Percent
Gender		
Male	139	68.8
Female	63	31.2
Race/Ethnicity		
White/Caucasian	121	59.9
Asian/American/Asian	45	22.3
African American/Black	12	5.9
Hispanic/Latino	13	6.4
Other Race/Ethnicity	11	5.4
Housing Status		
On Campus	166	82.2
Off Campus	36	17.8

Study participants' had relatively high SAT math scores that ranged from 550 to 800 with a mean score of 696 and a median score of 690. About one-third of the sample were CMPS majors (in the College of Computer Science, Mathematics, and Physical Science) in Fall 2004 and nearly seventy percent were ENGR majors (in the College of Engineering). For the fall 2004 semester 13.9% of study participants enrolled in pre-calculus (Precal), 44.6% enrolled in calculus I (Cal 1), 17.8% enrolled in calculus II (Cal

2) and 23.8% enrolled in calculus III or higher (Cal 3+). Almost eight out of ten students aspired to obtain a masters degree or higher (masters, doctoral, or professional degree) and one-third of the study participants aspired to complete a doctoral degree. Of the 202 students surveyed, nearly 70% indicated that their mother had obtained a bachelors degree or higher (bachelors, masters, doctoral, or professional degree). Approximately thirty percent of the participants stated that their mother had obtained a masters degree; however, less than six percent of the students said that their mother held a doctoral degree. Seventy-three percent of the sample stated that their father had obtained a bachelors degree or higher (bachelors, masters, doctoral, or professional degree). Nearly thirty percent of the students surveyed claimed that their father had obtained a masters degree, and less than eight percent of the participants said that their father a held doctoral degree. These results are shown in Table 6.

Table 6
Academic Characteristics of Study Participants

	Frequency	Percent
Fall04 Major		
CMPS	62	30.7
ENGR	140	69.3
Fall04 Math Course		
Precal	28	13.9
Cal 1	90	44.6
Cal 2	36	17.8
Cal 3+	48	23.8
Spring05 Math Course		
Precal	8	4.0
Cal 1	22	10.9
Cal 2	94	46.5
Cal 3+	63	31.2
Not Enrolled	15	7.4
Degree Aspiration		
Bachelors Degree	26	12.9
Masters Degree	88	43.6
Doctoral Degree	65	32.2
Professional Degree	8	4.0
Mother's Education Level		
High School Graduate/GED/Certificate of Completion	12	5.9
Associate Degree	8	4.0
Bachelors Degree	67	33.2
Masters Degree	56	27.7
Doctoral Degree	12	5.9
Professional Degree	4	2.0
Father's Education Level		
High School Graduate/GED/Certificate of Completion	11	5.4
Associate Degree	4	2.0
Bachelors Degree or Higher	57	28.2
Masters Degree	65	32.2
Doctoral Degree	16	7.9
Professional Degree	10	5.0

Data shown in Table 7 revealed that nearly seven in ten (67.8%) students indicated that they were very likely to continue their pursuit of a degree in CMPS or

ENGR while only 6.4% indicated that it was either very or somewhat likely that they would not do so. Of the 65 students who asserted that they were very unlikely, somewhat unlikely, or somewhat likely to stay within their current major nearly two-thirds indicated that they were considering another major in CMPS or ENGR, one-fifth stated that they were considering a major outside of CMPS or ENGR, the remaining 16.9% did not indicate a major that they were considering.

Table 7
Likelihood to Persist in MSEC

Likelihood to Persist	Frequency	Percent
Very Unlikely	1	.5
Somewhat Unlikely	12	5.9
Somewhat Likely	52	25.7
Very Likely	137	67.8

Students were considered to have been retained in MSEC from fall 2004 to fall 2005 only if they met both of the following criteria: (1) they were listed as a CMPS or ENGR major in university records and (2) they were enrolled in a CMPS or ENGR course for the fall 2005 semester. University records indicated that 85.6% (173) of the study participants were retained in MSEC from fall 2004 to fall 2005, with male and female students being retained at almost the same rate, 84.9% and 87.3%, respectively. Within race/ethnicity, African American/Black students had the smallest percentage of students retained (83.3%) while 100% of Hispanic/Latino students who began as MSEC majors for fall 2004 remained within an MSEC program for fall 2005. The retention rate across fall 2004 math courses was fairly consistent. The smallest percentage of students retained by fall 2004 math course was in Cal 1 (84.4%) and the highest percentage of students retained (89.3%) were enrolled in Precal for fall 2004 (results are shown in Table 8).

Table 8
Fall 2004 to Fall 2005 Retention in MSEC

	Frequency	Percent
Retained in MSEC	173	85.6
Not Retained in MSEC	29	14.4
Retention by Gender		
Male	118	84.9
Female	55	87.3
Retention by Race/Ethnicity		
White/Caucasian	103	85.1
Asian/Asian American	38	84.4
Black/African American	10	83.3
Hispanic/Latino	13	100
Retention by Fall 2004 Math Course		
Precal	25	89.3
Cal 1	76	84.4
Cal 2	31	86.1
Cal 3+	41	85.4

Crosstabulations were conducted to obtain a profile of study participants by race/ethnicity, gender, and ability (determined by fall 2004 math course), to examine the relationship between students' ACPI experiences in class and out of class (formally- and informally-organized), and to determine who students interacted with during ACPIs. Tables 9 and 10 provide a profile of study participants by race/ethnicity, gender, and fall 2004 and spring 2005 math course. The findings revealed that, of the 202 study participants who began as CMPS or ENGR majors for the fall 2005 semester, 187 remained enrolled in a pre-calculus or calculus course for the spring 2005 semester. With the exception of African American/Black students, male participants had greater representation than female participants across racial/ethnic categories for both the fall 2004 and spring 2005 semesters. These tables also revealed that there were no female students in this sample who enrolled in Precal for the fall 2004 semester and no females who enrolled in either Precal or Cal 1 for the spring 2005 semester. There were also very small numbers of African Americans/Blacks and Hispanics/Latinos enrolled in each of the math courses for the fall 2004 and spring 2005 semesters. These small sample sizes made it extremely difficult or impossible at times to explore differences by race/ethnicity in the multivariate analyses.

According to the data shown in Table 9, 20.1% of male participants enrolled in Precal for the fall 2004 semester, nearly 50% enrolled in Cal 1, another 13.7% enrolled in Cal 2, and the remaining 18.7% enrolled in Cal 3+. Approximately two in five females enrolled in Cal 1, three in ten enrolled in Cal 2, and one-third enrolled in Cal 3+ for the fall 2005 semester. Although White/Caucasian, male participants had greater representation in the fall 2004 math courses than female participants and participants in each of the racial/ethnic categories, the majority (62.9%) of White/Caucasian, male students were enrolled in Cal 1 for the fall 2004 semester. White/Caucasian females had greater representation in Cal 1 and Cal 2 than females in other racial/ethnic categories; however, Asian American/Asian females were more likely than females in other racial/ethnic categories to be enrolled in Cal 3+. Table 9 also revealed that Asian American/Asian females had greater representation in Cal 1 and Cal 3+ than Asian American/Asian males, and African American/Black females were more likely to be enrolled in Cal 3+ than African American/Black males.

Table 9
Profile of Study Participants by Race/Ethnicity, Gender, and Fall04 Math Course

		Gender			
		M		F	
F04 Math Course	Race/Ethnicity	Freq	% within M	Freq	% within F
Precal	White/Caucasian	11	7.9%		
	Asian Am/Asian	14	10.1%		
	African Am/Black	0	0%		
	Hispanic/Latino	0	0%		
	Other Race/Ethnicity	3	2.2%		
	Precal Total	28	20.1%		
Cal 1	White/Caucasian	56	40.3%	12	19.0%
	Asian Am/Asian	3	2.2%	9	14.3%
	African Am/Black	3	2.2%	1	1.6%
	Hispanic/Latino	2	1.4%	1	1.6%
	Other Race/Ethnicity	2	1.4%	1	1.6%
	Cal 1 Total	66	47.5%	24	38.1%
Cal 2	White/Caucasian	9	6.5%	17	27.0%
	Asian Am/Asian	6	4.3%	0	0%
	African Am/Black	2	1.4%	0	0%
	Hispanic/Latino	2	1.4%	0	0%
	Other Race/Ethnicity	0	0%	0	0%
	Cal 2 Total	19	13.7%	17	27.0%
Cal 3+	White/Caucasian	13	9.4%	3	4.8%
	Asian Am/Asian	3	2.2%	10	15.9%
	African Am/Black	1	.7%	5	7.9%
	Hispanic/Latino	6	4.3%	2	3.2%
	Other Race/Ethnicity	3	2.2%	2	3.2%
	Cal 3+ Total	26	18.7%	22	34.9%
Total	White/Caucasian	89	64.0%	32	50.8%
	Asian Am/Asian	26	18.7%	19	30.2%
	African Am/Black	6	4.3%	6	9.5%
	Hispanic/Latino	10	7.2%	3	4.8%
	Other Race/Ethnicity	8	5.8%	3	4.8%
	Total	139	100.0%	63	100.0%

During the spring 2005 semester one-half of the 132 male and one-half of the 55 female participants were enrolled in Cal 2. An additional 30% of males and 50% of females enrolled in Cal 3+ for the spring 2005 semester. There were the same number

(4) of White/Caucasian males as Asian American/Asian males in Precal and this 6.1% of the male participants made up the entire sample of students enrolled in Precal for spring 2005. There was a slightly larger number of Asian American/Asian males than White/Caucasian males enrolled in Cal 1 for spring 2005, 10 (7.6% of males) compared to 9 (6.8% of males), respectively. While this difference is very small, this was the only time when White/Caucasian, male participants were not the majority in a course. Table 10 also shows that Asian American/Asian females had greater representation in Cal 2 than Asian American/Asian males, and African American/Black females were more likely to be enrolled in Cal 3+ than African American/Black males for the spring 2005 semester.

Table 10
Profile of Study Participants by Race/Ethnicity, Gender, and Spring05 Math Course

		Gender			
		M		F	
S05 Math Course	Race/Ethnicity	Freq	% within M	Freq	% within F
Precal	White/Caucasian	4	3.0%		
	Asian Am/Asian	4	3.0%		
	African Am/Black	0	0%		
	Hispanic/Latino	0	0%		
	Other Race/Ethnicity	0	0%		
	Precal Total	8	6.1%		
Cal 1	White/Caucasian	9	6.8%		
	Asian Am/Asian	10	7.6%		
	African Am/Black	0	0		
	Hispanic/Latino	0	0		
	Other Race/Ethnicity	3	2.3%		
	Cal 1 Total	22	16.7%		
Cal 2	White/Caucasian	56	42.4%	15	27.3%
	Asian Am/Asian	3	2.3%	10	18.2%
	African Am/Black	3	2.3%	1	1.8%
	Hispanic/Latino	2	1.5%	1	1.8%
	Other Race/Ethnicity	2	1.5%	1	1.8%
	Cal 2 Total	66	50.0%	28	50.9%
Cal 3+	White/Caucasian	14	10.6%	14	25.5%
	Asian Am/Asian	9	6.8%	6	10.9%
	African Am/Black	3	2.3%	4	7.3%
	Hispanic/Latino	7	5.3%	1	1.8%
	Other Race/Ethnicity	3	2.3%	2	3.6%
	Cal 3+ Total	36	27.3%	27	49.1%
Total	White/Caucasian	83	62.9%	29	51.7%
	Asian Am/Asian	26	19.7%	16	29.1%
	African Am/Black	6	4.5%	5	9.1%
	Hispanic/Latino	9	6.8%	2	3.6%
	Other Race/Ethnicity	8	6.1%	3	5.5%
	Total	132	100.0%	55	100.0%

Data summarized in Tables 11-16 show students' level of participation in ACPIs in class, formally organized ACPIs out of class, and informally organized ACPIs out of class. Each type of ACPI was examined by race/ethnicity and by fall 2004 math course and gender. Correlation analyses were conducted using Pearson's correlations to examine bivariate relationships between and among select background characteristics (i.e., race/ethnicity, gender, and ability (determined by fall 2004 math course)) and study participants' ACPI experiences (in class, formal out of class, and informal out of class). Results of correlation analyses were consistent with findings from the crosstab analyses and are reported with crosstab results in Tables 11-16. Correlation analyses were tested for statistical significance at the alpha = 0.05 and 0.01 levels. Bivariate correlations for all study variables are included in Appendix E.

Table 11 displays students' perceptions of the frequency of in-class ACPI opportunities by race/ethnicity. For seven out of the eleven in-class ACPIs (excluding Discover, Strategy, Question1, and Question2), less than one-tenth of the participants stated that the ACPI occurred in their fall 2004 math course "Three or More Times a Week" and the remaining students differed in their opinion of whether each in-class ACPI occurred "Not at All," "About Once a Month," or "Once or Twice a Week." Twelve percent (12%) of students in the sample identified Discover, "Students were expected to 'investigate' or 'discover' mathematical principles or ideas," 11.4% identified Strategy, "Students shared strategies for approaching or solving a problem," 21.3% identified Question1, "When students were working together, they were encouraged to admit confusion and ask questions," and 10.9% identified Question2, "Students directed questions to each other about mathematical ideas/concepts," as having occurred "Three or More Times a Week" in their fall 2004 math course.

A majority of students across all racial/ethnic categories (more than three in five) agreed that Teach, "Students taught a particular mathematical idea to the class," and

PrjWork, “Students worked in groups on projects to be turned in for a grade or extra credit,” occurred “Not at All” in their fall 2004 math course, and approximately half of the students surveyed also agreed that Proof, “Students worked together to evaluate or construct proofs or make conjectures/propositions,” and BoardWork, “Students put individual or group work on the board for classmates to examine or comment on,” happened “Not at All” in their fall 2004 math course. With the exception of Proof, Teach, BoardWork, and PrjWork over half of the students asserted that each in-class ACPI occurred either “About Once a Month” or “Once or Twice a Week.” Furthermore, almost an equal percentage of students (33%) described Discover, “Students were expected to ‘investigate’ or ‘discover’ mathematical principles or ideas,” and Connect, “Students discussed connections between mathematical ideas/concepts,” as having occurred “About Once a Month” compared to those who indicated that these in-class ACPIs happened “Once or Twice a Week.”

Approximately half of White/Caucasian students indicated that ListEval, “Students listened to and evaluated each others’ ideas, solutions, or points of view,” Explain, “Students were challenged to defend, extend, clarify, or explain how they derived their answers or ideas,” PrblmEx, “Students worked together to explore new ideas/concepts through problems or examples,” and Strategy, “Students shared strategies for approaching or solving a problem,” occurred “Once or Twice a Week.” While Asian American/Asian students generally agreed with White Caucasian students about how frequently ListEval, Explain, PrblmEx, and Strategy occurred in their fall 2004 math courses, the percentage of Asian Americans/Asians who agreed with this statement was slightly lower and ranged from 40.0% to 50.0%. African American/Black students’ and

Hispanic/Latino students' were less likely to report that in-class ACPIs occurred frequently in their fall 2004 math course. While approximately 40% or more of students in other racial/ethnic categories stated that Strategy, "Students shared strategies for approaching or solving a problem," occurred "Once or Twice a Week," only one in four African American/Black students agreed, and while at least forty percent of students in other racial/ethnic categories stated that ListEval, "Students listened to and evaluated each others' ideas, solutions, or points of view," occurred "Once or Twice a Week" in their fall 2004 math courses, over half of Hispanic/Latino students indicated that it happened "Not at All" in their math courses. Hispanics/Latinos also varied from students in other racial/ethnic categories in their perceptions of how frequently PrblmEx, "Students worked together to explore new ideas/concepts through problems or examples," occurred in their fall 2004 math course. While approximately half of the students in other racial/ethnic categories indicated that PrblmEx occurred "Once or Twice a Week," almost 50% of Hispanic/Latino students stated that it occurred "About Once a Month." These differences in students' perceptions of how frequently in-class ACPIs occurred in their fall 2004 math course suggest that students' who are in the same precalculus or calculus class may be experiencing the learning of mathematics in different ways. Generally, White/Caucasian students and Asian American/Asian students reported that in-class ACPIs occur more frequently than African American/Black and Hispanic/Latino students.

Table 11

In-Class ACPIs by Race/Ethnicity (% within Race/Ethnicity)

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
ListEval	Not at All	24.8	37.8	16.7	53.8	45.5	30.2
	About Once a Month	11.6	15.6	33.3	23.1	0.0	13.9
	Once or Twice a Week	52.1	44.4	41.7	15.4	36.4	46.5
	Three or More Times a Week	11.6	2.2	8.3	7.7	18.2	9.4
		r=.185**	r=-.127	r=.016	r=-.151*	r=-.019	
Explain	Not at All	19.0	33.3	16.7	38.5	18.2	23.3
	About Once a Month	22.3	22.2	25.0	15.4	9.1	21.3
	Once or Twice a Week	48.8	40.0	41.7	46.2	72.7	47.5
	Three or More Times a Week	9.9	4.4	16.7	0.0	0.0	7.9
		r=.125	r=-.141*	r=.049	r=-.091	r=.037	
Discover	Not at All	15.0	26.7	16.7	23.1	36.4	19.4
	About Once a Month	37.5	28.9	50.0	30.8	0.0	33.8
	Once or Twice a Week	35.0	37.8	16.7	30.8	36.4	34.3
	Three or More Times a Week	12.5	6.7	16.7	15.4	27.3	12.4
		r=.069	r=-.089	r=-.018	r=-.004	r=.037	
PrblmEx	Not at All	15.7	11.4	16.7	23.1	36.4	16.4
	About Once a Month	24.8	31.8	33.3	46.2	27.3	28.4
	Once or Twice a Week	51.2	50.0	50.0	23.1	36.4	48.3
	Three or More Times a Week	8.3	6.8	0.0	7.7	0.0	7.0
		r=.094	r=.035	r=-.036	r=-.094	r=-.129	

*p< .05. **p< .01.

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
Strategy	Not at All	12.4	22.2	25.0	23.1	54.5	18.3
	About Once a Month	21.5	26.7	41.7	30.8	18.2	24.3
	Once or Twice a Week	52.1	44.4	25.0	38.5	18.2	46.0
	Three or More Times a Week	14.0	6.7	8.3	7.7	9.1	11.4
		r=.230**	r=-.087	r=-.093	r=-.056	r=-.179*	
Just	Not at All	26.4	46.7	41.7	61.5	27.3	34.2
	About Once a Month	24.0	26.7	16.7	23.1	27.3	24.3
	Once or Twice a Week	40.5	17.8	25.0	15.4	36.4	32.7
	Three or More Times a Week	9.1	8.9	16.7	0.0	9.1	8.9
		r=.194**	r=-.147*	r=.001	r=-.164*	r=.026	
Connect	Not at All	19.0	28.9	8.3	30.8	18.2	21.3
	About Once a Month	38.8	33.3	58.3	23.1	54.5	38.6
	Once or Twice a Week	37.2	35.6	16.7	30.8	9.1	33.7
	Three or More Times a Week	5.0	2.2	16.7	15.4	18.2	6.4
		r=.040	r=.088	r=.048	r=.017	r=.006	
Proof	Not at All	48.8	55.6	66.7	69.2	36.4	52.0
	About Once a Month	28.9	28.9	25.0	15.4	18.2	27.2
	Once or Twice a Week	22.3	15.6	8.3	15.4	18.2	19.3
	Three or More Times a Week	0.0	0.0	0.0	0.0	27.3	1.5
		r=.048	r=-.067	r=-.087	r=-.077	r=.192**	

*p< .05. **p< .01.

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
Question1	Not at All	18.2	22.2	25.0	15.4	27.3	19.8
	About Once a Month	15.7	28.9	0.0	30.8	9.1	18.3
	Once or Twice a Week	44.6	33.3	50.0	30.8	27.3	40.6
	Three or More Times a Week	21.5	15.6	25.0	23.1	36.4	21.3
		r=.072	r=-.110	r=.028	r=-.005	r=.022	
Teach	Not at All	72.3	73.3	83.3	76.9	54.5	72.5
	About Once a Month	13.4	11.1	0.0	7.7	27.3	12.5
	Once or Twice a Week	10.9	15.6	16.7	15.4	0.0	12.0
	Three or More Times a Week	3.4	0.0	0.0	0.0	18.2	3.0
		r=-.002	r=-.022	r=-.038	r=-.023	r=.107	
Question2	Not at All	28.1	48.9	41.7	38.5	36.4	34.7
	About Once a Month	25.6	15.6	16.7	15.4	27.3	22.3
	Once or Twice a Week	30.6	35.6	33.3	38.5	27.3	32.2
	Three or More Times a Week	15.7	0.0	8.3	7.7	9.1	10.9
		r=.173*	r=-.169	r=-.027	r=-.010	r=-.024	
BoardWork	Not at All	38.8	53.3	83.3	76.9	54.5	48.0
	About Once a Month	24.8	15.6	0.0	7.7	18.2	19.8
	Once or Twice a Week	31.4	28.9	16.7	15.4	9.1	27.7
	Three or More Times a Week	5.0	2.2	0.0	0.0	18.2	4.5
		r=.176*	r=-.048	r=-.145*	r=-.137	.006	

*p< .05. **p< .01.

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
PrjWork	Not at All	61.3	60.0	66.7	53.8	45.5	60.0
	About Once a Month	10.1	15.6	25.0	23.1	27.3	14.0
	Once or Twice a Week	24.4	24.4	8.3	23.1	27.3	23.5
	Three or More Times a Week	4.2	0.0	0.0	0.0	0.0	2.5
		r=.037	r=-.023	r=-.074	r=.003	r=.036	

*p< .05. **p< .01.

Results of analyses comparing students' in-class ACPI experiences by fall 2004 math course and gender (shown in Table 12) revealed that in many cases male and female students had different perceptions of how frequently in-class ACPI opportunities arose; however, students' in the same fall 2004 math course had ACPI experiences that were more alike than they were different. Across all fall 2004 math courses both male and female students were less likely to describe in-class ACPIs as having occurred "Three or More Times a Week" and more likely to indicate that most in-class ACPIs (with the exception of Teach, Proof, PrjWork, and BoardWork) occurred either "About Once a Month" or "Once or Twice a Week." Discover, "Students were expected to 'investigate' or 'discover' mathematical principles or ideas," Question1, "When students were working together, they were encouraged to admit confusion and ask questions," and Question2, "Students directed questions to each other about mathematical ideas/concepts," were the only in-class ACPIs where over one-tenth of both male and female students indicated that it occurred "Three or More Times a Week." Both male and female students agreed that Teach, "Students taught a particular mathematical idea to the class," Proof, "Students worked together to evaluate or construct proofs or make conjectures/propositions," and PrjWork, "Students worked in groups on projects to be turned in for a grade or extra credit," occurred "Not at All" in their fall 2004 math course; however, they disagreed on how frequently BoardWork, "Students put individual or group work on the board for classmates to examine or comment on," occurred. Fifty percent of male students were almost evenly divided on whether BoardWork happened "About Once a Month" or "Once or Twice a Week" while nearly 60% of female students indicated that BoardWork occurred "Not at All" in their fall 2004 math course.

Approximately half of the male students in the sample claimed that ListEval, "Students listened and evaluated each others' ideas, solutions, or points of view," Explain, "Students were challenged to defend, extend, clarify, or explain how they derived their answers or ideas," and PrblmEx, "Students worked together to explore new ideas/concepts through problems or examples," occurred in their fall 2004 math course "Once or Twice a Week." Male students in Precal, Cal 1, and Cal 2 (over 53% in each course) were more likely to agree that Explain occurred "Once or Twice a Week" in their fall 2004 math course while male students in Cal 3+ could not agree on how frequently Explain occurred. In contrast, nearly 60% of males in Cal 3+ stated that Just, "Students justified their reasoning in a problem or steps in a proof," happened "Not at All" in their courses while male students in other courses were undecided on how frequently Just occurred. Approximately half of the males in Precal and half of the males in Cal 2 agreed that Connect, "Students discussed connections between mathematical ideas/concepts," occurred "About Once a Month" in their fall 2004 math courses while male students in other courses did not agree on the frequency of Connect. Male students in Cal 2 and male students in Cal 3 were more likely than other males to agree that Proof occurred "Not at All" in their fall 2004 math courses, males in Precal were less likely than other male students to indicate that Teach, "Students taught a particular mathematical idea to the class," happened "Not at All," and males in Precal and males in Cal 2 were more likely than other males to indicate that PrjWork, "Students worked in groups on projects to be turned in for a grade or extra credit," occurred "Not at All" in their fall 2004 math courses.

There was greater variation in the views of female students in this study in how frequently in-class ACPIs occurred in their fall 2004 math courses than of male students in this study. Teach, "Students taught a particular mathematical idea to the class," was the only in-class ACPI for which more than half of the females in each course agreed; over 62% of females in each course claimed that Teach happened "Not at All" in their fall 2004 math course. For the following in-class ACPIs female students in Cal 2 and female students in Cal 3+ were more likely to state that the activity occurred "Not at All" or "About Once a Month" while female students in Cal 1 were more likely to describe the ACPI as having occurred "Once or Twice a Week":

- ListEval, "Students listened and evaluated each others' ideas, solutions, or points of view,"
- Discover, "Students were expected to 'investigate' or 'discover' mathematical principles or ideas,"
- PrblmEx, "Students worked together to explore new ideas/concepts through problems or examples,"
- Strategy, "Students shared strategies for approaching or solving a problem," and
- Connect, "Students discussed connections between mathematical ideas/concepts."

Further analyses of the data shown in Table 12 revealed that male and female students' views of the frequency of in-class ACPIs were more similar within each fall 2004 math course than they were across courses. However, there were still some differences within fall 2004 math course. The largest differences between male and female students within Cal 1 arose in the frequency of Discover, "Students were expected to 'investigate' or 'discover' mathematical principles or ideas," were only one-third of males compared to nearly 60% of females indicated that Discover occurred “Once or Twice a Week” in their courses. Students in Cal 1 also disagreed on the frequency of Connect, “Students discussed connections between mathematical ideas/concepts.” Four in ten male students stated that Connect occurred “Once or Twice a Week” while seven in ten female students made the same claim.

Male students in Cal 2 were more likely than female students in Cal 2 to indicate that in-class ACPIs occurred more frequently in their fall 2004 math course. Less than four-tenths of male students and over six-tenths of female students in Cal 2 indicated that ListEval, “Students listened to and evaluated each others’ ideas, solutions, or points of view,” occurred “Not at All” in their fall 2004 math course while nearly 50% of male students compared to less than 20% of female students in Cal 2 stated that ListEval happened “Once or Twice a Week.” Similarly, almost three-fourths of males compared to less than one-fifth of females in Cal 2 said that Explain, “Students were challenged to defend, extend, clarify, or explain how they derived their answers or ideas,” occurred “Once or Twice a Week,” and one-third of males compared to six percent of females in Cal 2 agreed that and Discover, “Students were expected to ‘investigate’ or ‘discover’ mathematical principles or ideas,” happened “Once or Twice a Week” in their fall 2004 math course.

Among students in Cal 3+, male students were more likely than female students to indicate that opportunities for Question2, “Students directed questions to each other about mathematical ideas/concepts,” and PrjWork, “Students worked in groups on projects to be turned in for a grade or extra credit.” arose more frequently in their fall 2004 math course. Less than 40% of males compared to nearly 70% of females in Cal

3+ indicated that Question2 occurred “Not at All” while 23.1% of males compared to 9.1% of females in Cal 3+ stated that Question2 happened “Once or Twice a Week.” The ratio of male students to female students in Cal 3+ who responded that PrjWork happened “Not at All” was 2:3 while the ratio of male students to female students in Cal 3+ who indicated that PrjWork occurred “About Once a Month” was 5:3. These results are shown in Table 12.

Table 12

In-Class ACPIs by Fall 2004 Math Course and Gender (% within F04MathCourse)

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3+		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
ListEval	Not at All	21.4	15.2	16.7	36.8	64.7	46.2	50.0	25.2	41.3
	About Once a Month	21.4	9.1	0.0	10.5	11.8	19.2	31.8	13.7	14.3
	Once or Twice a Week	46.4	62.1	75.0	47.4	17.6	23.1	18.2	49.6	39.7
	Three or More Times a Week	10.7	13.6	8.3	5.3	5.9	11.5	0.0	11.5	4.8
		r=.045	r=.349**		r=-.188**		r=-.275**		r=-.181**	
Explain	Not at All	17.9	12.1	25.0	15.8	41.2	34.6	40.9	18.0	34.9
	About Once a Month	25.0	18.2	16.7	10.5	41.2	26.9	18.2	20.1	23.8
	Once or Twice a Week	53.6	57.6	41.7	73.7	17.6	34.6	31.8	54.7	31.7
	Three or More Times a Week	3.6	12.1	16.7	0.0	0.0	3.8	9.1	7.2	9.5
		r=.012	r=.235**		r=-.103		r=-.191**		r=-.175*	
Discover	Not at All	14.3	13.6	16.7	27.8	35.3	30.8	13.6	18.8	20.6
	About Once a Month	21.4	36.4	8.3	27.8	47.1	46.2	50.0	34.1	33.3
	Once or Twice a Week	60.7	33.3	58.3	33.3	5.9	19.2	18.2	36.2	30.2
	Three or More Times a Week	3.6	16.7	16.7	11.1	11.8	3.8	18.2	10.9	15.9
		r=.058	r=.181**		r=-.134		r=-.139*		r=.009	
PrblmEx	Not at All	3.6	4.5	4.2	26.3	47.1	32.0	31.8	12.3	25.4
	About Once a Month	42.9	19.7	8.3	36.8	29.4	36.0	40.9	29.7	25.4
	Once or Twice a Week	42.9	72.7	62.5	36.8	23.5	20.0	27.3	52.2	39.7
	Three or More Times a Week	10.7	3.0	25.0	0.0	0.0	12.0	0.0	5.8	9.5
		r=.072	r=.401**		r=-.282**		r=-.274**		r=-.097	

*p< .05. **p< .01.

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3+		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
Strategy	Not at All	14.3	10.6	8.3	10.5	17.6	30.8	50.0	15.1	25.4
	About Once a Month	35.7	15.2	4.2	42.1	35.3	26.9	31.8	25.2	22.2
	Once or Twice a Week	35.7	60.6	70.8	47.4	41.2	23.1	18.2	46.8	44.4
	Three or More Times a Week	14.3	13.6	16.7	0.0	5.9	19.2	0.0	12.9	7.9
		r=-.002	r=.310**		r=-.073		r=.294**		r=-.114	
Just	Not at All	35.7	22.7	20.8	42.1	29.4	57.7	50.0	34.5	33.3
	About Once a Month	25.0	19.7	29.2	21.1	47.1	23.1	18.2	21.6	30.2
	Once or Twice a Week	28.6	47.0	41.7	31.6	17.6	15.4	18.2	35.3	27.0
	Three or More Times a Week	10.7	10.6	8.3	5.3	5.9	3.8	13.6	8.6	9.5
		r=-.008	r=.242**		r=-.076		r=-.208		r=-.025	
Connect	Not at All	17.9	13.6	16.7	15.8	29.4	34.6	36.4	18.7	27.0
	About Once a Month	50.0	40.9	12.5	52.6	58.8	23.1	36.4	41.0	33.3
	Once or Twice a Week	25.0	42.4	70.8	21.1	5.9	23.1	22.7	32.4	36.5
	Three or More Times a Week	7.1	3.0	0.0	10.5	5.9	19.2	4.5	7.9	3.2
		r=-.018	r=.153*		r=-.091		r=-.083		r=-.073	
Proof	Not at All	46.4	42.4	33.3	63.2	76.5	65.4	63.6	50.4	55.6
	About Once a Month	28.6	30.3	37.5	21.1	17.6	23.1	22.7	27.3	27.0
	Once or Twice a Week	21.4	24.2	29.2	15.8	5.9	11.5	13.6	20.1	17.5
	Three or More Times a Week	3.6	3.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0
		r=.057	r=214**		r=-.161*		r=-.151*		r=-.068	
Question1	Not at All	10.7	12.1	4.2	26.3	29.4	34.6	40.9	18.0	23.8
	About Once a Month	25.0	9.1	0.0	21.1	23.5	26.9	40.9	17.3	20.6
	Once or Twice a Week	42.9	51.5	66.7	31.6	41.2	11.5	18.2	39.6	42.9
	Three or More Times a Week	21.4	27.3	29.2	21.1	5.9	26.9	0.0	25.2	12.7
		r=.045	r=.330**		r=-.124		r=-.311**		r=-.124	

*p< .05. **p< .01.

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3+		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
Teach	Not at All	53.6	70.3	62.5	68.4	88.2	80.8	95.5	68.6	81.0
	About Once a Month	25.0	6.3	16.7	26.3	11.8	7.7	4.5	13.1	11.1
	Once or Twice a Week	17.9	17.2	20.8	0.0	0.0	11.5	0.0	13.9	7.9
	Three or More Times a Week	3.6	6.3	0.0	5.3	0.0	0.0	0.0	4.4	0.0
		r=.128	r=.147*		r=-.102		r=-.184**		r=-.153*	
Question2	Not at All	39.3	24.2	4.2	47.4	47.1	38.5	68.2	33.1	38.1
	About Once a Month	17.9	25.8	33.3	10.5	11.8	23.1	22.7	21.6	23.8
	Once or Twice a Week	35.7	37.9	45.8	36.8	23.5	23.1	9.1	34.5	27.0
	Three or More Times a Week	7.1	12.1	16.7	5.3	17.6	15.4	0.0	10.8	11.1
		r=-.033	r=.247**		r=-.062		r=-.206**		r=-.053	
BoardWork	Not at All	39.3	25.8	29.2	73.7	82.4	73.1	68.2	43.9	57.1
	About Once a Month	14.3	34.8	16.7	5.3	5.9	11.5	18.2	22.3	14.3
	Once or Twice a Week	35.7	33.3	45.8	21.1	11.8	15.4	13.6	28.8	25.4
	Three or More Times a Week	10.7	6.1	8.3	0.0	0.0	0.0	0.0	5.0	3.2
		r=.122	r=.324**		r=-.241**		r=-.261**		r=-.098	
PrjWork	Not at All	70.4	56.9	41.7	78.9	94.1	38.5	59.1	59.1	61.9
	About Once a Month	18.5	1.5	0.0	5.3	5.9	50.0	31.8	14.6	12.7
	Once or Twice a Week	11.1	38.5	50.0	15.8	0.0	7.7	9.1	24.1	22.2
	Three or More Times a Week	0.0	3.1	8.3	0.0	0.0	3.8	0.0	2.2	3.2
		r=-.126	r=.289**		r=-.236		r=-.023		r=-.012	

*p< .05. **p< .01.

Tables 13 and 14 provide a summary of student participation in formally organized, out-of-class ACPIs by race/ethnicity and by fall 2004 math course and gender, respectively. Both tables revealed fairly high percentages of students who indicated that they do not participate in formally organized, out-of-class ACPIs. Nevertheless, further examination of these tables provided additional information about similarities and differences between and among students by race/ethnicity, gender, and ability (determined by students' fall 2004 math course).

Over 58.2% of students surveyed indicated that they had not participated in each formally organized, out-of-class ACPI while less than six percent of students surveyed stated that each formally organized, out-of-class ACPI occurred "Three or More Times a Week." White/Caucasian students and Asian American/Asian students were more likely than African American/Black and Hispanic/Latino students to indicate that they had participated in formally organized, out-of-class ACPIs. Furthermore, while White/Caucasian students and Asian American/Asian students had similar patterns of participation in each formally organized, out-of-class ACPI, their greatest difference was in how frequently they engaged in SuppF, "Working on supplemental math problems" Approximately one-fourth of White/Caucasian students and Asian American/Asian students stated that they engaged in SuppF "Not at All." Of the remaining White/Caucasian and Asian American/Asian students, 7.7% of White/Caucasian students compared to 19.0% of Asian American/Asian students stated that they engaged in SuppF "Once or Twice a Week."

The least variation in students' responses by race/ethnicity arose among African American/Black students. In their responses to how frequently they engaged in each of the following formally organized, out-of-class ACPIs, the percentage of African American/Black students who indicated that they engaged in the ACPI "Not at All" was the same as or higher than the percentage of White/Caucasian, Asian American/Asian, and Hispanic/Latino students who gave the same response:

- ReviewF, "Reviewing math homework or working on homework problems,"
- PrjF, "Working on math- or science-based research projects,"
- SuppF, "Working on supplemental math problems," and
- TutMenF, "Tutoring or mentoring students for a math- or science-based course."
- SIF, "Received supplemental instruction or tutoring for math- or science-based courses,"
- ReadingF, "Reading math, science, engineering, or computer science textbooks,"
- CareerF, "Discussing careers in math, science, engineering, or computer science,"
- MeetingF, "Attending meetings for math, science, engineering, or computer science organizations,"

The frequency with which Hispanic/Latino students' participated in formally organized, out-of-class ACPIs was similar to that of White/Caucasian students and Asian American/Asian students; however, Hispanic/Latino students were more likely than other students to engage in SuppF, "Working on supplemental math problems" or EventsF, "Attending math, science, engineering, or computer science lectures/seminars/social events," "Three or More Times a Week." Furthermore, while less than 17% of students in other racial/ethnic groups indicated that they participated in SucceedF, "Discussing how to succeed in math- or science-based majors," "About Once a Month," over 23% of Hispanic/Latino students made the same claim. Similarly, 23% of Hispanic/Latinos compared to 16% of students of other racial/ethnic groups stated that they engaged in ReadingF, “Reading math, science, engineering, or computer science textbooks,” “Once or Twice a Week.”

Table 13

Formally Organized Out-of-Class ACPIs by Race/Ethnicity (% within Race/Ethnicity)

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
ReviewF	Not at All	65.0	66.7	91.7	84.6	81.8	69.2
	About Once a Month	17.1	11.9	8.3	0.0	9.1	13.8
	Once or Twice a Week	15.4	19.0	0.0	15.4	9.1	14.9
	Three or More Times a Week	2.6	2.4	0.0	0.0	0.0	2.1
		r=.088	r=.042	r=-.129	r=-.061	r=-.067	
SuppF	Not at All	74.4	71.4	83.3	84.6	54.5	73.8
	About Once a Month	14.5	9.5	8.3	0.0	18.2	12.3
	Once or Twice a Week	7.7	19.0	8.3	7.7	27.3	11.3
	Three or More Times a Week	3.4	0.0	0.0	7.7	0.0	2.6
		r=-.038	r=.033	r=-.056	r=-.013	r=.094	
PrjF	Not at All	82.9	90.5	91.7	76.9	81.8	84.6
	About Once a Month	8.5	2.4	8.3	7.7	18.2	7.7
	Once or Twice a Week	6.0	7.1	0.0	15.4	0.0	6.2
	Three or More Times a Week	2.6	0.0	0.0	0.0	0.0	1.5
		r=.060	r=-.051	r=-.067	r=.056	r=-.026	
TutMenF	Not at All	93.1	93.0	100.0	100.0	72.7	92.8
	About Once a Month	5.2	2.3	0.0	0.0	0.0	3.6
	Once or Twice a Week	0.9	4.7	0.0	0.0	27.3	3.1
	Three or More Times a Week	0.9	0.0	0.0	0.0	0.0	0.5
		r=-.053	r=.009	r=-.065	r=-.068	r=.241**	

*p< .05. **p< .01.

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
SIF	Not at All	80.3	76.2	100.0	76.9	54.5	79.0
	About Once a Month	13.7	14.3	0.0	15.4	36.4	14.4
	Once or Twice a Week	4.3	7.1	0.0	7.7	9.1	5.1
	Three or More Times a Week	1.7	2.4	0.0	0.0	0.0	1.5
		r=-.047	r=.066	r=-.118	r=.006	r=.096	
SucceedF	Not at All	79.5	81.4	75.0	69.2	81.8	79.1
	About Once a Month	12.8	16.3	16.7	23.1	9.1	14.3
	Once or Twice a Week	7.7	0.0	8.3	7.7	9.1	6.1
	Three or More Times a Week	0.0	2.3	0.0	0.0	0.0	0.5
		r=-.005	r=-.032	r=.022	r=.046	r=-.004	
ReadingF	Not at All	66.7	79.1	91.7	69.2	81.8	71.9
	About Once a Month	13.7	2.3	0.0	7.7	9.1	9.7
	Once or Twice a Week	15.4	9.3	8.3	23.1	0.0	13.3
	Three or More Times a Week	4.3	9.3	0.0	0.0	9.1	5.1
		r=.076	r=-.016	r=-.098	r=.007	r=-.040	
CareerF	Not at All	65.0	69.0	75.0	69.2	72.7	67.2
	About Once a Month	28.2	26.2	16.7	15.4	0.0	24.6
	Once or Twice a Week	6.0	4.8	8.3	15.4	18.2	7.2
	Three or More Times a Week	0.9	0.0	0.0	0.0	9.1	1.0
		r=.012	r=-.047	r-.033	r=.016	r=.078	

*p< .05. **p< .01.

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
IEExpF	Not at All	92.3	88.1	83.3	92.3	81.8	90.3
	About Once a Month	3.4	7.1	16.7	7.7	18.2	6.2
	Once or Twice a Week	2.6	2.4	0.0	0.0	0.0	2.1
	Three or More Times a Week	1.7	2.4	0.0	0.0	0.0	1.5
		r=-.034	r=.050	r=.008	r=-.038	r=.015	
MeetingF	Not at All	62.4	68.2	75.0	61.5	100.0	66.5
	About Once a Month	28.2	27.3	0.0	23.1	0.0	24.4
	Once or Twice a Week	8.5	4.5	25.0	15.4	0.0	8.6
	Three or More Times a Week	0.9	0.0	0.0	0.0	0.0	0.5
		r=.089	r=-.060	r=.027	r=.043	r=-.156*	
EventsF	Not at All	59.0	55.8	58.3	46.2	72.7	58.2
	About Once a Month	28.2	37.2	25.0	30.8	18.2	29.6
	Once or Twice a Week	7.7	4.7	8.3	15.4	0.0	7.1
	Three or More Times a Week	5.1	2.3	8.3	7.7	9.1	5.1
		r=.000	r=-.041	r=.023	r=.082	r=-.040	

*p< .05. **p< .01.

Table 14 displays the frequency of students' participation in formally-organized ACPIs outside of class by Fall 2004 math course and gender. Regardless of the particular ACPI activity, the data showed that very high percentages of both male and female students across all fall 2004 math courses indicated that they did not participate in formally organized, university-sanctioned ACPIs while few students indicated that they engaged in these types of activities "Three or More Times a Week." The particular ACPI activity for which the smallest percentage of students (60.7% of males and 52.5% of females) stated that they participated in the ACPI "Not at All" was EventsF, "Attending math, science, engineering, or computer science lectures/seminars/social events." The largest percentage of male students who indicated that they participated in a formally organized, out-of-class ACPI "Three or More Times a Week" was 6.7% who stated that they participated in EventsF, and the largest percentage of female students who indicated that they engaged in a formally organized, out-of-class ACPI "Three or More Times a Week" was 5.0% who stated that they participated in SuppF, "Working on supplemental math problems."

The largest differences in the frequency of male students' participation in formally organized ACPIs arose between male students in Precal and male students in other courses. In particular, male students in Precal were more likely than other male students to report higher levels of participation in ReviewF, "Reviewing math homework or working on homework problems," SuppF, "Working on supplemental math problems," SIF, "Received supplemental instruction or tutoring for math- or science-based courses," and ReadingF, "Reading math, science, engineering, or computer science textbooks."

Female students had a pattern of participation in formally organized, out-of-class ACPIs that was similar to the male students in this study; thus, female students' level of participation was negatively related to their ability (determined by fall 2004 math course). Female students in Cal 1 were more likely to indicate varied levels of participation while females in Cal 3+ were more likely to assert that they engaged in formally organized, out-of-class ACPIs "Not at All." Moreover, female students in Cal 3+ were the only group that did not participate in any formally organized, out-of-class ACPI "Three or More Times a Week."

The greatest differences in female students' level of participation in a formally organized, out-of-class ACPIs arose between Cal 1 students and female students in other fall 2004 math courses. While 18.2% of female students in Cal 1 stated that they participated in PrjF, "Working on math- or science-based research projects," "Once or Twice a Week" less than 5% of female students in other courses made the same statement. Female students in Cal 1 were the only group who indicated that they participated in TutMenF, "Tutoring or mentoring students for a math- or science-based course;" 100% of females in Cal 2 and Cal 3+ said they engaged in TutMenF "Not at All" while less than 74% of females in Cal 1 agreed with this statement. The nearly ten percent of female students in Cal 1 were the only females who described participating in SIF, "Received supplemental instruction or tutoring for math- or science-based courses," or IEExpF, "Participating in math- or science-based internship or externship experiences," "Three or More Times a Week." Over 30% of female students in Cal 1 compared to less than 13% of female students in Cal 2 or Cal 3+ stated that they participated in ReadingF, "Reading math, science, engineering, or computer science textbooks," "Once or Twice a Week." Another difference in female students' formally organized, out-of-class ACPI experiences arose between students in Cal 2 where one in four said that they participated in ReviewF, "Reviewing math homework or working on homework problems," "Once or Twice a Week" while less than fifteen percent of females in other courses made the same claim.

The data revealed that males and females in each fall 2004 math course had similar levels of participation in formally organized, out-of-class ACPIs; nevertheless, there were some notable differences. Among students in Cal 1, nine out of ten males compared to less than six out of ten females said that they had not "Received supplemental instruction or tutoring for math- or science-based courses," SIF, while 6.3% of males in Cal 1 compared to 36.4% of females in Cal 1 stated that they engaged in SIF "About Once a Month." Less than ten percent of males compared to thirty percent of females in Cal 1 described participating in ReadingF, "Reading math, science, engineering, or computer science textbooks," "Once or Twice a Week" and 3.1% of males compared to 20.8% of females in Cal 1 stated that they participated in MeetingF, "Attending meetings for math, science, engineering, or computer science organizations," "Once or Twice a Week."

Among students in Cal 2, 15.8% of males compared to 25.0% of females participated in ReviewF, "Reviewing math homework or working on homework problems," "Once or Twice a Week" and one-fourth of males compared to zero females participated in SucceedF, "Discussing how to succeed in math- or science-based majors," "About Once a Month."

Among students in Cal 3+, 12.5% of males compared to zero females in Cal 3+ stated that they participated in PrjF, "Working on math- or science-based research projects," "Once a Month," SucceedF "Once or Twice a Week," or ReadingF "Once or Twice a Month." Additionally, while 54.2% of males in Cal 3+ and 81.8% of female students in Cal 3+ indicated that they engaged in CareerF, "Discussing careers in math, science, engineering, or computer science," "Not at All," one in five males compared to zero females in Cal 3+ stated that they participated in CareerF "Once or Twice a Week." Finally, the females in Cal 3+ who indicated that they participated in EventsF, "Attending math, science, engineering, or computer science lectures/seminars/social events," as part of a formally organized, university-sanctioned program was "Once or Twice a Week." outnumbered the males in Cal 3+ who gave that same response with a ratio of 2:1.

Table 14

Formally Organized Out-of-Class ACPIs by Fall 2004 Math Course and Gender (% within F04MathCourse)

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3+		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
ReviewF	Not at All	53.6	65.6	68.2	57.9	62.5	91.7	90.9	66.7	75.0
	About Once a Month	17.9	17.2	18.2	21.1	12.5	4.2	0.0	15.6	10.0
	Once or Twice a Week	25.0	14.1	13.6	15.8	25.0	4.2	9.1	14.8	15.0
	Three or More Times a Week	3.6	3.1	0.0	5.3	0.0	0.0	0.0	3.0	0.0
		r=.144*	r=.033		r=.093		r=-.239**		r=-.073	
SuppF	Not at All	42.9	79.7	68.2	78.9	68.8	83.3	90.9	72.6	76.7
	About Once a Month	21.4	14.1	9.1	15.8	12.5	8.3	0.0	14.8	6.7
	Once or Twice a Week	35.7	3.1	13.6	5.3	12.5	8.3	9.1	11.1	11.7
	Three or More Times a Week	0.0	3.1	9.1	0.0	6.3	0.0	0.0	1.5	5.0
		r=.261**	r=-.044		r=-.011		r=-.151*		r=.029	
PrjF	Not at All	82.1	82.8	81.8	94.7	81.3	79.2	95.5	83.7	86.7
	About Once a Month	14.3	7.8	0.0	5.3	12.5	12.5	0.0	9.6	3.3
	Once or Twice a Week	3.6	6.3	18.2	0.0	0.0	8.3	4.5	5.2	8.3
	Three or More Times a Week	0.0	3.1	0.0	0.0	6.3	0.0	0.0	1.5	1.7
		r=-.023	r=.090		r=-.056		r=-.036		r=.002	
TutMenF	Not at All	92.9	92.1	78.3	94.7	100.0	95.8	100.0	93.3	91.8
	About Once a Month	0.0	3.2	17.4	0.0	0.0	4.2	0.0	2.2	6.6
	Once or Twice a Week	7.1	4.8	4.3	0.0	0.0	0.0	0.0	3.7	1.6
	Three or More Times a Week	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.7	0.0
		r=.028	r=.104		r=-.031		r=-.116		r=-.017	

*p< .05. **p< .01.

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3+		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
SIF	Not at All	57.1	90.6	54.5	68.4	75.0	91.7	95.5	80.7	75.0
	About Once a Month	14.3	6.3	36.4	31.6	25.0	4.2	4.5	11.1	21.7
	Once or Twice a Week	28.6	1.6	0.0	0.0	0.0	4.2	0.0	7.4	0.0
	Three or More Times a Week	0.0	1.6	9.1	0.0	0.0	0.0	0.0	0.7	3.3
		r=.269**	r=-.025		r=-.007		r=-.183**		r=.042	
SucceedF	Not at All	67.9	81.3	73.9	73.7	100.0	70.8	90.9	75.6	86.9
	About Once a Month	25.0	10.9	13.0	26.3	0.0	16.7	9.1	17.0	8.2
	Once or Twice a Week	7.1	7.8	8.7	0.0	0.0	12.5	0.0	7.4	3.3
	Three or More Times a Week	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	1.6
		r=.076	r=.048		r=-.114		r=-.016		r=-.094	
ReadingF	Not at All	57.1	73.4	56.5	78.9	68.8	75.0	95.5	71.1	73.8
	About Once a Month	10.7	12.5	8.7	5.3	12.5	12.5	0.0	11.1	6.6
	Once or Twice a Week	17.9	7.8	30.4	15.8	12.5	12.5	4.5	11.9	16.4
	Three or More Times a Week	14.3	6.3	4.3	0.0	6.3	0.0	0.0	5.9	3.3
		r=.170*	r=.052		r=-.028		r=-.174*		r=-.011	
CareerF	Not at All	53.6	70.3	59.1	73.7	81.3	54.2	81.8	64.4	73.3
	About Once a Month	35.7	23.4	27.3	26.3	18.8	20.8	18.2	25.9	21.7
	Once or Twice a Week	7.1	6.3	13.6	0.0	0.0	20.8	0.0	8.1	5.0
	Three or More Times a Week	3.6	0.0	0.0	0.0	0.0	4.2	0.0	1.5	0.0
		r=.113	r=-.020		r=-.137		r=.055		r=-.105	

*p< .05. **p< .01.

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3+		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
IEExpF	Not at All	85.7	92.2	90.9	89.5	100.0	87.5	86.4	89.6	91.7
	About Once a Month	10.7	3.1	0.0	10.5	0.0	8.3	13.6	6.7	5.0
	Once or Twice a Week	3.6	3.1	0.0	0.0	0.0	4.2	0.0	3.0	0.0
	Three or More Times a Week	0.0	1.6	9.1	0.0	0.0	0.0	0.0	0.7	3.3
		r=.023	r=.052		r=-.088		r=-.001		r=.009	
MeetingF	Not at All	64.3	68.8	50.0	73.7	81.3	58.3	72.7	66.7	66.1
	About Once a Month	35.7	28.1	29.2	10.5	6.3	20.8	22.7	25.9	21.0
	Once or Twice a Week	0.0	3.1	20.8	15.8	12.5	16.7	4.5	6.7	12.9
	Three or More Times a Week	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.7	0.0
		r=-.044	r=.015		r=-.042		r=.056		r=.036	
EventsF	Not at All	53.6	65.6	43.5	63.2	68.8	54.2	50.0	60.7	52.5
	About Once a Month	32.1	20.3	43.5	26.3	25.0	25.0	50.0	24.4	41.0
	Once or Twice a Week	7.1	4.7	8.7	10.5	6.3	16.7	0.0	8.1	4.9
	Three or More Times a Week	7.1	9.4	4.3	0.0	0.0	4.2	0.0	6.7	1.6
		r=.043	r=.035		r=-.092		r=.007		r=-.027	

*p< .05. **p< .01.

Students' experiences in informally organized, out-of-class ACPIs were markedly different than their experiences in formally organized, out-of-class ACPIs. Table 15 revealed greater diversity in students' responses to the frequency of their participation in ACPIs and fewer ACPIs for which a majority of students indicated that they engaged in these activities "Not at All."

Over half of the study participants indicated that they had not engaged in the following informally organized ACPIs:

- PrjInf, "Working on math- or science-based research projects,"
- TutMenInf "Tutoring or mentoring students for a math- or science-based course,"
- SIInf, "Received supplemental instruction or tutoring for math- or science-based courses,"
- SucceedInf, "Discussing how to succeed in math- or science-based majors,"
- IEExpInf, "Participating in math- or science-based internship or externship experiences,"
- MeetingInf, "Attending meetings for math, science, engineering, or computer science organizations,"
- EventsInf, "Attending math, science, engineering, or computer science lectures/seminars/social events,"

For each of the remaining informally organized ACPIs (i.e., ReviewInf, SuppInf, ("Working on supplemental math problems"), ReadingInf, and CareerInf ("Discussing careers in math, science, engineering, or computer science")) the percentage of students who indicated that they had not participated was 23.7% for ReadingInf, 25.1% for ReviewInf, 41.0% for CareerInf, and 45.9% for SuppInf, to 23.7% for ReadingInf.

Among these four ACPIs, the largest percentage of students indicated that they engaged in ReviewInf (37.4%) or ReadingInf (40.7%) "Once or Twice a Week."

Both similarities and differences were identified in students' responses about the frequency of their participation in each informally organized ACPI when examined in terms of race/ethnicity. White/Caucasian students and Asian American/Asian students were likely to report similar levels of participation in each informally organized, out-of-class ACPI. And, with the exception of ReviewInf and ReadingInf, these students were more likely than African American/Black students and Hispanic/Latino students to indicate higher levels of participation in each ACPI. Hispanic/Latino students (16.7%) were more likely than other students to report that they participated in ReviewInf "Three or More Times a Week." And while 38.5% of White/Caucasian students and 45.2% of Asian American/Asian students indicated that they engaged in ReadingInf "Once or Twice a Week," 50.0% of African Americans/Blacks and 58.3% of Hispanic/Latinos agreed with this statement. Moreover, once again Hispanics/Latinos (41.7%) were more likely than other students to report that they participated in ReadingInf "Three or More Times a Week." Another notable result shown in Table 15 was that with the exception of EventsInf, African American/Black students reported the lowest levels of participation in each informally organized, out-of-class ACPI.

Table 15

Informally Organized Out-of-Class ACPIs by Race/Ethnicity (% within Race/Ethnicity)

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
ReviewInF	Not at All	25.6	25.6	25.0	16.7	27.3	25.1
	About Once a Month	29.1	18.6	41.7	16.7	27.3	26.7
	Once or Twice a Week	32.5	46.5	33.3	50.0	45.5	37.4
	Three or More Times a Week	12.8	9.3	0.0	16.7	0.0	10.8
		r=-.022	r=.019	r=-.068	r=.116	r=-.041	
SuppInF	Not at All	49.1	39.5	58.3	41.7	27.3	45.9
	About Once a Month	26.7	34.9	8.3	33.3	54.5	29.4
	Once or Twice a Week	13.8	20.9	33.3	25.0	9.1	17.0
	Three or More Times a Week	10.3	4.7	0.0	0.0	9.1	7.7
		r=-.029	r=.027	r=-.033	r=.014	r=.032	
PrjInF	Not at All	82.9	74.4	91.7	75.0	45.5	79.0
	About Once a Month	12.0	14.0	0.0	8.3	45.5	13.3
	Once or Twice a Week	4.3	11.6	8.3	16.7	9.1	7.2
	Three or More Times a Week	0.9	0.0	0.0	0.0	0.0	0.5
		r=-.127	r=.084	r=-.053	r=.038	r=.134	
TutMenInF	Not at All	65.8	47.6	66.7	25.0	36.4	57.7
	About Once a Month	13.7	33.3	16.7	41.7	54.5	22.2
	Once or Twice a Week	14.5	19.0	16.7	25.0	9.1	16.0
	Three or More Times a Week	6.0	0.0	0.0	8.3	0.0	4.1
		r=-.099	r=.027	r=-.050	r=.187**	r=.014	

*p< .05. **p< .01.

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
SIInF	Not at All	60.7	62.8	83.3	75.0	63.6	63.6
	About Once a Month	27.4	30.2	8.3	16.7	18.2	25.6
	Once or Twice a Week	8.5	7.0	8.3	8.3	18.2	8.7
	Three or More Times a Week	3.4	0.0	0.0	0.0	0.0	2.1
		r=.091	r=-.032	r=-.082	r=-.065	r=.019	
SucceedInF	Not at All	61.5	61.9	83.3	50.0	63.6	62.4
	About Once a Month	28.2	33.3	8.3	41.7	18.2	28.4
	Once or Twice a Week	6.8	4.8	8.3	8.3	18.2	7.2
	Three or More Times a Week	3.4	0.0	0.0	0.0	0.0	2.1
		r=.091	r=-.032	r=-.082	r=-.065	r=.019	
ReadingInF	Not at All	25.6	21.4	25.0	0.0	36.4	23.7
	About Once a Month	13.7	9.5	16.7	0.0	9.1	11.9
	Once or Twice a Week	38.5	45.2	50.0	58.3	18.2	40.7
	Three or More Times a Week	22.2	23.8	8.3	41.7	36.4	23.7
		r=-.094	r=.040	r=-.057	r=.197**	r=-.025	
CareerInF	Not at All	42.7	34.9	75.0	16.7	36.4	41.0
	About Once a Month	37.6	44.2	8.3	50.0	54.5	39.0
	Once or Twice a Week	13.7	16.3	16.7	33.3	0.0	14.9
	Three or More Times a Week	6.0	4.7	0.0	0.0	9.1	5.1
		r=-.034	r=.049	r=-.128	r=.117	r=-.009	

*p< .05. **p< .01.

		Race/Ethnicity					
		White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
IEExpInF	Not at All	88.0	93.0	100.0	100.0	81.8	90.3
	About Once a Month	7.7	7.0	0.0	0.0	0.0	6.2
	Once or Twice a Week	2.6	0.0	0.0	0.0	18.2	2.6
	Three or More Times a Week	1.7	0.0	0.0	0.0	0.0	1.0
		r=.096	r=-.083	r=-.076	r=-.079	r=.110	
MeetingInF	Not at All	71.8	88.1	91.7	91.7	63.6	77.3
	About Once a Month	24.8	9.5	8.3	8.3	18.2	19.1
	Once or Twice a Week	2.6	2.4	0.0	0.0	18.2	3.1
	Three or More Times a Week	0.9	0.0	0.0	0.0	0.0	0.5
		r=.131	r=-.117	r=-.088	r=-.095	r=.126	
EventsInF	Not at All	74.1	85.7	91.7	100.0	100.0	80.7
	About Once a Month	19.0	7.1	8.3	0.0	0.0	13.5
	Once or Twice a Week	1.7	2.4	0.0	0.0	0.0	1.6
	Three or More Times a Week	5.2	4.8	0.0	0.0	0.0	4.2
		r=.156*	r=-.018	r=-.077	r-.112	r=-.103	

*p< .05. **p< .01.

Table 16 displays the frequency of students' participation in informally organized, out-of-class ACPIs by Fall 2004 math course and gender. Male and female students across all fall 2004 math courses reported similar levels of participation in each informally organized, out-of-class ACPI. With the exception of ReviewInf, "Reviewing math homework or working on homework problems," SuppInf, "Working on supplemental math problems," ReadingInf, "Reading math, science, engineering, or computer science textbooks," and CareerInf, "Discussing careers in math, science, engineering, or computer science," a majority of both male and female students did not participate in each informally organized, out-of-class ACPI. About one in ten males and females indicated that they engaged in ReviewInf (10.4% of males and 11.5% of females) and two in ten males (21.6%) compared to three in ten females (28.3%) reported that they participated in ReadingInf "Three or More Times a Week."

While male students across all fall 2004 math courses tended to report similar levels of participation in informally organized, out-of-class ACPIs, there were some ACPIs which male students' level of participation differed (see Table 16). While males in Precal were more likely than other males to have higher levels of participation in SuppInf, "Working on supplemental math problems," males in Cal 3+ were more likely than males in other courses to report higher levels of participation in PrjInf, "Working on math- or science-based research projects," and TutMenInf, "Tutoring or mentoring students for a math- or science-based course," and males in Cal 2 were more likely than males in other courses to report lower levels of participation in CareerInf.

Female students in Cal 1 and female students in Cal 2 reported similar patterns of participation in informally organized, out-of-class ACPIs while female students in Cal 3+

were less likely than other females to participate in informally organized, out-of-class ACPIs. However, for ReviewInf, "Reviewing math homework or working on homework problems," 77.3% of female students in Cal 3+ participated "Once or Twice a Week" compared to 34.8% of females in Cal 1 and 18.8% of females in Cal 2 who participated in ReviewInf "Once or Twice a Week" and 13.0% of females in Cal 1 and 25.0% of females in Cal 2 who engaged in ReviewInf "Three or More Times a Week."

Males and Females in the same fall 2004 math course reported similar levels of participation in informally organized, out-of-class ACPIs; however, some differences were identified among students within each fall 2004 math course. The largest differences between male and female students in Cal 1 arose in their level of participation in SuppInf, "Working on supplemental math problems" where 11.1% of males compared to 34.8% of females indicated that they engaged in SuppInf "Once or Twice a Week" and 12.7% of males compared to 4.3% of females stated that they participated in SuppInf "Three or More Times a Week." Another difference among Cal 1 students arose in students' responses to how frequently they participated in TutMenInf, "Tutoring or mentoring students for a math- or science-based course," SIInf, "Received supplemental instruction or tutoring for math- or science-based courses," and CareerInf, "Discussing careers in math, science, engineering, or computer science." Females were more than twice as likely as males to engage in TutMenInf "Once or Twice a Week." Over sixty percent of male students compared to forty percent of females in Cal 1 stated that they engaged in SIInf "Not at All" while one-fourth of males compared to over forty percent of females in Cal 1 participated in SIInf "About Once a Month." Almost half of the males in Cal 1 compared to slightly more than ten percent of the females in Cal 1 indicated that they engaged in CareerInf "About Once a Month," 9.5% of males compared to 30.4% of females in Cal 1 particpated in CareefInf "Once or Twice a Month" and 6.3% of males compared to 21.7% of females in Cal 1 engaged in CareerInf "Three or More Times a Week."

Among students who enrolled in Cal 2 for the fall 2004 semester, notable differences in male and female students' level of participation were evident in ReviewInf, "Reviewing math homework or working on homework problems," ReadingInf, "Reading math, science, engineering, or computer science textbooks," IEExpInf, "Participating in math- or science-based internship or externship experiences," and EventsInf, "Attending math, science, engineering, or computer science lectures/seminars/social events." No male students in Cal 2 compared to one-fourth of females in Cal 2 participated in ReviewInf "Three or More Times a Week," and 10.5% of males compared to 25.0% of females in Cal 2 engaged in ReadingInf "Three or More Times a Week." While over 80% of males and females in Cal 2 stated that they did not engage in IEExpInf and EventsInf as part of an informally organized, out-of-class activity, no males compared to 18.8% of females stated that they engaged in IEExpInf "About once a Month" and zero males compared to 12.5% of females said that they engaged in EventsInf "About Once a Month."

The largest differences in Cal 3+ male and female students' level of participation in informally organized, out-of-class ACPIs arose in how frequently students engaged in ReviewInf, "Reviewing math homework or working on homework problems," TutMenInf, "Tutoring or mentoring students for a math- or science-based course," SucceedInf, "Discussing how to succeed in math- or science-based majors," ReadingInf, “Reading math, science, engineering, or computer science textbooks,” and CareerInf, “Discussing careers in math, science, engineering, or computer science.” The largest percentage of male students and female students indicated that they engaged in ReviewInf “Once or Twice a Week;” however, the percentage of males giving this response (54.7%) was much lower than the percentage of females (77.3%). Male students in Cal 3+ were five times more likely than females in Cal 3+ to report participating in TutMenInf or SucceedInf “About Once a Month.” Female students in Cal 3+ were twice as likely as males in Cal 3+ to report participating in CareerInf “Not at All,” and the ratio of males to females who participated in CareerInf “Once or Twice a Week” was 3:0. While approximately 30% of male and female students in Cal 3+ participated in ReadingInf “Three or More Times a Week” 16.7% of males compared to 36.4% of females indicated that they engaged in ReadingInf “Not at All;” thus, males in Cal 3+ were more likely than females in Cal 3+ to participate in ReadingInf as part of an informally organized, out-of-class activity.

Table 16

Informally Organized Out-of-Class ACPIs by Fall 2004 Math Course and Gender (% within F04MathCourse)

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
ReviewInF	Not at All	17.9	31.7	26.1	26.3	25.0	20.8	18.2	26.1	23.0
	About Once a Month	39.3	25.4	26.1	42.1	31.3	20.8	4.5	29.9	19.7
	Once or Twice a Week	32.1	27.0	34.8	31.6	18.8	54.2	77.3	33.6	45.9
	Three or More Times a Week	10.7	15.9	13.0	0.0	25.0	4.2	0.0	10.4	11.5
		r=.005	r=-.034		r=-.053		r=.083		r=.075	
SuppInF	Not at All	25.0	52.4	39.1	38.9	37.5	58.3	59.1	45.9	45.9
	About Once a Month	32.1	23.8	26.1	38.9	37.5	29.2	31.8	28.6	31.1
	Once or Twice a Week	28.6	11.1	30.4	16.7	18.8	12.5	9.1	15.8	19.7
	Three or More Times a Week	14.3	12.7	4.3	5.6	6.3	0.0	0.0	9.8	3.3
		r=.190**	r=.027		r=.020		r=-.204**		r=-.041	
PrjInF	Not at All	75.0	87.3	82.6	94.7	75.0	58.3	68.2	80.6	75.4
	About Once a Month	17.9	7.9	8.7	5.3	25.0	20.8	18.2	11.9	16.4
	Once or Twice a Week	7.1	3.2	8.7	0.0	0.0	20.8	13.6	6.7	8.2
	Three or More Times a Week	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.7	0.0
		r=.017	r=-.132		r=-.113		r=.242**		r=.031	
TutMenInF	Not at All	53.6	66.7	63.6	52.6	75.0	37.5	45.5	56.7	60.0
	About Once a Month	17.9	19.0	13.6	10.5	6.3	41.7	45.5	21.6	23.3
	Once or Twice a Week	28.6	9.5	22.7	21.1	12.5	20.8	4.5	17.2	13.3
	Three or More Times a Week	0.0	4.8	0.0	15.8	6.3	0.0	4.5	4.5	3.3
		r=.034	r=-.108		r=.046		r=.058		r=-.056	

*p< .05. **p< .01.

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
SIInF	Not at All	50.0	63.5	39.1	57.9	75.0	79.2	86.4	62.7	65.6
	About Once a Month	28.6	25.4	43.5	31.6	18.8	16.7	13.6	25.4	26.2
	Once or Twice a Week	21.4	9.5	8.7	10.5	0.0	4.2	0.0	11.2	3.3
	Three or More Times a Week	0.0	1.6	8.7	0.0	6.3	0.0	0.0	0.7	4.9
		r=.125	r=.116		r=-.021		r=-.217**		r=-.013	
SucceedInF	Not at All	42.9	52.4	63.6	68.4	68.8	70.8	95.5	56.0	76.7
	About Once a Month	53.6	33.3	18.2	26.3	25.0	20.8	4.5	34.3	15.0
	Once or Twice a Week	3.6	14.3	9.1	5.3	0.0	4.2	0.0	9.0	3.3
	Three or More Times a Week	0.0	0.0	9.1	0.0	6.3	4.2	0.0	0.7	5.0
		r=.062	r=.166*		r=-.063		r=-.188**		r=-.113	
ReadingInF	Not at All	25.0	19.0	27.3	26.3	25.0	16.7	36.4	20.9	30.0
	About Once a Month	25.0	11.1	4.5	21.1	6.3	8.3	4.5	14.9	5.0
	Once or Twice a Week	39.3	42.9	36.4	42.1	43.8	45.8	31.8	42.5	36.7
	Three or More Times a Week	10.7	27.0	31.8	10.5	25.0	29.2	27.3	21.6	28.3
		r=-.113	r=.102		r=-.060		r=.027		r=-.010	
CareerInF	Not at All	39.3	38.1	34.8	57.9	56.3	25.0	50.0	38.8	45.9
	About Once a Month	35.7	46.0	13.0	36.8	31.3	45.8	50.0	42.5	31.1
	Once or Twice a Week	21.4	9.5	30.4	5.3	12.5	29.2	0.0	14.9	14.8
	Three or More Times a Week	3.6	6.3	21.7	0.0	0.0	0.0	0.0	3.7	8.2
		r=.020	r=.157*		r=-.184**		r=-.034		r=.003	

*p< .05. **p< .01.

		F04MathCourse								
		Precal	Cal 1		Cal 2		Cal 3		Tot	
		M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
IEExpInF	Not at All	89.3	84.1	91.3	100.0	81.3	95.8	100.0	89.6	91.8
	About Once a Month	10.7	6.3	8.7	0.0	18.8	0.0	0.0	5.2	8.2
	Once or Twice a Week	0.0	7.9	0.0	0.0	0.0	0.0	0.0	3.7	0.0
	Three or More Times a Week	0.0	1.6	0.0	0.0	0.0	4.2	0.0	1.5	0.0
		r=-.031	r=.139*		r=-.054		r=-.089		r=-.084	
MeetingInF	Not at All	82.1	66.7	68.2	89.5	93.8	79.2	86.4	75.4	81.7
	About Once a Month	17.9	28.6	22.7	5.3	6.3	16.7	13.6	20.9	15.0
	Once or Twice a Week	0.0	4.8	9.1	5.3	0.0	0.0	0.0	3.0	3.3
	Three or More Times a Week	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.7	0.0
		r=-.068	r=.198**		r=-.137		r=-.054		r=-.060	
EventsInF	Not at All	85.7	74.6	68.2	89.5	81.3	86.4	90.9	81.1	80.0
	About Once a Month	7.1	19.0	27.3	0.0	12.5	9.1	9.1	12.1	16.7
	Once or Twice a Week	3.6	0.0	0.0	5.3	0.0	4.5	0.0	2.3	0.0
	Three or More Times a Week	3.6	6.3	4.5	5.3	6.3	0.0	0.0	4.5	3.3
		r=-.025	r=.127		r=-.004		r=-.125		r=-.015	

*p< .05. **p< .01.

Study participants were asked to indicate who (i.e., undergraduates, graduate students/TAs, or professors) that they interacted with during each of the eleven out-of-class ACPIs (whether formally or informally organized). Tables 17 and 18 provide a comparison by race/ethnicity and by fall 2004 math course and gender, respectively, of the mean number of different out-of-class ACPIs in which study participants engage with different persons (i.e., by themselves (ACPI_S), with another undergraduate (ACPI_U), with a graduate student (ACPI_G), or with a professor (ACPI_P).

Across the board ACPI_S had the highest mean (5.19) indicating that on average, students tended to participate in about five different out-of-class ACPIs by themselves. The average number out-of-class ACPIs that students participated in with other undergraduates was 3.37, and the average number of out-of class ACPIs that students participated in with graduate students/TAs or professors was less than one. These data indicate that, while some students engaged in a variety of active-learning opportunities outside of class, most of the time they were doing so in isolation. Students interacted somewhat less with other undergraduates during ACPIs; however, students had very limited interactions with advanced peers (graduate students/TAs) or professors. When examined in terms of race/ethnicity, Table 17 reveals that Hispanic/Latino students reported slightly different patterns in the types of persons they interacted with during out-of-class ACPIs. While the mean number of out-of-class ACPIs that Hispanic/Latino students participated in alone was close to the overall mean (5.77), the mean was higher (6.00) for the number of ACPIs that Hispanics/Latinos engage in with other undergraduates. Furthermore, while it was still small, the average number of out-of-class ACPIs in which Hispanic/Latino students interacted with graduate students/TAs and professors was higher than the mean for any other racial/ethnic group (1.54 and 1.69, respectively).

Table 17
Mean Number of Out-of-Class ACPIs by Race/Ethnicity and Persons Involved

	Race/Ethnicity					
	White /Caucasian (n=121)	Asian American /Asian (n=45)	African American /Black (n=12)	Hispanic /Latino (n=13)	Other Race /Ethnicity (n=11)	Tot (n=202)
ACPI_S	4.86 r=-.144*	5.67 r=.090	5.67 r=.042	5.77 r=.053	5.73 r=.045	5.19
ACPI_U	3.21 r=-.065	3.20 r=-.031	2.92 r=-.040	6.00 r=.244**	3.09 r=-.023	3.37
ACPI_G	.89 r=-.015	.80 r=-.039	.33 r=-.097	1.54 r=.109	1.45 r=.087	.91
ACPI_P	.89 r=.028	.53 r=-.110	.33 r=-.084	1.69 r=.140*	1.36 r=.077	.86

*p< .05. **p< .01.

Data displayed in Table 18 shows the mean number of out-of-class ACPIs in which students interacted with other undergraduates, graduate students/TAs, or professors by fall 2004 math course and gender. When examined in terms of gender, male and female students gave similar responses; the mean number of out-of-class ACPIs that students participated in alone was 4.99 for males and 5.65 for females. The mean number of ACPIs students engaged in with other undergraduates was 3.44 for males and 3.21 for females. Once again, students indicated that on average they participated in less than one out-of-class ACPI with graduate students/TAs and professors. There was little variability in the mean number of out-of-class ACPIs students participated in when examined in terms of fall 2004 math course. Regardless of fall 2004 math course, male and female students tended to participate in active learning in isolation (means across fall

2004 math course ranged from 4.58 for males in Cal 2 to 6.09 for females in Cal 3). Nevertheless, students did participate in some ACPIs with other undergraduates; the mean number of out-of-class ACPIs in which students interacted with other undergraduates ranged from 2.80 for males in Cal 1 to 4.07 for males in Precal. One notable finding from Table 18 was that in terms of each fall 2004 math course female students tended to engage in a higher number of active learning activities in isolation than their male counterparts, and with the exception of Cal 1, on average male students participated in a higher number of out-of-class ACPIs with other undergraduates. Additionally, male students in precal and Cal 3+ were the only groups whose mean number of out-of-class ACPIs that involved graduate students/TA exceeded one; the same was true for the mean number of ACPIs that involved professors for male students in Cal 3+.

Table 18
Mean Number of Out-of-Class ACPIs by Fall 2004 Math Course, Gender, and Persons Involved

	F04MathCourse								
	Precal	Cal 1		Cal 2		Cal 3+		Tot	
	M (n=28)	M (n=66)	F (n=24)	M (n=19)	F (n=17)	M (n=26)	F (n=22)	M (n=139)	F (n=63)
ACPI_S	5.96	4.65	5.50	4.58	5.29	5.08	6.09	4.99	5.65
	r=.109	r=-.100		r=-.046		r=.069		r=.109	
ACPI_U	4.07	2.80	3.46	3.95	3.06	4.00	3.05	3.44	3.21
	r=.100	r=-.123		r=.027		r=.039		r=.038	
ACPI_G	1.57	.73	.67	.58	.88	1.19	.86	.96	.79
	r=.176*	r=-.119		r=-.058		r=.049		r=-.053	
ACPI_P	.93	.82	.63	.26	.88	1.46	.91	.88	.79
	r=.018	r=-.051		r=-.089		r=.125		r=-.027	

*p< .05. **p< .01.

Post Hoc Analyses

Three post hoc analyses were conducted using the Tukey HSD procedure to determine whether there were statistically significant differences in the mean number of out-of-class ACPIs in which students engaged with different persons by race/ethnicity, gender, and ability (determined by fall 2004 math course). According to Powell (2002) a post hoc analysis is appropriate when comparisons arise as a result of observing data rather than prior to examining the data. Furthermore, Powell asserts that when a post hoc analysis is conducted, the researcher must guard against bias by using "a statistical procedure that takes into consideration the fact that under the null hypothesis of equal group means, the distribution of the difference among the largest and smallest sample means will be different than the sampling distribution of the differences among two arbitrarily chosen sample means" (p. 36). The Tukey HSD procedure guards against this bias. The test of statistical significance for all post hoc analyses was set at the alpha = .10 level.

Results of post hoc analyses that examined the mean number of out-of-class ACPIs in which students engaged with different persons revealed statistically significant differences between the mean amount of time Hispanic/Latino students engaged in ACPI_S (mean=6.00) compared to White/Caucasian students (mean=3.21), Asian American/Asian students (mean=3.20), and African American/Black students (mean=2.92). No statistically significant differences were found between male and female students; however, there was a statistically significant difference in the mean amount of time students in Precal (mean=1.57) participated in ACPI_G compared to students who enrolled in Cal 1 (mean=.71) for fall 2004.

Summary of Descriptive Statistics and Correlation Analyses

Descriptive statistics and correlation analyses provided a profile of study participants and their experiences in in-class and out-of-class (formally and informally organized) academic-centered peer interactions and revealed differences in the level of students' participation in ACPIs by race/ethnicity, gender, and ability. White/Caucasian students and Asian American/Asian students were more likely than other students to report higher levels of participation in in-class ACPIs. Male students were more likely than female students to report that in-class ACPIs occurred more frequently in their fall 2004 math course. Nevertheless, students' level of participation in in-class ACPIs was more closely related to their fall 2004 math course than to race/ethnicity or gender. Students in Cal 1 were more likely than students in other courses to report higher levels of participation in in-class ACPIs and students in Cal 3+ were more likely to report less frequent participation in in-class ACPIs.

Across the board, students indicated low levels of participation in formally organized, and in informally organized, out-of-class ACPIs; however, African American/Black students were more likely than other students to indicate that they did not participatein in out-of-class ACPIs at all. Among out-of-class ACPIs, students spent the most amount of time reviewing math homework or working on homework problems and reading math, science, engineering, or computer science textbooks. Nevertheless, Hispanic/Latino students were more likely than other students to spend more time engaging in these types of activities. Male students in Precal and students in Cal 1 were more likely than other students to participate in formally organized, out-of-class ACPIs, and male and female students in Cal 2 and Cal 3+ were more likely to report that they did not participate in formally organized, out-of-class ACPIs. Across the board students also indicated that they engaged in out-of-class ACPIs by themselves and had very limited interactions with other undergraduates, graduate students, and professors outside of class. White/Caucasian students were more likely than other students to engage in out-of-class ACPIs by themselves and Hispanic/Latino students were more likely than other students to participate in out-of-class ACPIs with other undergraduates or with a professor. Male students in Precal were also more likely than other students to engage in out-of-class ACPIs with a professor. These findings provide information about first-year students' experiences learning mathematics that can be used to improve undergraduate mathematics education. Implications of these findings are discussed in Chapter Six.

ANOVA and Multiple Regression Analyses

Research Question 2

2. Is there a statistically significant difference in the amount of time students spent involved in ACPIs when examined in terms of race/ethnicity, gender, and ability (determined by students' fall 2004 math course)? Does this vary by the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students)?

ANOVA analyses were used to address the second research question. Three analyses were conducted on the three factors identified based on the factor analysis (i.e., FInClass (in-class ACPIs), FOutFormal (formally organized, out-of-class ACPIs), and FOutInformal (informally organized, out-of-class ACPIs)) to examine relationships between students' race/ethnicity, gender, and ability (determined by fall 2004 math course) and the amount of time students spent involved in ACPIs. Each analysis involved a one-way ANOVA and multiple comparisons to examine relationships between the independent variables and dependent variables. ANOVAs answered the question of whether to believe that a set of group means were equal and multiple comparisons were used to determine whether any differences in pairs of means were statistically significant.

When conducting ANOVA analyses, the assumption of homogeneity of variances must be met, otherwise the ANOVA analysis is invalid (Powell, 2002). The Levene Statistic was used to test this assumption in the ANOVA analyses. The test of statistical significance for the Levene statistic was set at the alpha = .10 level. Only ANOVA analyses that produced a Levene Statistic < .10 were further analyzed. Multiple comparison analyses were not restricted based on the Levene statistic. The test of statistical significance for all ANOVA analyses was set at the less stringent significance level of alpha = .10 because of the exploratory nature of the study and the small sample size.

Race/Ethnicity.

Tests of homogeneity of variances produced a Levene Statistics < .10 that warranted ANOVA analyses to examine relationships between race/ethnicity and FInClass (in-class ACPIs). ANOVA analyses indicated that there was a statistically significant relationship between race/ethnicity (measured by a series of dichotomous variables (No = 0; Yes=1): White/Caucasian, Asian American/Asian, African American/Black, Hispanic/Latino, and Other Race/Ethnicity) and FInClass (p=.056, df=197, F=2.347). These results are shown in Tables 19 and 20.

Table 19
Test of Homogeneity of Variances for Race/Ethnicity

	Levene Statistic	df1	df2	Sig.
FInclass	2.092	4	197	.083
FOutFormal	.378	4	197	.824
FOutInformal	1.005	4	197	.406

Table 20
ANOVA for Race/Ethnicity

		Sum of Squares	df	Mean Square	F	Sig.
FInclass	Between Groups	9.181	4	2.295	2.347	.056
	Within Groups	192.682	197	.978		
	Total	201.863	201			
FOutFormal	Between Groups	1.252	4	.313	.311	.870
	Within Groups	198.060	197	1.005		
	Total	199.312	201			
FOutInformal	Between Groups	8.134	4	2.033	2.082	.085
	Within Groups	192.381	197	.977		
	Total	200.514	201			

Six contrasts were investigated using multiple comparisons (Table 21) to make pairwise comparisons across race/ethnicity and the mean amount of time students spent participating in In-Class ACPIs (FInClass), Formally Organized Out-of-Class ACPIs (FOutFormal), and Informally Organized Out-of-Class ACPIs (FOutInformal). Means for these factors were both positive and negative; more negative means indicated lower levels of participation in FInClass, FOutFormal, and FOutInformal, and more positive means indicated higher levels of participation in FInClass, FOutFormal, and FOutInformal (G. Hancock, personal communication, October 8, 2005). The test of statistical significance for multiple comparisons was set at the family alpha = .10 level. Hence, the test of statistical significance for each contrast was alpha = $1-(1-.10)^{1/6}=.017$.

Under the assumption of equal variances, multiple comparison results revealed that on average White/Caucasian students spent statistically significantly more time participating in FInClass (In-Class ACPIs, r=.195, mean=.161) when compared to students who classified themselves as Asian American/Asian (r=-.146, mean=-.271, p=.013). This assumption also revealed that African American/Black students spent statistically significantly less time participating in FOutInformal (Informally Organized Out-of-Class ACPIs, r=-.134, mean=-.298) when compared to students who classified themselves as Hispanic/Latino (r=.126, mean=-.026, p=.011).

Multiple comparisons produced similar results when not assuming equal variances. There was a statistically significant difference in the mean amount of time White/Caucasian students spent participating on FInClass (r=.195, mean=.161) when compared to Asian American/Asian students (r=-.146, mean=-.271, p=.014), and a statistically significant difference between the amount of time African American/Black students spent participating in FOutInformal (r=-.134, mean=-.298) when compared to Hispanic/Latino students (r=.126, mean=-.026, p=.009). Multiple comparisons did not reveal any other statistically significant differences in the mean amount of time students spent participating in ACPIs when examined in terms of race/ethnicity.

Table 21
Multiple Comparisons by Race/Ethnicity

		Contrast	t	Sig. (2-tailed)
FInClass	Assume equal variances	White/Caucasian vs. Asian American/Asian	2.504	.013
		White/Caucasian vs. African American/Black	.596	.552
		White/Caucasian vs. Hispanic/Latino	2.126	.035
		Asian American/Asian vs. African American/Black	-.790	.430
		Asian American/Asian vs. Hispanic/Latino	.582	.561
		African American/Black vs. Hispanic/Latino	1.100	.273
	Does not assume equal variances	White/Caucasian vs. Asian American/Asian	2.501	.014
		White/Caucasian vs. African American/Black	.882	.390
		White/Caucasian vs. Hispanic/Latino	2.023	.062
		Asian American/Asian vs. African American/Black	-1.082	.289
		Asian American/Asian vs. Hispanic/Latino	.556	.584
		African American/Black vs. Hispanic/Latino	1.271	.218
FOutFormal	Assume equal variances	White/Caucasian vs. Asian American/Asian	.176	.860
		White/Caucasian vs. African American/Black	1.029	.305
		White/Caucasian vs. Hispanic/Latino	.139	.889
		Asian American/Asian vs. African American/Black	.864	.389
		Asian American/Asian vs. Hispanic/Latino	.031	.975
		African American/Black vs. Hispanic/Latino	-.677	.500

		Contrast	t	Sig. (2-tailed)
FOutFormal	Does not assume equal variances	White/Caucasian vs. Asian American/Asian	.180	.857
		White/Caucasian vs. African American/Black	1.051	.312
		White/Caucasian vs. Hispanic/Latino	.158	.877
		Asian American/Asian vs. African American/Black	.889	.386
		Asian American/Asian vs. Hispanic/Latino	.035	.972
		African American/Black vs. Hispanic/Latino	-.732	.472
FOutInformal	Assume equal variances	White/Caucasian vs. Asian American/Asian	-.814	.417
		White/Caucasian vs. African American/Black	1.585	.115
		White/Caucasian vs. Hispanic/Latino	-1.862	.064
		Asian American/Asian vs. African American/Black	1.914	.057
		Asian American/Asian vs. Hispanic/Latino	-1.274	.204
		African American/Black vs. Hispanic/Latino	-2.555	.011
	Does not assume equal variances	White/Caucasian vs. Asian American/Asian	-.897	.372
		White/Caucasian vs. African American/Black	1.616	.129
		White/Caucasian vs. Hispanic/Latino	-2.261	.037
		Asian American/Asian vs. African American/Black	2.014	.061
		Asian American/Asian vs. Hispanic/Latino	-1.575	.130
		African American/Black vs. Hispanic/Latino	-2.860	.009

Gender.

Tests of homogeneity of variances (shown in Table 22) did not produce a Levene Statistics < .10 that warranted further ANOVA analyses to examine relationships between gender and FInClass (In-Class ACPIs), FOutFormal (Formally Organized Out-of-Class ACPIs), or FOutInformal (Informally Organized Out-of-Class ACPIs).

Table 22
Test of Homogeneity of Variances for Gender

	Levene Statistic	df1	df2	Sig.
FInclass	.664	1	200	.416
FOutFormal	.171	1	200	.680
FOutInformal	.987	1	200	.322

Ability.

Tests of homogeneity of variances (Table 23) produced a Levene Statistics < .10 that warranted ANOVA analyses to examine relationships between ability (determined by students' fall 2004 math course) and FInClass (In-Class ACPIs), FOutFormal (Formally Organized Out-of-Class ACPIs), and FOutInformal, (Informally Organized Out-of-Class ACPIs). Results of ANOVA analyses (shown in Table 24) indicated that there was a statistically significant relationship between fall 2004 math course and FInClass ($p=.000$). No statistically significant differences were identified in the amount of time students spent participating in FOutFormal or FOutInformal when examined in terms of fall 2004 math course.

Table 23
Test of Homogeneity of Variances for Ability

	Levene Statistic	df1	df2	Sig.
FInclass	3.200	3	198	.024
FOutFormal	2.940	3	198	.034
FOutInformal	2.396	3	198	.069

Table 24
ANOVA for Ability

		Sum of Squares	df	Mean Square	F	Sig.
FInclass	Between Groups	40.793	3	13.598	16.715	.000
	Within Groups	161.070	198	.813		
	Total	201.863	201			
FOutFormal	Between Groups	3.376	3	1.125	1.137	.335
	Within Groups	195.936	198	.990		
	Total	199.312	201			
FOutInformal	Between Groups	1.092	3	.364	.361	.781
	Within Groups	199.423	198	1.007		
	Total	200.514	201			

Six contrasts were investigated using multiple comparisons to make pairwise comparisons between fall 2004 math course and the mean amount of time students spent participating in FInClass, FOutFormal, and FOutInformal. The test of statistical significance for multiple comparisons was set at the family alpha = .10 level. Hence, the test of statistical significance for each contrast was alpha = $1-(1-.10)^{1/6}$=.017. Multiple comparison results are shown in Table 25.

Under both assumptions, assuming equal variances and not assuming equal variances, multiple comparison indicated that on average students who enrolled in Precal for fall 2004 (all males) spent statistically significantly more time engaging in FInClass (r=.030, mean=.077) compared to students who enrolled in Cal 3+ (r=-.329, mean=-.588, p=.002 and .006, respectively); students in Cal 1 spent statistically significantly more time engaging in FInClass (r=.404, mean=.452) compared to Cal 2 students (r=-.185, mean=-.396, p=.000 and .000, respectively); and students in Cal 1 (r=.404, mean=.452) spent statistically significantly more time participating in FInClass compared to Cal 3+ (r=-.329, mean=-.396, p=.000 and .000, respectively). There were no statistically significant differences in the amount of time students spent in FOutFormal and FOutInformal when examined in terms of fall 2004 math course.

Table 25
Multiple Comparisons by F04MathCourse

		Contrast	t	Sig. (2-tailed)
FInClass	Assume equal variances	Precal vs. Cal 1	-1.921	.056
		Precal vs. Cal 2	2.081	.039
		Precal vs. Cal 3+	3.100	.002
		Cal 1 vs. Cal 2	4.767	.000
		Cal 1 vs. Cal 3+	6.452	.000
		Cal 2 vs. Cal 3+	.966	.335
	Does not assume equal variances	Precal vs. Cal 1	-1.928	.061
		Precal vs. Cal 2	1.975	.053
		Precal vs. Cal 3+	2.839	.006
		Cal 1 vs. Cal 2	4.708	.000
		Cal 1 vs. Cal 3+	6.012	.000
		Cal 2 vs. Cal 3+	.863	.391
FOutFormal	Assume equal variances	Precal vs. Cal 1	.984	.326
		Precal vs. Cal 2	1.647	.101
		Precal vs. Cal 3+	1.506	.134
		Cal 1 vs. Cal 2	1.025	.307
		Cal 1 vs. Cal 3+	.813	.417
		Cal 2 vs. Cal 3+	-.258	.797
	Does not assume equal variances	Precal vs. Cal 1	1.071	.288
		Precal vs. Cal 2	2.187	.033
		Precal vs. Cal 3+	1.770	.082
		Cal 1 vs. Cal 2	1.209	.229
		Cal 1 vs. Cal 3+	.801	.425
		Cal 2 vs. Cal 3+	-.332	.741
FOutInformal	Assume equal variances	Precal vs. Cal 1	.191	.849
		Precal vs. Cal 2	.873	.384
		Precal vs. Cal 3+	.498	.619
		Cal 1 vs. Cal 2	.906	.366
		Cal 1 vs. Cal 3+	.432	.666
		Cal 2 vs. Cal 3+	-.460	.646
	Does not assume equal variances	Precal vs. Cal 1	.229	.819
		Precal vs. Cal 2	.996	.323
		Precal vs. Cal 3+	.637	.527
		Cal 1 vs. Cal 2	.853	.396
		Cal 1 vs. Cal 3+	.448	.655
		Cal 2 vs. Cal 3+	-.472	.638

Summary of ANOVA Analyses

ANOVAs and multiple comparisons revealed differences in the mean amount of time students engaged in in-class ACPIs by race/ethnicity and fall 2004 math course, but did not show any significant differences by gender. There were differences in the amount of time White/Caucasian students spent participating in in-class ACPIs compared to Asian Americans/Asians; students who enrolled in Precal for fall 2004 spent significantly more time engaging in in-class ACPIs compared to students who enrolled in Cal 3+, students in Cal 1 spent more time engaging in in-class ACPIs compared to Cal 2 students, and students in Cal 1 spent statistically significantly more time participating in in-class ACPIs compared to Cal 3+. With the exception of showing that African American/Black students spent significantly less time participating in out-of-class informally organized ACPIs than Hispanic/Latino students, ANOVA and multiple comparison analyses did not reveal any statistically significant differences in the mean amount of time students participated in out-of-class formally organized ACPIs or out-of-class informally organized ACPIs by race/ethnicity, gender, or ability.

Research Question 3

3. Is the amount of time students spent involved in ACPIs a statistically significant predictor of fall 2004 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

The Input-Environment-Output (I-E-O) model was used to examine research questions three, four, and five because it addresses the non-random assignment of students (inputs) to programs (environments) and reduces input bias by controlling for the effects of input variables before determining if environmental variables or intermediate outcomes add anything to the prediction of the dependent variable (Astin & Astin, 1992). The I-E-O model was employed using blocked hierarchical linear regression analyses to determine whether select student characteristics (i.e., race/ethnicity, gender, and ability), the type of ACPIs in which students are involved, or the persons who participate in the ACPIs were useful in explaining the variability in first-year students' fall 2004 math course grades, spring 2005 math course grades, and fall 2004 to fall 2005 retention. The test of statistical significance was set at the alpha = .10 level for all regression analyses.

Three blocks of variables were entered into the regression to examine the predictive relationship between race/ethnicity, gender, ability (determined by students' fall 2004 math course), and students' participation in ACPIs and the academic outcome of fall 2004 math course grades. The first block of input variables included students' characteristics as they entered the university: race/ethnicity (comparison category was White/Caucasian students), gender (comparison category was male students), and SAT math score. The second block included the environmental variable fall 2004 math course (comparison category was Cal 3+). The factors that represented the frequency of in-class ACPIs (FInClass); formally organized, out-of-class ACPIs (FOutFormal); and informally organized, out-of-class ACPIs (FOutInformal) were included in the third block of environment variables. Variables that identified who was involved in the ACPI, ACPI_S (number of ACPIs a student participated in by themselves), ACPI_U (number of ACPIs a student participated in with another undergraduate), ACPI_G (number of ACPIs a student participated in with a graduate student), and ACPI_P (number of ACPIs a student participated in with a professor), were also included in the third block.

Results of the regression analysis predicting fall 2004 math course grade revealed that the total model explained 17.8% of the variance in fall 2004 math course grade. Block 1 explained 3.6%, Block 2 explained an additional 11.9%, and Block 3 explained an additional 2.3% of the variance in students' fall 2004 math course grades. The R Square change from Block 1 to Block 2 was statistically significant and the R Square change from Block 2 to Block 3 was not statistically significant.

Table 26 shows bivariate correlations and standardized regression coefficients for the final regression model. The results of Block 2 indicated that Other Race/Ethnicity ($p=.049$), Precal ($p=.000$), and Cal 2 ($p=.008$) were statistically significant predictors of fall 2004 math course grade. According to Block 2, the mean fall 2004 math course grade for students who were categorized as Other Race/Ethnicity was statistically significantly higher ($\beta=.139$) than students from other racial/ethnic categories, students in Precal (all male) had a statistically significantly lower mean fall 2004 math course grade ($\beta=-.395$) than students enrolled in Cal 3+, and students in Cal 2 had a statistically significantly lower mean fall 2004 math course grade ($\beta=-.228$) than students in Cal 3+.

After Block 3 variables were entered, Other Race/Ethnicity ($p=.043$), Precal ($p=.000$), and Cal 2 ($p=.006$) remained statistically significant predictors of fall 2004 math course grades. The mean fall 2004 math course grade for students who were categorized as Other Race/Ethnicity was statistically significantly higher ($\beta=.145$) than for White/Caucasian students, students in Precal (all male) had a statistically significantly lower mean fall 2004 math course grade (β=-.379) than students enrolled in Cal 3+, and students in Cal 2 had a statistically significantly lower fall 2004 math course grade (β=-.241) than students in Cal 3+. Neither the amount of time students spent involved in ACPIs nor who they were involved with during ACPIs were statistically significant predictors of fall 2004 math course grade for MSEC students.

Table 26
Regression Predicting Fall 2004 Math Course Grade All Students in the Sample (N=202)

Pearson's Correlations and Standardized Regression Coefficients			
Variable	Pearson's Correlations	Beta	Sig
Entry Characteristics (Inputs)			
Race/Ethnicity: Asian American/Asian	-.077	.016	
Race/Ethnicity: African American/Black	.078	.031	
Race/Ethnicity: Hispanic/Latino	.038	-.023	
Race/Ethnicity: Other Race/Ethnicity	.123	.145	**
Sex: Female	.085	.029	
SAT Math Score	-.073	-.001	
	R^2 = .036	R^2 Change = .036	
Fall 2004 Math Course (Environment)			
Precal	-.301***	-.379	***
Cal 1	.119	-.111	
Cal 2	-.127	-.241	**
	R^2 = .155	R^2 Change = .119	***
ACPIs (Environment)			
FInClass	-.004	-.003	
FOutFormal	-.082	-.062	
FOutInformal	.065	.078	
ACPI_S	-.090	-.089	
ACPI_U	.018	.069	
ACPI_G	-.073	-.080	
ACPI_P	.009	.035	
	R^2 = .178	R^2 Change = .023	

*p< .10. **p<.05. ***p<.01.

Research Question 4

4. Is the amount of time students spent involved in ACPIs a statistically significant predictor of spring 2005 math course GPA for MSEC students? Does the effect of

participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

A blocked hierarchical linear regression analysis was conducted to determine whether select student characteristics (i.e., race/ethnicity, gender, and ability), the type of ACPIs in which students were involved, or the persons who participated in the ACPIs were useful in explaining the variability in first-year students' spring 2005 math course grades. The test of statistical significance was set at the alpha = .10 level.

Five blocks of variables were entered into the regression model. The first block of input variables included race/ethnicity, gender, and SAT math score. The second block included dichotomous measures of the fall 2004 math course in which students were enrolled. Factors representing students' ACPI experiences in class; in formally organized, university-sanctioned programs; and informally organized by students themselves, and who students participated in ACPIs with were included in the third block of environmental variables. Fall 2004 math course grade was included in the fourth block of as an intermediate outcome, and the fifth block included dichotomous measures of spring 2005 math course (comparison category was Cal 3+). The outcome variable was spring 2005 math course grade.

The total regression model accounted for 21.8% of the variance in students' spring 2005 math grades. Block 1 accounted for 5.3% of the variance. The R Square change from Block 1 to Block 2 was 6.0% and was statistically significant (p=.013). The

R Square change from Block 2 to Block 3 was 1.2% and was not statistically significant. The R Square change from Block 3 to Block 4 (1.0%) and was not statistically significant, and the R Square change from Block 4 to Block 5 was 8.3% and was statistically significant ($p=.001$).

Table 27 shows the bivariate correlations and standardized regression coefficients for the entire model. The results of Block 2 revealed that being enrolled in Precal ($p=.002$), being enrolled in Cal 1 ($p=.006$), or being enrolled in Cal 2 for fall 2004 ($p=.077$) were statistically significant predictors of spring 2005 math course grades. Students who enrolled in Precal (all males) for fall 2004 ($\beta=-.308$) had a statistically significantly lower mean spring 2005 math course grade than students enrolled in Cal 3+, the mean spring 2005 math course grade for students who enrolled in Cal 1 for fall 2004 was significantly lower ($\beta=-.294$) than for students enrolled in Cal 3+, and the mean spring 2005 math course grade for students who enrolled in Cal 2 for fall 2004 was significantly lower ($\beta=-.164$) than for students who enrolled in Cal 3+ for fall 2004.

Results of Block 5 showed that being enrolled in Precal for spring 2005 ($p=.010$) was also statistically significant in explaining the variance in spring 2005 math course grades. Students in Precal for spring 2005 (all male) had a statistically significantly lower mean spring 2005 math course grade ($\beta=-.519$) than students enrolled in Cal 3+ for spring 2005. ACPI variables were not statistically significant predictors of spring 2005 math course grade for study participants.

Table 27
Regression Predicting Spring 2005 Math Course Grade Students Enrolled for Spring 2005 (N=187)

Pearson's Correlations and Standardized Regression Coefficients			
Variable	Pearson's Correlations	Beta	Sig
Entry Characteristics (Inputs)			
Race/Ethnicity: Asian American/Asian	.084	.140	
Race/Ethnicity: African American/Black	.095	.063	
Race/Ethnicity: Hispanic/Latino	.048	-.027	
Race/Ethnicity: Other Race/Ethnicity	.140	.094	
Sex: Female	.113	-.017	
SAT Math Score	-.097	-.040	
	R^2 = .053	R^2 Change = .053	
Fall 2004 Math Course (Environment)			
Precal	-.137	.160	**
Cal 1	-.149**	-.368	**
Cal 2	.002	-.180	**
	R^2 = .113	R^2 Change = .060	**
ACPIs (Environment)			
FInClass	-.050	.044	
FOutFormal	-.068	-.024	
FOutInformal	.049	-.005	
ACPI_S	.029	.041	
ACPI_U	.088	.082	
ACPI_G	.005	.145	
ACPI_P	.027	-.115	
	R^2 = .126	R^2 Change = .012	
Fall 2004 Math Course Grade (Intermediate Outcome)			
Fall 2004 Math Course Grade	.190**	.014	
	R^2 = .135	R^2 Change = .010	
Spring 2005 Math Course (Intermediate Outcome)			
Precal	-.321***	-.519	**
Cal 1	.009	-.322	
Cal 2	-.110	.077	
	R^2 = .218	R^2 Change = .083	***

*p< .10. **p<.05. ***p<.01.

The findings from the regression analyses that examined the predictive relationship between students' race/ethnicity, gender, ability (determined by fall 2004 math course), and participation in in-class and out-of-class ACPIs and the academic outcomes of fall 2004 math course grade and spring 2005 math course grades indicated that the type of math course in which students were enrolled `was a better predictor of math course grades than were measures of ACPIs.

Research Question 5

5. Is the amount of time students spent involved in ACPIs a statistically significant predictor of retention of first-year students in MSEC programs from the fall 2004 to the fall 2005 semester (determined by fall 2005 major and course enrollment)? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

A blocked hierarchical linear regression analysis was conducted to determine whether select student characteristics (i.e., race/ethnicity, gender, and ability), the type of ACPIs in which students were involved, or the persons who participated in the ACPIs were useful in explaining the variance in first-year students' fall 2004 to fall 2005 retention in any MSEC program.

Six blocks of variables were entered into the regression analysis. The first block of input variables included race/ethnicity, gender, and SAT math score. The second block included the environment variable fall 2004 math course. FInClass, FOutFormal, and FOutInformal, ACPI_S, ACPI_U, ACPI_G, and ACPI_P were included in the third block of environmental variables. The intermediate outcomes fall 2004 math course grade, spring 2005 math course, and spring 2005 math course grade, were included in blocks four, five, and six, respectively. The outcome variable was fall 2004 to fall 2005 retention in MSEC majors and was based on study participants' fall 2005 major and MSEC course enrollment. Only students who held a major in a CMPS or ENGR program and who were also enrolled in CMPS or ENGR coursework for fall 2005 were considered 'retained' in MSEC. The test of statistical significance for the regression analysis was set at the alpha = .10 level.

Results of the regression analysis (shown in Table 28) revealed that Block 1 explained 5.4% of the variance in students' fall 2004 to fall 2005 retention. After Block 2 was added, the model explained 6.5% of the variance. Block 3 explained an additional .8% of the variance and Block 4 explained another .3% of the variance in retention. After Block 5 was added, the model explained 8.9% of the variance and after Block 6 was added the total model explained only 9.0% of the variance in students' fall 2004 to fall 2005 retention in MSEC majors. None of the R Square changes were statistically significant. The ANOVA for each model revealed that none of the models were statistically significant in explaining the variability in fall 2004 to fall 2005 retention; therefore, none of the models were analyzed further.

Table 28
Regression Predicting Fall 2004 to Fall 2005 Retention All Students in the Sample (N=202)

Pearson's Correlations and Standardized Regression Coefficients		
Variable	Pearson's Correlations	Beta
Entry Characteristics (Inputs)		
Race/Ethnicity: Asian American/Asian	-.018	-.111
Race/Ethnicity: African American/Black	-.017	-.036
Race/Ethnicity: Hispanic/Latino	.107	.091

Race/Ethnicity: Other Race/Ethnicity	-.026	-.035
Sex: Female	.032	.150
SAT Math Score	.156*	.240
	R^2 = .054	R^2 Change = .054
Fall 2004 Math Course (Environment)		
Precal	.042	-.044
Cal 1	-.031	.102
Cal 2	.006	.032
	R^2 = .065	R^2 Change = .010
ACPIs (Environment)		
FInClass	-.014	.046
FOutFormal	-.039	-.082
FOutInformal	.071	-.004
ACPI_S	.018	.030
ACPI_U	.068	.016
ACPI_G	.079	-.065
ACPI_P	.061	.082
	R^2 = .073	R^2 Change = .008
Fall 2004 Math Course Grade (Intermediate Outcome)		
Fall 2004 Math Course Grade	-.073	-.026
	R^2 = .075	R^2 Change = .003
Spring 2005 Math Course (Intermediate Outcome)		
Precal	.083	.086
Cal 1	.007	.011
Cal 2	-.043	-.224
	R^2 = .089	R^2 Change = .014
Spring 2005 Math Course Grade (Intermediate Outcome)		
Spring 2005 Math Course Grade	-.080	-.042
	R^2 = .090	R^2 Change = .001

*p< .10. **p<.05. ***p<.01.

Post Hoc Analyses

To further illuminate results of the regression analyses, four post hoc analyses were conducted using the Tukey HSD procedure to determine whether there were statistically significant differences in students' mean fall 2004 math course grade, mean spring 2005 math course grade, mean retention rate, and mean total amount of time spent participating in ACPIs in any context (ACPITot) by race/ethnicity, gender, and ability.

The test of statistical significance for all post hoc analyses was set at the alpha = .10 level.

There were no statistically significant differences in the mean fall 2004 math grade, spring 2005 math grade, retention rate, or total amount of time spend participating in any ACPI by race/ethnicity or gender; however, there were statistically significant differences in these academic outcomes when examined in terms of ability. Results of post hoc analyses indicated that students who enrolled in Precal for fall 2004 (mean=2.07) had a lower mean fall 2004 math grade compared to students who enrolled in Cal 1 (mean=2.99) and also compared to students who enrolled in Cal 3+ (mean=3.26). Results also indicated that students who enrolled in Cal 2 (mean=2.57) had a significantly lower mean fall 2004 math grade compared to students who enrolled in Cal 3+ (mean=3.26). Students who enrolled in Cal 3+ for fall 2004 had a significantly higher mean spring 2005 math grade (mean=3.38) compared to students who enrolled in Precal for fall 2004 (mean=2.46) and also compared to students who enrolled in Cal 1 (mean=2.64). Students who enrolled in Cal 3+ for spring 2005 also had a significantly higher mean spring 2005 math grade (mean=3.17) than students who enrolled in Precal for spring 2005 (mean=1.25). There were also statistically significant differences in the mean total amount of time students who enrolled in Precal for fall 2004 spent participating in any ACPI (mean=29.61) compared to students who enrolled in Cal 2 (mean=21.10) and compared to students who enrolled in Cal 3+ (mean=20.37) for fall 2004.

The total amount of time students spent participating in ACPIs in any context. (ACPITot) was included in three regression analyses that were used to examine the relationship between race/ethnicity, gender, ability (measured by fall 2004 math course), and students' overall participation in ACPIs and the academic outcomes of fall 2004 math course grade, spring 2005 math course grade, and fall 2004 to fall 2005 retention. ACPITot was not a significant predictor of any of the academic outcomes.

Summary of Regression Analyses

Blocked hierarchical regression analyses used to determine the relative role that race/ethnicity, gender, ability (determined by fall 2004 math course), and ACPI experiences had in predicting students' fall 2004 math course grades, spring 2005 math course grades, and fall 2004 to fall 2005 retention revealed that race/ethnicity and ability were predictors of fall 2004 math course grade, and the fall 2004 and spring 2005 math courses in which students enrolled were predictors of spring 2005 math course grade. Neither gender nor ACPI experiences were predictors of students' academic achievement, and neither race/ethnicity, gender, ability, nor ACPI experiences were predictors of fall 2004 to fall 2005 retention.

Existing research indicates differences in educational outcomes by race/ethnicity, gender, and ability (Fox & Soller, 2001; Fries-Britt, 1998; Grandy, 1998; Hurley, 1982; Kennedy & Parks, 2000; Linn & Kessel, 1996; Mau & Leitze, 2001; NCES, 2000; Rosser, 1997; Seymour & Hewitt, 1997; Treisman, 1985, 2000); therefore, race/ethnicity and ability were expected to be predictors of fall 2004 and spring 2005 math course grades. Findings related to Other Race/Ethnicity must be interpreted with caution because the small number of students categorized as Other Race/Ethnicity (11) may have exaggerated differences in fall 2004 math course grades when compared to other students. Because the sample size of African American/Black and Hispanic/Latino students was also small (12 and 13, respectively), it was not surprising that being African American/Black or Hispanic/Latino did not predict fall 2004 or spring 2005 math grades. Furthermore, post hoc analyses did not reveal any differences in the mean fall 2004 or spring 2005 math course grades by race/ethnicity. Additional research with larger samples is necessary to further examine relationships between race/ethnicity and academic outcomes.

Descriptive statistics and correlation analyses indicated that students had more similar learning experiences by their fall 2004 math course than by race/ethnicity or gender; therefore, it was not surprising that ability was a predictor of fall 2004 and spring 2005 math course grades. Results of post hoc analyses were consistent with these findings and show that students learning experiences in their math courses play an important role in their academic success in mathematics during their first year of undergraduate study.

It was unexpected, but not surprising, that gender was not a predictor of students' academic achievement. Post hoc analyses revealed no significant difference in the mean fall 2004 math grades for males and females (2.79 and 2.98, respectively) and no significant difference in the mean spring 2005 math grade for males and females (2.72 and 2.98, respectively). Furthermore, correlation analyses did not result in significant correlations between gender and fall 2004 or spring 2005 math grade. That race/ethnicity, gender, and ability did not predict fall 2004 to fall 2005 retention was unexpected. However, the sample size was relatively small and there was a very limited amount of variance to explain in fall 2004 to fall 2005 retention (mean=.86, standard deviation=.352).

ACPI opportunities provide social and academic supports that can positively influence students' academic achievement and degree persistence in undergraduate math- and science-based programs (Alexander et al., 1996; Duncan & Dick, 2000; Eisenberg & Browne, 1973; Grandy, 1998; Lazar, 1993; Moreno & Muller, 1999; Treisman, 1985, 1992; Wheatland, 2000; Wine & Cooper, 1985; Zunkel, 2002) and were expected to be predictors of fall 2004 math grade, spring 2005 math grade, and fall 2004 to fall 2005 retention. Results of the regression analyses did not support this. These findings may be due to low levels of student participation in ACPIs that made it difficult for regression models to identify differential relationships between ACPI experiences and fall 2004 math grade, spring 2005 math grade, and fall 2004 to fall 2005 retention. This is consistent with findings from correlation analyses that showed no significant relationships between ACPI composite factors and these academic outcomes. However, while composite factors were useful for reducing the number of ACPI variables that were included in the regression models and for establishing reliability of the survey items, they did not allow for the examination of relationships between specific ACPIs and academic outcomes; some which may have been muffled by the use of composite factors. Additional research with larger sample sizes is needed to further examine these relationships.

CHAPTER FIVE: RESULTS OF QUALITATIVE ANALYSES

The qualitative component of this study was designed to illuminate the quantitative data by exploring the nature of students' learning experiences both in and outside of the classroom setting and the sense students make of how these experiences relate to their academic success and decisions to continue pursuing a degree in a MSEC program. The composition of the focus groups and a description of participants is shared, and three assertions are discussed that evolved from an inductive analysis of the data.

- Assertion 1: When students struggle with learning mathematics their primary resource is the course text.
- Assertion 2: Students recognize the benefit of learning mathematics with other students both in- and outside of class, but they do not do it outside of class!
- Assertion 3: Formally-organized, out-of-class interactions with undergraduates, TAs, faculty, and professors in CMPS and ENGR have a strong influence in helping students to connect with others in MSEC programs. Students report that this can influence their persistence in MSEC.

Quotations have been selected from the focus group and individual interviews to clarify and illuminate the assertions and are illustrative of the experiences of the majority of the students interviewed. The quotes which are used are similar in context and meaning to other students' responses and descriptions and include both confirming and divergent viewpoints. The quotes have been edited to eliminate idiomatic phrases which can be distracting for the reader; however, the content and the intent of the students' statements have been preserved. In order to maintain confidentiality, a pseudonym has been substituted for each participant's real name.

Of the 202 study participants, 81 (40%) indicated at the end of the *MSEC ACPI Experiences Survey* that they were willing to be contacted at a later date to participate in a 90 minute focus group about their experiences learning mathematics with peers. The composition of focus group sessions were determined based on findings from preliminary analyses of the survey data and the goals of this study. These analyses suggested (1) differences in the learning experiences of racial/ethnic minority students; (2) differences in the types of activities in which male and female students participate; and (3) differences in students' learning experiences by fall 2004 math course. Based on these findings and the goals of this study, subsets of the participants were invited to participate in three focus group interviews that were conducted toward the end of April 2005.

Composition of the Focus Groups

Focus Group 1: Females

The first focus group consisted of female students of various racial/ethnic backgrounds who enrolled in Cal 1, Cal 2, or Cal 3+ for the fall 2004 semester. Eleven students were initially invited to participate in this focus group. Two students agreed to attend the focus group session and three students indicated that they were unable to attend due to end of semester responsibilities for their courses or scheduling conflicts. Six students did not respond to the initial email invitation or to any follow up emails. A second wave of invitations was sent to another 12 students in an attempt to increase the size of the focus group. A total of five female students (Sunni, Elaine, Lola, Ty, and Bethany) agreed to participate in this focus group. Six students declined and twelve did not respond.

The female focus group consisted of two White/Caucasian students and two Asian American/Asian students: Sunni, Elaine, Lola, and Ty. Bethany did not arrive until the last five minutes of the focus group and; therefore, was unable to participate. Sunni was a chemical engineering major who enrolled in Cal 2 for the fall 2004 semester, Elaine majored in computer engineering and enrolled in Cal 3+, Lola was engineering undecided and enrolled in Cal 1, and Ty majored in biological resources engineering and enrolled in Cal 1 for the fall 2004 semester.

Focus Group 2: Males

The second focus group was planned to consist of male students who enrolled in Precal, Cal 1, Cal 2, or Cal 3+ for the fall 2004 semester. A total of 21 students were invited to participate in this focus group. Five students agreed to attend the focus group session (but one later declined because of a schedule conflict), four students stated that they were unable to attend, and the remaining 12 students did not respond to the initial email invitation or to any follow up emails.

The male focus group consisted of three White/Caucasian students: Richard, Keenan, and Martin. One student who indicated that he would attend did not show up to the session. Richard majored in computer science and was enrolled in Cal 1 for the fall 2004 semester, Keenan was a physics major seeking a minor in mathematics and who enrolled in Cal 3+, and Martin was a computer engineering major who enrolled in Cal 1 for the fall 2004 semester.

Individual Interview

The third focus group was planned to consist of male and female African American/Black students who enrolled in Precal, Cal 1, Cal 2, or Cal 3+ for the fall 2004 semester. All six of the students meeting these criteria were invited to participate in this focus group. One female student, Mia, agreed to participate. Two students indicated that they were unable to attend, and three students did not respond to the initial email invitation or to any follow up emails. Mia majored in chemical engineering and enrolled in Cal 1 for the fall 2004 semester.

Inductive Analysis

The data gathered during the interviews were analyzed inductively to identify themes and to categorize results. Students' responses to the same questions in the interview protocol were merged into a master transcript and sorted into the following categories: math course structures and how questions are handled in class, experiences with formally-organized programs, informal learning resources outside of class, informal interactions with other students outside of class, interactions with professors and teaching assistants, and factors influencing students' decisions to continue pursuing a degree in MSEC. The data were analyzed further to identify reoccurring themes that arose within and across categories. Three assertions offered a synthesis of the interview data.

Assertion 1: When students struggle with learning mathematics their primary resource is the course text.

For the CMPS and ENGR students interviewed the course text was an important resource in their learning experience. When students did not understand a mathematical idea their first response was to turn to the course text rather than their professor, TA, or another student. Many students in the larger lecture courses (i.e., Cal 1 and Cal 2) stated that they generally did not feel comfortable asking questions during lecture. They recognized that opportunities to ask questions or go over problems in class were limited because of the size of the class and the amount of material that needed to be covered, but were also concerned about asking a question that they did not consider very insightful or worthy of interrupting class time. As a result, students often supplemented the lecture by reading through explanations and proofs and working through examples from the text. In response to a question about whether there are opportunities for students to discuss mathematics during class, Sunni answered, “Well, for my calc II and calc III class I don’t really think so. I guess that’s what discussion class is for. Yea, ‘cause calc class is just lecture and if you ask questions, basically, like, there are more than a hundred people in class, and if you ask a question it sort of slows down the time.” Richard also noted limited opportunities to ask questions during class and explained what he did when he didn’t immediately understand something.

> A couple of times during the proof, I’d kind of space out so I don’t get too confused. But other times I try to write down what he’s writing and then when I get home I’m doing the work for homework and stuff. I try to look at the book then look at that [the notes] and try hard to get through and try to follow and understand what is being done. It kind of helps me with the homework and stuff, just taking the extra time to understand it. (Richard)

Students sometimes remain confused after they leave class and look to the book to help them gain a sense of what was discussed in lecture or to help with homework. Elaine stated, “The main thing for me would be to look up examples in the book if the professor didn’t have time to really give some examples. Maybe they just gave you the theory, theorem, or something and the book usually has a bunch of examples to help with homework.”

Despite students' reliance on the book to supplement course material, they found that the book is not always the best resource. Some books were not easy for students to read and the sequence or depth of the topics covered in the text did not always align with what was covered in class. Keenan described his experience, "I mean we tried the book last year, but the book wasn't that easy to understand. [laughs] That's the first place we turned to see if we understand what's going on here; that sometimes worked, other times didn't."

The Internet was also an additional source for information to supplement their lecture notes. One student explained, "Yea, like, if you go to Google and type in a certain topic like integrals or antiderivatives and you'll pull up different pages from different colleges and they'll have lecture notes up on the website and I'll go through that just before an exam" (Lola).

Interview participants were reluctant to seek help from a TA or professor. It was only after they tried the book and some friends that many students would consider turning to a TA or professor for assistance. Students stated that they did not find TAs or professors to be very helpful because they were too theoretical and did not explain things in a way that they could understand. Other students described TAs and professors as expecting students to take on greater responsibility for their learning and wanting them to figure things out with limited assistance from the TA or professor. Mia talked about her experiences from the fall 2004 semester to the spring 2005 semester and how she came to seek assistance from her TA:

> Well, I could understand what was happening [in the math course], and I brought my notes from home so I was able to look at those and see what I didn't

understand compared to the notes and just try to work from there. But this semester, I don't have any backup notes, I guess, to go back on. So I think that's why I have been talking to my TA more and stuff. (Mia)

Sunni pointed out that the quality of the assistance that TAs or professors give varies from person to person. "Well, I guess it also depends on which professor you have and which TA you have. You know, I mean if you got a professor who doesn't, who makes things complicated and you got a TA who doesn't explain much, just expects you to know a lot of stuff, then probably the whole semester is ruined." (Sunni)

When students struggled with a particular mathematical idea or problem they looked to the course textbook as a primary resource for clarification of the mathematical idea and for problem examples that they could work through to try to understand the idea. Seeking assistance from other undergraduates, TAs (or other graduate students), or professors was secondary and students utilized these resources very infrequently. This pattern was consistent with students' survey responses that showed that "Reading math, science, engineering, or computer science textbooks" (ReadingF and ReadingInf) was one of the two out-of-class ACPIs in which students reported engaging in more frequently than other out-of-class ACPIs. This finding is particularly significant because while reading a textbook does get students actively involved in learning mathematics, students are more likely to enagage in this sort of activity in isolation and; therefore, are not able to realize the academic, social, and motivational benefits of discussing mathematics with others.

Assertion 2: Students recognize the benefit of learning mathematics with other students both in- and outside of class, but they do not do it outside of class!

Focus group participants described their recitation/discussion sections and the smaller, Cal 3+ courses as providing opportunities to talk about mathematics with other undergraduates, the TA, or the professor and to address questions that they had from lecture or homework. Two students described their courses: “I kind of like my [discussion] class right now. We’re pretty open to asking questions, and the students themselves would actually, some of them would go up to the board and explain it rather than having just the TA do it.” (Lola). Keenan described his initial expectations for in-class interactions between and among students and the professor and the benefits he realized when unexpected opportunities for discussion arose.

> When I first got there I kind of assumed [the professor] was there to lecture and then if someone had a pressing question, then he would answer it and move on… But if one person doesn’t understand something they’ll ask questions about it and then he’ll go on some more and kind of invent an example on the spot - something to address their point and then he’ll kind of discuss that more in depth and how it’s related to applications. Then we have some really brilliant high schoolers in our class who can, who pull things out of thin air and he’ll talk about those. If you’re pretty sharp with it you can really get a sort of a glimpse of what they’re talking about. And, um, that’s the really interesting thing about higher mathematics that aren’t really taught but it’s kind of discussed in front of you, and there’s no fear in asking a question and not having it answered or things like that. (Keenan)

Students noted that when they had difficulty with a particular idea or were struggling through a problem, the explanations given by professors, TAs, and other undergraduates were quite different. Professors' explanations were seen as very abstract and sometimes difficult for many students to understand. They stated that professors would sometimes get excited and point out how nicely the mathematical ideas came together, and even though they didn't understand the professor's explanation, students would say "ok" and try to figure it out later. When asked why they were reluctant to ask questions, students said that they realized that class time is limited and they did not want to "waste that time to ask stupid questions" when they could figure it out later. Elaine described this as one frustrating aspect of her math courses,

> Last semester my professor would sometimes just expect us to understand what he was talking about. Like he'll be giving a proof or something and he'll be, like, 'see how this works, see it?!!', and we're, like, sure, but we don't really know so we just kind of have to let it go and that can be pretty frustrating when you don't really get what he's saying. I guess it's hard for them to kind of put themselves in our shoes. You know they don't really know if we, they don't really care if we understand all the time [laughs]. (Elaine)

Focus group participants viewed TAs as having the important role of being a bridge between the professor and students by explaining things that the professor said in a way that students can understand. Students asserted that TAs explanations are useful because TAs offer different ways of thinking about and solving problems and help them to understand and use mathematical terminology. In response to a question about the differences in professors' and TAs' explanations, Richard argued, "A teaching assistant and a professor? 'Professor', the very word, doesn't mean to teach it means to tell you something and to let you go with it, [laughter] and you either got it or you didn't. That's really what it means and the teaching assistant is really who basically brings things down into layman's terms…" Ty and Lola attempted to clarify the differences in professors' and TAs' explanations:

> She's [the TA] a lot more clear in the way she goes about teaching it to us, and also just the way she goes over it and then we go over problems together like that. He [the professor] makes it more theoretical and tells us all these theories and things that just don't have to do with what we're learning. (Ty)

> My TA, he kind of simplifies it; he doesn't use, like, I guess my professor, like, she uses a lot of symbols and my symbols always get mixed up because I don't know what she's talking about… and it all looks the same. But the TA they can, they just simplify the explanation into what it really means rather than elaborating, like, the theoretics behind it. (Lola)

When asked about their in-class learning experiences with other students, many interview participants stated that they learn mathematics best from working with other students. They argued that other undergraduate students' explanations are very helpful because other students are able to recognize where they are having trouble and are able to explain how to resolve the issue using words and terminology that another student can understand. Two students described their experiences learning math with other students and a third made a recommendation for incorporating ACPI opportunities into future math courses:

I guess a student maybe would know more what you were confused about with the problem. Like, they could say if there was just one thing that was keeping you from understanding, they'll have had the same problem, maybe. Whereas it's just so easy for them [the TAs], they don't even really think about it as an issue. (Elaine)

Yea. It's actually, it's been really nice because I think I was having so many problems that I would say something and they'd be like, no this is wrong, but I would still ask them why, or, like, what they were doing, and they're still able to explain what they are doing, which is really nice. So I definitely, I found a good group, I think. (Mia)

Well, I think it [lecture] should be more group-oriented. 'Cause I know it [group work] doesn't really work for everyone, but it really worked for me and it really worked for a lot of people in my class last semester. We had the teacher five times a week, twenty of us, we broke up into groups and then we did group work together and solved it ourselves and she would come by and see how we were doing and she would correct us and tell us what we did wrong. I just thought it was a more productive way to learn. (Ty)

Interview participants also saw the value of working with students to learn mathematics outside of class. Many stated that although they do not really plan to study with other students, when they are working on something that they do not readily understand they look for other students in similar programs (usually in their dorms) to help them work through a problem.

> I have a math study group of people that are in my class, but they aren't really people that I met through the class, its just people that I knew before I came to school or I met because they live on the same floor as us or whatever, and then its like, oh, you're in my math class so let's study together. (Elaine)

> So usually I'll start off the year doing a lot of work independently and then we go more and more group-based throughout the year as we get more and more lazy and we don't want to do stuff on our own. Any individual work that you have done, you can use to help the other people through theirs and help them to understand it; and I really think that teaching other people how to do problems helps you more than it helps them. (Keenan)

Although study participants noted that discussing course material with other students outside of class is beneficial, they often did not take the time to work with other students to learn mathematics until right before homework was due or the night before an exam. They recognized that getting together with other students at the last minute was not very helpful, but they found that scheduling time to work with other students was difficult. Mia and Ty respond to a question about whether or not they study with other CMPS or ENGR students.

> Sometimes it depends 'cause everyone is so busy with all this other work. So sometimes people will work on it, you know, like Monday night before it is due… Before a test my friend and I actually, we review stuff. Like for the past test I was

> able to do note cards and we were reviewing that way and then doing practice problems and stuff. (Mia)

> Yes, I never really had a study group as such. We tried. I've studied with certain people on my floor, but then we kind of went different ways with classes and there's just different people in my classes. We just don't really schedule very well. (Ty)

First-year CMPS or ENGR students face many new challenges in managing academic time demands and utilizing the resources that are available to them to support their academic success. They make decisions about what to do when they are having difficulty with a concept, but their decisions do not always align with the ways they feel they learn best.

Assertion 3: Formally-organized, out-of-class interactions with undergraduates, TAs, faculty, and professors in CMPS and ENGR have a strong influence in helping students to connect with others in MSEC programs. Students report that this can influence their persistence in MSEC.

In describing various aspects of their programs, interview participants discussed a variety of ways that interacting with other people outside of their courses influenced their decisions to continue pursuing a degree in a MSEC field. Formally-organized ACPIs with other undergraduates provided students with a set of friends with whom they could take courses, study, work on projects, or expand their knowledge of and commitment to MSEC. One student described the structure of her Math Bridge course:

I mean, like having a regular class, like math or like chemistry or physics, it's a huge class and it's really hard for you to have any interactions with other people besides saying "excuse me" and stuff like that. Well, having a team [in Math Bridge], it sort of forces you to talk with other people and you have to say 'how are we going to solve this problem?' and you have to meet after class. (Sunni)

Oh, yea, well it [Mac Terps] was actually just forming and I had met a guy in Stamp and he was the president and he was actually at this school – I think he's computer science – and he was working with Apple. He asked me if I wanted to join with him when I was talking to him about Apples. Because I'm a UNIX developer 'cause it's the basis of the Apple operating system. So we were discussing that and he just said, 'well you should come to a meeting', and I just started going. (Richard)

Interactions with TAs, graduate students, or other faculty in CMPS or ENGR faculty outside of class provided students with a set of mentors who checked on their progress, directed them to various learning resources, and encouraged them to continue pursuing degrees in MSEC.

For me the [Math Bridge] program is really helpful, especially having a tutor who's an older person who's been in the program he encourages me to stick with it. (Ty)

I work in the Center of Minorities [in Science and Engineering] and so that's definitely been helpful because they've (the Center staff) just been nice people

> anyway. But I think just working with them I can talk to them any time I want more than I think I would if I didn't work there. But that's definitely been a big help because just knowing that there are people in that building that actually kind of care. I mean it's just nicer being able to go to people that I feel I can talk to more or maybe relate to more. I think that's the big thing. (Mia)

> For me being in Inventist and Society of Women Engineers really makes me stay within engineering especially 'cause with Inventis if you do research they say they'll pay you … that's incentive. And Society of Women Engineers gives me something to do and I really enjoy that, so it helps. (Elaine)

> 'Cause my teacher is also the coach for the Putnam math team and I kind of heard about that and wanted to try that out. So since I knew he was the professor and since he was kind of advocating for us to come to practice, I did that. So through that I saw him during the team practices and eat lunch with him and the rest of the team during the competitions. (Keenan)

Despite efforts of formally organized, university-sanctioned programs to support students' success and retention in CMPS and ENGR, students face other challenges that influence their decisions to persist in MSEC. Most of the students interviewed were concerned about the amount of time they were allowed to complete their programs. They explained that CMPS and ENGR program timelines are very strict and if you miss or fail a course it puts you behind and makes it more difficult to complete the program in the time allowed. Students discuss the challenges of meeting CMPS and ENGR program timelines:

> I was going to be behind, and I didn't really want to stay an extra semester or, for me, it would have been an extra year, so I think that's kind of added to me changing to a different major. (Lola)

> One thing, too is that the engineering classes are very compact; like how you have to, you're supposed to do this chemistry class this year; otherwise, you won't be able to do it next year, or you won't be able to be on track for your sophomore year. (Sunni)

> So, it's been pretty stressful, in terms of just trying to keep up with them telling me I'm a year behind, but I need to graduate in four years. So I said 'What if I don't make it in four years? How am I going to handle the situation?' They said 'Oh, well, we'll give you four and an half." So basically they are setting a limit. And I talked to my professors and advisors and they tend to tell me 'Well, if you take four and a half, that's ok', but they give me that limit. They're not saying if you extend the time, you'll be ok. It's pretty stressful. (Richard)

Although participants' views about the benefits of participating in formally organized, university-sanctioned programs are promising, efforts to attract students to these programs do not appear to have been effective for the population of students in this study. Descriptive analyses revealed that very few students engaged in formally organized out-of-class ACPIs, and; therefore, very few students would have an opportunity able to realize the benefits of connecting with other MSEC students through formally organized programs or experience other aspects of these programs that can influence students' academic achievement or persistence in MSEC.

There are many different aspects of first-year students' learning experiences that influence their academic success and persistence in CMPS and ENGR programs. The structure and pedagogy of the math lecture and recitation/discussion sections influence the types of opportunities students have to discuss mathematics in the classroom setting. This was apparent in the descriptive analyses that showed similar levels of participation in in-class ACPIs among students who were enrolled in the same fall 2004 math course, and was also evident in interview participants' descriptions of the types of ACPIs opportunities they perceived to exist in their fall 2004 math course. Unfortunately, many students also indicated that, because of the number of students in the class and the volume of material to be covered, there was limited opportunity to ask questions of the professor or of other students during lecture.

Students who had a recitation/discussion section or a smaller fall 2004 math course were able to engage in some valuable ACPIs with other students and had some opportunities to ask questions of the TA. Nevetheless, students in this study were often reluctant to ask questions of the professor or TA and despite the benefits of learning mathematics with other students that study participants identified, they had limited interactions with professors, TAs, and other undergraduates beyond the classroom. The analyses that examined the mean amount of time students spent participating in ACPIs with others showed low levels of study participants' ACPIs with professors and graduate students (or TAs) and corresponded with findings from the interview data. Moreover, descriptive and means analyses revealed low levels of participation in ACPIs with other undergraduates; therefore, study participants are primarily learning mathematics in isolation. This finding is particularly vexing because by learning math in isolation students are not gaining the benefit of learning from others or, as one student pointed out, learning from teaching mathematics to others.

Moreover, instead of asking questions of professors, TAs or other undergraduates, students in this study turned to the course textbook first as a primary resource to help them to understand a particular mathematical idea. While students are engaging in an active-learning activity by reading a math textbook, the textbook cannot always provide them with the information they need or explain a mathematical idea in a way that they can understand. According to participants in this study that was the greatest benefit of learning mathematics with other undergraduates; the other student can often see things and explain them in a way that another student can understand and that in many cases is more clear than explanations given by either professors or TAs.

Finally, there are additional opportunities for students to interact with other undergraduates, graduate students, faculty and professors in CMPS and ENGR in different ways outside of the classroom setting. Interview participants recognized that the things they do to learn mathematics and with whom they interact outside of the classroom influences their academic success and persistence in MSEC programs in different ways. However, formally organized, university-sanctioned programs have not been effective in attracting many of the first-year students in this study to their programs. Descriptive analyses revealed that students are just not participating in ACPIs as part of a formally organized, out-of-class activity. Thus, it becomes critical that these programs are able to determine a way to work with the time requirements of CMPS and ENGR programs and make participating in formally organized, university-sanctioned programs a natural part of students' learning experiences in undergraduate MSEC programs.

CHAPTER SIX: CONCLUSIONS

The purpose of this study was to examine the nature of students' experiences learning mathematics with peers through interactions that have an academic focus (academic-centered peer interactions, ACPIs), and how participation in these experiences in and outside of math classrooms (both formally and informally organized) relate to students' academic success in pre-calculus and calculus courses and their retention in undergraduate math, physical science, engineering, and computer science (MSEC) programs. This study was guided by Astin's theory of student involvement (Astin, 1993a, 1996, 1999) which asserts that "the amount of physical and psychological energy that the student devotes to the academic experience" in formal and informal contexts both in and outside the classroom are directly related to learning outcomes (Astin, 1996, p. 518). Moreover, because active learning inherently requires students to invest physical and psychological energy in the learning process, the theory of student involvement suggests that examining active involvement in the academic experience both in and outside of the classroom can be useful in trying to understand factors that influence students' affective and cognitive development. This study examined a specific categorization of active learning that involved students' experiences learning mathematics with other students in formally-organized and informally-organized contexts both in and outside of the classroom setting.

This concluding chapter discusses the major research findings of the study by research question and the relationship of these findings to previous research. These relationships; however, must be interpreted with caution because the terminology and methodological procedures of other studies were not always similar in nature to this study. This chapter concludes with a discussion of the implications of this research for undergraduate mathematics education and recommendations for future studies.

Research Question 1

1. What was the nature of students' involvement in ACPIs (i.e., In what types of, with what frequency, and with whom were students participating in ACPIs? What role did ACPI experiences play in students' perceptions of their academic performance and decisions to persist in undergraduate MSEC programs?)?

Descriptive Statistics and Correlation Analyses

In many ways the population of students who participated in this study fit the general profile of students who typically enroll in math- and science-based majors. A majority of the students were White/Caucasian males, there was an overrepresentation of Asian American/Asian students relative to the percent of Asian American/Asian students enrolled at the institution, there was an underrepresentation of African American/Black students, and SAT math scores of study participants were relatively high. Nevertheless, there were some notable characteristics of this population that may distinguish them from others. Almost 80% of the study participants aspired to obtain a master's degree and 40% aspired to earn a doctoral degree. This is of particular interest because of the small numbers of persons who hold advanced degrees in MSEC fields and the decreasing number of students aspiring to such degrees (Barton, 2002; National Center for Education Statistics, 2000). Through their math and science programs colleges and universities play an important role in preparing professionals in math- and science-based fields and have the ability to develop researchers and technologists who will lead this nation into the next era of scientific innovations and technological advances. That such a large percentage of students in this study aspired to obtain an advanced degree may reflect an increase in the number of future professionals in math- and science-based fields.

An additional distinctive characteristic of this study population was the absence of female students enrolled in Precal and the larger number of females (across race/ethnicity) who enrolled in an advanced math course (Cal 3+) during their first semester as an undergraduate (approximately one-third of the females in the sample). Descriptive statistics and correlation analyses revealed that female students, African American/Black students, and Hispanic/Latino students were more likely than other groups to have been enrolled in an advanced math course for fall 2004. This finding is significant because existing literature suggests that women and racial/ethnic minorities are often marginalized in K-12 mathematics education (Mau & Leitze, 2001; Rogers, 1992; Seymour & Hewitt, 1997), and racial/ethnic minorities are more likely to be academically underprepared for MSEC majors (NCES, 2001). That these groups of students were more likely to enroll in higher-level math courses is promising because it suggests that at least some women and racial/ethnic minorities may be receiving the academic and social supports in their K-12 education that help them to succeed in undergraduate mathematics courses. Moreover, an increase in the number of females and racial/ethnic minorities who excel in math- and science-based fields and obtain advanced degrees in these fields is a critical contribution that higher education must make to fulfill the needs of a more diverse and technologically advanced society (Barton, 2003; National Center for Education Statistics, 2000; National Science Foundation, 1996; Seymour & Hewitt, 1997).

In-Class ACPIs

Descriptive statistics and correlation analyses revealed that White/Caucasian students were more likely to participate in in-class ACPIs (r=.195**) while being Asian American/Asian, African American/Black or Hispanic/Latino was either not significantly related to the frequency of in-class ACPIs or was related to less frequent participation in in-class ACPIs. Additionally, being female was either not correlated or negatively correlated with the frequency of each of the in-class ACPIs. These findings were not surprising because existing research has shown that women and racial/ethnic minorities are often excluded from classroom discourse about mathematics (Alexander, et al, 1996; Fox & Soller, 2001; Kennedy & Parks, 2000; Linn & Kessel, 1996; Margolis & Fisher, 2002; Rosser, 1997; Seymour & Hewitt, 1997).

Another interesting finding was that participation in in-class ACPI experiences was related to the fall 2004 math course in which students enrolled. Specifically, students who enrolled in Cal 1 were more likely to participate in the thirteen in-class ACPIs (r=.404**) while students enrolled in other courses for the fall 2004 semester had either no correlation or a negative relationship with each in-class ACPI. Moreover, students enrolled in Cal 3+ were less likely to report participation in eleven out of the thirteen in-class ACPIs (r=-.329**). It was not surprising that being enrolled in Cal 1 was positively correlated with the frequency of in-class ACPIs because the recitation/discussion sections of these courses were designed to create those opportunities (see Bryant, 1998); however, it was surprising that students tended not to have these opportunities in the more advanced courses where there was a smaller student-teacher ratio.

Out-of-Class ACPIs

Formally-Organized ACPIs.

Neither race/ethnicity nor gender was correlated with the frequency of out-of-class ACPIs as part of a formally organized, university-sanctioned program; however, the fall 2004 math course in which students enrolled was related to their participation in certain formally-organized ACPIs. Students who enrolled in Precal for fall 2004 were more likely than students in other courses to engage in the following activities as part of a university-sanctioned program:

- "Reviewing math coursework or working on homework problems" (r=.144*),
- "Working on supplemental math problems" (r=.261**),
- "Receiving supplemental instruction or tutoring for math or science-based courses" (r=.269**), and
- "Reading math, science, engineering, or computer science textbooks" (r=.170*).

Being enrolled in Cal 1 or Cal 2 was not correlated with any formally-organized ACPI. However, being enrolled in Cal 3+ was negatively correlated with

- "Reviewing math coursework or working on homework problems" (r=-.239**),
- "Working on supplemental math problems" (r= -.151*),
- "Receiving supplemental instruction or tutoring for math or science-based courses" (r=-.183*), and
- "Reading math, science, engineering, or computer science textbooks" (r=-.174*).

These findings were not surprising because many formally organized, university-sanctioned programs that seek to recruit and retain students in math- and science-based programs target students who are considered at risk for dropping out of those programs.

Among the groups that are considered 'at risk' are students who are underprepared for math- and science-based programs. The percentage of students who begin their studies in Precal at the University of Maryland and go on to complete an undergraduate degree in a math- or science-based field is very low (D. Gulick, personal communication, February 11, 2005); therefore, students who were enrolled in Precal for fall 2004 were probably more likely to be invited to participate in formally-organized programs than students who enrolled in other math courses, and students who enrolled in Cal 3+ for fall 2004 were probably less likely to be invited to participate in formally-organized programs that target at-risk MSEC students.

Informally-Organized ACPIs.

White/Caucasian students and Hispanics/Latinos were the only two racial/ethnic groups that were positively correlated with any out-of-class ACPI variables. In particular, being White/Caucasian was positively correlated with "Attending math, science, engineering, or computer science lectures/seminars/social events," (r=.156*) and being Hispanic/Latino was positively correlated with reporting more frequent participation in "Tutoring or mentoring students for a math- or science-based course" (r=.187**) and "Reading math, science, engineering, or computer science textbooks" (r=.197**) In addition, White/Caucasian students were less likely than students in other racial ethnic groups (r=-.144*) to report engaging in out-of-class ACPIs by themselves, and Hispanics/Latinos was more likely to report interactions with other undergraduates (r=.244**) and with professors (r=.140*) outside of class than students in other racial/ethnic groups. Gender was not correlated with any informally organized, out-of-class ACPI.

Current research indicates that women and racial/ethnic minorities in math- and science-based majors are often excluded from some in-class learning activities that can lead to study groups with other students outside of class and are also often excluded from study groups formed outside of class (Alexander, Burda, & Millar, 1996; Fox & Soller, 2001; Frye-Lucas, 2003; Kennedy & Parks, 2000; Linn & Kessel, 1996; Margolis & Fisher, 2002; Rosser, 1997; Seymour & Hewitt, 1997). Therefore, it was expected that there would be differences by race/ethnicity and gender in the amount of time students spent participating in out-of-class ACPIs. It was not surprising that being Hispanic/Latino was positively correlated with engaging in some out-of-class ACPIs because Hispanics/Latinos are traditionally underrepresented in math- and science-based programs and are likely to be targeted by those who run formally organized, university-sanctioned programs that could lead to relationships among students that extend outside of formally organized activities. For the same reason it was surprising that being African American/Black or being female was not correlated with out-of-class ACPIs. This finding is particularly concerning because descriptive statistics showed that African American/Black students participated in informally organized, out-of-class ACPIs very infrequently. Additional research needs to explore factors that may be influencing African American/Black students' lack of participation in these activities. Descriptive statistics and correlation analyses suggest a possible explanation for female students' low involvement in out-of-class ACPIs. According to the findings from these analyses, female students' tended to report different experiences based on the fall 2004 math course in which they were enrolled; therefore, the level of female students' participation in out-of-class ACPIs may have been mediated by their fall 2004 math course enrollment.

Students who were enrolled in Precal for fall 2004 (all male) were more likely to indicate that they worked on supplemental math problems (r=.109**) and had more interactions with graduate students outside of class (r=.176*). Being enrolled in Cal 1 was positively related to:

- "Discussing how to succeed in math- or science-based majors" (r=.166*),
- "Discussing careers in math, science, engineering, or computer science" (r=.157*),
- "Participating in math- or science-based internship or externship experiences" (r=.139*), and
- "Attending meetings for math, science, engineering, or computer science organizations" (r=.198**).

Being enrolled in Cal 2 was negatively correlated with "Discussing careers in math, science, engineering, or computer science" (r=-.184**), and being enrolled in Cal 3 was positively related to "Working on math- or science-based research projects" (r=.242**) and negatively correlated with:

- "Working on supplemental math problems" (r=-.204**),
- "Receiving supplemental instruction or tutoring for math or science-based courses" (r=.217**), and
- "Discussing how to succeed in math- or science-based majors" (r=-.188**).

Students who enrolled in Precal or Cal 1 for fall 2004 were more likely than students who enrolled in Cal 2 or Cal 3+ to participate in formally organized, university-sanctioned activities that provided opportunities for academically-centered interactions outside of the classroom setting. This finding was not surprising because students in Precal and Cal 1 are more likely than other students to be targeted by those who run formally organized, university-sanctioned programs. "Working on math- or science-based research projects" is a particular type of ACPI that is typically offered to students who are interested in pursuing graduate degrees in MSEC fields (Kardash, 2000); therefore, it was not surprising that students who enrolled in Cal 3+ were more likely to participate in this type of ACPI.

These findings suggest relationships between students' in-class learning experiences and their learning experiences outside of class. This is important because scholars assert that students' academic success and retention in undergraduate education is influenced by a combination of factors both in and outside of the classroom setting (Astin 1996; 1999; Pascarella & Terenzini, 1991; Terenzini et al., 1995; Whitt et al., 1999). Understanding relationships between students' learning and academic outcomes can provide valuable information that can be used by undergraduate MSEC faculty and administration to enhance students' learning experiences in both settings and support their academic success and retention in math- and science-based programs.

Research Question 2

2. Is there a statistically significant difference in the amount of time students spent involved in ACPIs when examined in terms of race/ethnicity, gender, and ability (determined by students' fall 2004 math course)? Does this vary by the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students)?

In-Class ACPIs

ANOVAs and multiple comparisons conducted to examine relationships between race/ethnicity, gender, and fall 2004 math course and the composite factors representing in-class ACPIs, out-of-class formally organized ACPIs, and out-of-class informally organized ACPIs revealed that White/Caucasian students spent significantly more time participating in in-class ACPIs than Asian Americans/Asians; however, no other statistically significant differences by race/ethnicity were identified in the mean amount of time that students spent participating in in-class ACPIs. Additionally, there were no statistically significant differences in the mean amount of time male and female students participated in in-class ACPIs. These results did not reflect differences by race/ethnicity or gender that were identified in the descriptive statistics and correlation analyses. However, descriptive statistics and correlation analyses revealed that students in different racial/ethnic groups participated in certain in-class ACPIs more than others. Because the composite factors represent general participation in in-class ACPIs, ANOVA analyses involving the composite factors do not reflect differences in students' participation in particular in-class ACPIs. Therefore, this finding was not surprising. For similar reasons, it was also not surprising that ANOVA and multiple comparison analyses did not reveal differences in the mean amount of time male and female students participated in in-class ACPIs.

ANOVAs and multiple comparisons indicated differences in students' in-class ACPI experiences based upon the fall 2004 math course in which students enrolled. Results showed that students who enrolled in Precal for fall 2004 spent significantly more time engaging in in-class ACPIs compared to students who enrolled in Cal 3+, students in

Cal 1 spent statistically significantly more time engaging in in-class ACPIs compared to Cal 2 students, and students in Cal 1 spent more time participating in in-class ACPIs compared to Cal 3+. These findings aligned with results of descriptive statistics and correlation analyses that showed more consistency in the mean amount of time students participated in in-class ACPIs by fall 2004 math course. Because math courses can have different structures and instructors have varied expectations and pedagogical styles, differences in students' in-class experiences by fall 2004 math course were anticipated. These findings were also consistent with existing literature suggesting that the number and types of opportunities students have to participate in active-learning activities during a math class are related to the structure and pedagogy of the course (Couco, Goldenberg, & Mark, 1996; Davidson, 1971; Ganter, 2001; Holton, 2001; Legrand, 2001; Mau & Letize, 2001; Millett, 2001; Wahlberg, 1997; Weissglass, 1993; Yackel & Cobb, 1996).

Out-of-Class ACPIs

With the exception of showing that African American/Black students spent significantly less time participating in out-of-class informally organized ACPIs than Hispanic/Latino students, ANOVA and multiple comparison analyses did not reveal any significant differences in the mean amount of time students participated in out-of-class formally organized ACPIs or out-of-class informally organized ACPIs by race/ethnicity, gender, or ability (determined by fall 2004 math course). That differences were identified in the mean amount of time African American/Black students and Hispanic/Latino students spent in out-of-class informally organized ACPIs must be interpreted with caution because of the small sample sizes (12 and 13, respectively) may result in exaggerated differences. Additional research with larger samples is necessary to determine whether these differences are real.

Research Question 3

3. Is the amount of time students spent involved in ACPIs a statistically significant predictor of fall 2004 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

The blocked hierarchical linear regression analysis that was used to examine whether race/ethnicity, gender, or ability (determined by students' fall 2004 math course) and ACPI experiences (i.e., the frequency and type of ACPIs in which students were involved or the persons who participate in the ACPIs) were useful in explaining the variance in first-year students' fall 2004 math course grades revealed that two blocks of variables produced statistically significant changes in the R^2 of fall 2004 math course grades. The model that included race/ethnicity, gender, SAT math score, and fall 2004 math course accounted for 15.5% of the variance in students' fall 2004 math course grades, and showed that being classified as Other Race/Ethnicity, being enrolled in Precal for fall 2004, or being enrolled in Cal 2 for fall 2004 were statistically significant predictors of fall 2004 math course grade. In particular, the mean fall 2004 math course grade for students who were categorized as Other Race/Ethnicity was statistically significantly higher (mean=3.40, p=.049, β=.145) than for White/Caucasian students (mean=2.82), students in Precal (all male) had a statistically significantly lower mean fall 2004 math course grade (mean=2.07, p=.000, β=-.379) than students enrolled in Cal 3+ for fall 2004 (mean=3.26), and students in Cal 2 had a statistically significantly lower fall 2004 math course grade (mean=2.57, p=.008, β=-.241) than students who enrolled in Cal 3+ for fall 2004 (mean=3.26). Gender and SAT math score were not statistically significant predictors of fall 2004 math course grades. ACPI variables were not included in this block.

The model that included race/ethnicity; gender; SAT math score; fall 2004 math course; in-class ACPIs; formally organized, out-of-class ACPIs; informally organized, out-of-class ACPIs; the number of ACPIs students participated in by themselves; the number of ACPIs students participated in with other undergraduates; the number of ACPIs students participated in with graduate students or TAs; and the number of ACPIs students participated in with professors accounted for 17.8% of the variance in students' fall 2004 math course grades. Being categorized as Other Race/Ethnicity, being enrolled in Precal for fall 2004, or being enrolled in Cal 2 for fall 2004 were the only variables that were statistically significant predictors of fall 2004 math course grades. The mean fall 2004 math course grade for students who were categorized as Other Race/Ethnicity was statistically significantly higher (mean=3.40, p=.043, β=.145) than for White/Caucasian students (mean=2.82), students in Precal (all male) had a statistically significantly lower mean fall 2004 math course grade (mean=2.07, p=.000, β=-.379) than students enrolled in Cal 3+ for fall 2004 (mean=3.26), and students in Cal 2 had a statistically significantly lower mean fall 2004 math course grade (mean=2.57, p=.006, β=-.241) than students who enrolled in Cal 3+ for fall 2004 (mean=3.26). Results of post hoc analyses did not indicate differences in mean fall 2004 math course grade by race/ethnicity. Findings related to Other Race/Ethnicity must be interpreted with caution because the small number of students categorized as Other Race/Ethnicity (11) may have exaggerated differences in fall 2004 math course grades when compared to other students.

Gender, SAT math score, and ACPI experiences were not statistically significant predictors of fall 2004 math course grade for MSEC students. Post hoc analyses revealed no significant difference in the mean fall 2004 math grades for males and females (2.79 and 2.98, respectively); therefore, it was not surprising that gender did not predict fall 2004 math grade. Descriptive statistics showed that the SAT math scores of study participants were relatively high (mean=696); therefore, it was expected that SAT math score did not predict fall 2004 math course grade. The fact that none of the ACPI variables were significant predictors was somewhat surprising. Results of descriptive statistics, correlation analyses, and ANOVA analyses suggested differences in students' ACPI experiences by race/ethnicity, gender, and ability (determined by fall 2004 math course) and those differences were expected to explain a significant amount of the variance in students' fall 2004 math course grades. Nevertheless, the ability of ACPI experiences to predict students' fall 2004 math course grades may have been limited by low levels of participation in ACPIs. In addition, composite factors were useful for reducing the number of ACPI variables that were included in the regression models, but may have muffled relationships between specific ACPIs and fall 2004 math course grade. These findings suggest a need for additional research with larger samples to look more closely at the relationship between students' level of participation in ACPIs and their relationship to first semester math course grades. Examining relationships between students' learning experiences both in- and outside of class and academic outcomes is particularly important because existing research suggests that what students do in and outside of class can influence their academic performance (Astin, 1996, 1999; Pike, 1999; Terenzini et al., 1995; Treisman, 1985).

Research Question 4

4. Is the amount of time students spent involved in ACPIs a statistically significant predictor of spring 2005 math course GPA for MSEC students? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

A blocked hierarchical linear regression analysis was conducted to determine whether race/ethnicity, gender, and ability (determined by fall 2004 math course) and ACPI experiences (i.e., the frequency and type of ACPIs in which students were involved or the persons who participate in the ACPIs) were useful in explaining the variance in first-year students' spring 2005 math course grades.

The model that included race/ethnicity, gender, SAT math score, and fall 2004 math course accounted for 11.3% of the variance in students' spring 2005 math course grades and showed that being enrolled in Precal for fall 2004, being enrolled in Cal 1 for fall 2004, or being enrolled in Cal 2 for fall 2004 were statistically significant predictors of spring 2005 math course grades. In particular, students who enrolled in Cal 3+ for fall 2004 had a statistically significantly higher mean spring 2005 math course grade (mean=3.38) compared to students who enrolled in Precal (all males) for fall 2004 (mean=2.46, p=.002, β=-.308), students who enrolled in Cal 1 for fall 2004 (mean=2.64, p=.006, β=-.294), and students who enrolled in Cal 2 for fall 2004 (mean=2.80, p=.077, β=-.164). Gender, race/ethnicity, and SAT math score were not significant predictors of spring 2005 math course grades. ACPI variables were not included in this block.

The model that included race/ethnicity, gender, SAT math score, fall 2004 math course, in-class ACPIs, formally organized, out-of-class ACPIs, informally organized, out-of-class ACPIs, who else was involved in the ACPI, fall 2004 math course grades, and spring 2005 math course accounted for 21.8% of the variance in students' spring 2005 math grades. Being enrolled in Precal for spring 2005 was a statistically significant predictor of spring 2005 math course grades. Students who enrolled in Precal for spring 2005 (all male) had a statistically significantly lower mean spring 2005 math course grade (mean=1.25, p=.010, β=-.5.19) than students enrolled in Cal 3+ for spring 2005 (mean=3.17).

Gender, race/ethnicity, SAT math score, ACPI experiences, and fall 2004 math course grades were not statistically significant predictors of spring 2005 math course grade for study participants. Post hoc analyses revealed no significant difference in mean spring 2005 math grades for males and females (2.72 and 2.98, respectively), or by race/ethnicity; therefore, it was not surprising that gender and race/ethnicity did not predict fall 2004 math grade. Because students' SAT math scores were relatively high (mean=696) it was expected that SAT math score would not predict spring 2005 math course grade. Students' were surveyed about their ACPI experiences early during the spring 2005 semester and their ACPI experiences may have changed over the course of the semester due to different course strucutures or requirements, changes in students' level of participation in formally organized, university-sanctioned programs, changes in time management skills, or changes in students' study habits; therefore, the ACPI experiences that students reported may not reflect their ACPI experiences for the spring 2005 semester. Because it can be a measure of ability, it was somewhat surprising that fall 2004 math course grades did not predict students' spring 2005 math course grades. Nevertheless, many factors (e.g., course material, pedagogical style, amount of student effort) influence students performance in any math course and can vary greatly.

Research Question 5

5. Is the amount of time students spent involved in ACPIs a statistically significant predictor of retention of first-year students in MSEC programs from the fall 2004 to the fall 2005 semester (determined by fall 2005 major and course enrollment)? Does the effect of participation in ACPIs vary by (a) race/ethnicity, gender, or ability (determined by students' fall 2004 math course); (b) the type of ACPIs in which students were involved (i.e., in class; formally organized, university-sanctioned; informally organized by students); or (c) who else was involved in the ACPI (i.e., undergraduate students, graduate students, professors)?

Results of the regression analysis that examined the role of race/ethnicity, gender, ability (determined by fall 2004 math course), and ACPI experiences in predicting students' fall 2004 to fall 2005 retention revealed that combinations of these variables did not account for a statistically significant amount of the variance in students' retention in MSEC from fall 2004 to fall 2005. This finding was surprising because it does not align with previous research that suggests that students' participation in active-learning activities (in and outside of class) is positively related to their retention in undergraduate math- and science-based programs (Alexander et al., 1996; Asera, 2001; Duncan & Dick, 2000; Grandy, 1998; Moreno & Muller, 1999; Zunkel, 2002). Nevertheless, descriptive statistics revealed that almost 86% of students in the sample were retained from fall 2004 to fall 2005; thus, there was very little variance in students' fall 2004 to fall 2005 retention (standard deviation=.352) for the regression model to explain. Therefore, the ability of the model to explain the variance in students' fall 2004 to fall 2005 retention was very limited.

Findings from Qualitative Analyses

Three assertions about the nature of students' experiences learning mathematics with others were made based on findings from the interviews with the students.

Assertion 1: When students struggle with learning mathematics their primary resource is the course text.

The students in this study relied heavily on the course textbook as a primary resource for learning mathematics. Instead of turning to their professor, a TA, or another undergraduate to help them learn mathematics, students turned to the textbook for additional notes and problem examples. Students chose to study with other undergraduates usually right before an assignment was due or right before an exam; thus, many students were learning math in isolation outside of the classroom setting.

Reading is a form of active learning that involves students in doing things and in thinking about the things that they are doing that can lead to the creation of new mental structures (Biggs & MacLean, 1969; Bonwell & Eison, 1991; Meyers & Jones, 1993) and that causes students to devote physical and psychological energy to the academic experience. However, Astin asserts that of the three forms of involvement that have the greatest influence on cognitive and affective outcomes, academic involvement; involvement with faculty; and involvement with peers, involvement with peers has the most powerful influence on students' academic and personal development (Astin, 1993a, 1996, 1999). Because most students are learning math in isolation, they are missing out on cognitive and affective benefits of working with other students. Furthermore, while many of the formally organized, university-sanctioned programs that seek to recruit and retain students in math- and science-based programs provide students with supplemental instruction on mathematics content and teach them study and time management skills (College Board, 1999), these programs do not provide students with instruction on how to read a math or science textbook. Developing skills for reading math and science textbooks seemed critical for the students in this study because the textbook was such an important resource to help them understand course material. Clearly, teaching students how to read math and science textbooks will not guarantee their academic success or retention in MSEC, but it can help them use the textbook as a resource more effectively.

Assertion 2: Students recognize the benefit of learning mathematics with other students both in- and outside of class, but they do not do it outside of class!

Interactions among students during class were limited to opportunities that resulted from how the instructor structured the course. However, opportunities for interactions among students outside of class were largely left up to the students themselves. Students said that when they had a question about mathematics other students were often able to relate to the difficulty they were having and give an explanation that they could understand. They also said that when they explained mathematics to other students it helped them to develop a better understanding of the material. Nevertheless, students complained that time was a barrier to interacting with other students outside of class. Students said their programs were very demanding because of the amount of material they had to study for each class. They explained that it was difficult to schedule time to get together with other students outside of class because everyone had so much work to do and had such different schedules. Hence, often it was not until right before an assignment was due or the night before an exam when they would find time to get together.

Existing research suggests that interactions among students during class and outside of class can positively influence students' academic achievement and persistence in undergraduate MSEC programs (Fries-Britt, 1998; Treisman, 1985, 1992; Zunkel, 2002). While some students in this study interacted with other students during class many of them did not spend time learning mathematics with their peers outside of class. There was some evidence that students who were enrolled in courses that offered them structured opportunities to learn mathematics together during class also continued to engage in these similar activities outside of class. Moreover, students indicated that being involved in a formally organized, university-sanctioned program also encouraged them to learn mathematics with other students outside of class. Nevertheless, a large majority of the students in this study had very limited interactions with other students outside of class; and, as a result, many of them learned math in isolation outside of class. Unfortunately, studies have shown that working in isolation has disproportionately negative effects on women and racial/ethnic minorities in MSEC which contributes to them switching out of these majors (Seymour & Hewitt, 1997; Treisman, 1985, 1992).

Assertion 3: Formally-organized, out-of-class interactions with undergraduates, TAs, faculty, and professors in CMPS and ENGR have a strong influence in helping students to connect with others in MSEC programs. Students report that this can influence their persistence in MSEC.

Once a student chooses an undergraduate MSEC major most of their courses are designed to prepare them for careers particular to that major. However, many students indicated on the *MSEC ACPI Experiences Survey* and during interviews that they were also interested in other areas within MSEC. The students who were interviewed described how their participation in formally organized, university-sanctioned programs helped then to explore some of these interests. As a result several students indicated that they became involved in math- and science-based clubs or joined a residential learning community that was geared for students in another MSEC program. Students indicated that their participation in these activities helped them develop relationships with other students with similar interests, graduate students and professors in MSEC, and exposed them to professionals who were working in math- and science-based fields.

Previous research suggests that it is beneficial for first- and second-year students in undergraduate MSEC programs in general, and for women and racial/ethnic minorities in particular, to interact with immediate and more advanced peers in MSEC and MSEC faculty who can provide students with social and academic support that can positively influence students' academic achievement and degree persistence (Alexander et al., 1996; Duncan & Dick, 2000; Eisenberg & Browne, 1973; Grandy, 1998; Lazar, 1993; Moreno & Muller, 1999; Treisman, 1985, 1992; Wheatland, 2000; Wine & Cooper, 1985; Zunkel, 2002). Students in this study concurred that their interaction with these people influenced their decisions to persist in MSEC. Mia described her relationship with the MSEC faculty in one formally organized program:

> I work in the Center of Minorities [in Science and Engineering] and so that's definitely been helpful because they've (the Center staff) just been nice people anyway. But I think just working with them I can talk to them any time I want more than I think I would if I didn't work there. But that's definitely been a big help because just knowing that there are people in that building that actually kind of care. I mean it's just nicer being able to go to people that I feel I can talk to more or maybe relate to more. I think that's the big thing. (Mia)

Conclusions and Implications

Results of this study provided evidence that students have different experiences learning mathematics in-class and outside-of-class by race/ethnicity, gender, and ability (determined by fall 2004 math course). Descriptive statistics and correlation analyses revealed that in both of these contexts fall 2004 math course had the strongest relationship to students' level of participation in ACPIs. Additional research is needed to further explore relationships between the structure of students' precalculus or calculus math course and the pedagogical practices incorporated into those math courses and the types and frequency of students' participation in in-class ACPIs. Research should consider whether students within the same math class have different perceptions (or whether the differences are real behaviorally) of the types and frequency of active-learning opportunities available to them during class. Future research also needs to look more closely at specific ACPI activities and their relationship to race/ethnicity, gender, and ability to determine whether groups of students are engaging in certain types of ACPIs rather than others and examine reasons behind their lack of participation in particular activities. The studies will be important because they can help to provide mathematics educators with a better understanding of how to meet the needs of a diverse body of students in undergraduate math courses and provide professors and TAs with information that can help them actively engage their students in the learning of mathematics.

Because of large number of ACPI variables, the small sample size, and in order to calculate reliabilities, a factor analysis was conducted to identify composite factors that were used to examine relationships between engaging in in-class ACPIs; out-of-class, formally organized ACPIs; and out-of-class, informally organized ACPIs and students' academic achievement in mathematics and retention in MSEC after their first year. ANOVA and multiple comparison analyses revealed differences in students' participation in in-class ACPIs by race/ethnicity and ability (determined by fall 2004 math course). Regression analyses revealed that the math course in which students enrolled for the fall 2004 semester and for the spring 2005 semester was predictive of students' fall 2004 and spring 2005 math course grades. Students' level of participation in ACPIs did not predict their academic achievement in mathematics for fall 2004 or spring 2005 and also did not predict students fall 2004 to fall 2005 retention in undergraduate MSEC programs. Additional research is needed that look more closely at specific ACPI activities and their relationship to educational outcomes to determine whether participation in certain types of ACPIs influence students' academic success and retention in different ways.

While the results of the qualitative part of this study are not generalizable, they do provide important insights into students' learning experiences during their first year of undergraduate study in a math- or science-based program. Additional qualitative inquiry is needed to explore reasons why students' behaviors may not align with their perceptions of ways to support their academic success. In particular, research is needed to determine why students choose not to study or learn mathematics with other undergraduates when they identify working with other undergraduates as beneficial to their understanding of mathematics. Clearly, the resources that students use to enhance their learning of mathematics, the academic-centered interactions among MSEC students', and the relationships students have with other MSEC students, graduate students/TAs, faculty, and professors as part of formally organized, university-sanctioned program all play an important role in students' academic success and retention in undergraduate math- and science-based programs.

Recommendations

Critics of higher education have called for a new learning paradigm for higher education that requires shared responsibility for learning among students and between faculty and students rather than one which filters out students based on their deficiencies (Johnson et al., 1991). The students in this study appear not to have developed a partnership for learning with other MSEC undergraduates, TAs, or professors like that called for by Johnson and colleagues. They rarely sought assistance when they had a question during class and had very limited interaction with others outside of class. Students admitted being reluctant to ask questions of their professors during class because they were acutely aware of the limited amount of class time available to cover course material and often felt that their questions were not worthy of taking up class time. Outside of class students complained that professors and TAs were not very receptive to answering their questions, and instead, expected students to figure things out on their own. While it is clear that students should take on more responsibility for their learning in undergraduate mathematics education, MSEC professors and TAs should find ways to support student learning and to encourage students to take on a more active role in the learning process.

Although students stated that they thought that learning mathematics with other undergraduates was beneficial, they said that limited time was a barrier to getting together with other undergraduates outside of class. As a result they tended to turn to the book as their primary resource for learning mathematics. While undergraduate MSEC programs can be time intensive, students' need to use the resources available to them and one of their greatest resources is their peers. Students spend more time with other undergraduates in class and outside of class than they do with professors, TAs, or other graduate students. As students in this study indicated, other undergraduates seemed to understand the challenges that they have in learning mathematics and are often better than professors or TAs in explaining a problem in a way that they can understand. Many universities support formally organized programs that are designed to recruit and retain students in undergraduate MSEC programs by providing mentoring, academic support, and psychosocial support (Gandara & Maxwell-Jolly, 1999). While these efforts are laudable, it is also important for programs to create specific structured opportunities to encourage undergraduates to learn mathematics with each other (Treisman, 1985, 1992). Because the course text can be a critical academic resource for students, formally organized, university-sanctioned programs should also provide students with instruction on how to read and effectively use a math- or science-based textbook.

This study is important because it described the nature of students' experiences learning math with peers both in and outside of the classroom and explored relationships between these experiences and students' mathematics achievement and retention in undergraduate MSEC programs from the beginning of their first semester through the fall semester of their second year. It increased understanding of students' learning experiences during undergraduate mathematics education and filled gaps in the literature regarding similarities and differences in students' learning experiences based on race/ethnicity, gender, ability, the frequency and types of ACPIs in which students participate, and who is involved in the ACPIs, and the relationships between these variables and students' academic success in mathematics and retention in undergraduate math- or science-based programs. This study provided information about students' learning experiences that can be valuable to undergraduate math and math education faculty and university administrators who are interested in improving undergraduate mathematics education.

The findings of this research suggest the need for further research on students' experiences in undergraduate mathematics education. Both quantitative and qualitative data suggested that students experience in-class ACPIs in different ways and have different levels of participation in various out-of-class ACPIs. Future studies should look more closely at these experiences to understand some of the factors influencing these differences.

Researcher's Final Reflections

This research project was a very personal journey for me. As an undergraduate I was one of five female students who majored in mathematics at a Historically Black University. At that time I was aware that my experiences and the learning experiences of the other female students in my cohort were different from that of our male counterparts. Those experiences framed my identity as a female in a math- and science-based field. It was not until I enrolled in my first graduate course in mathematics at a Predominantly White Institution that I became more acutely aware of how my learning experiences differed from male students and students of other racial/ethnic backgrounds. I began this work because I was particularly interested in understanding more about other students' learning experiences and the role that race/ethnicity and gender play in those experiences. Through this work I learned a little bit about these aspects of undergraduate students' experiences in math- and science-based programs, and I am excited about future opportunities to study larger and more diverse populations of students and to look more closely at active learning opportunities.

Completing this study caused me to grow both personally and professionally. I have developed a better sense of the immense responsibility of undergraduate professors and teaching assistants. Not only are we charged to provide students with information, we must also give them the tools that will help them to continue to expand their knowledge and understanding of mathematics beyond our courses. I have also been empowered to continue this work on a more practical level in the mathematics courses that I teach for pre-service teachers. It may be even more important for pre-service teachers to be actively engaged in the learning of mathematics because of the influence it can have on their own teaching of mathematics.

APPENDICES

Appendix A: IRB Application

UNIVERSITY OF
MARYLAND

INSTITUTIONAL REVIEW BOARD

2100 Lee Building
College Park, Maryland 20742-5121
301.405.4212 TEL 301.314.1475 FAX

To:	Dr. Jeffrey Milem Kadian Howell Department of Education Policy and Leadership
From:	Roslyn Edson, M.S., CIP IRB Manager University of Maryland, College Park
Re:	Application Number and Project Title: 04-0546; "First-Year MSEC ACPI Experiences"
Approval Date:	January 6, 2005
Expiration Date:	January 6, 2006
Type of Application:	New Project
Type of Review For Application:	Expedited

The University of Maryland, College Park Institutional Review Board (IRB) approved your IRB application. The research was approved in accordance with 45 CFR 46, the Federal Policy for the Protection of Human Subjects, and the University's IRB policies and procedures. Please reference the above-cited IRB application number in any future communications with our office regarding this research.

Recruitment/Consent: For research requiring written informed consent, the IRB-approved and stamped informed consent document is enclosed. The IRB approval expiration date has been stamped on the informed consent document. Please keep copies of the consent forms used for this research for three years after the completion of the research.

Continuing Review: If you want to continue to collect data from human subjects or analyze data from human subjects after the expiration date for this approval, you must submit a renewal application to the IRB Office at least 30 days before the approval expiration date.

Modifications: Any changes to the approved protocol must be approved by the IRB before the change is implemented except when a change is necessary to eliminate apparent immediate hazards to the subjects. If you want to modify the approved protocol, please submit an IRB addendum application to the IRB Office.

(continued)

Unanticipated Problems Involving Risks: You must promptly report any unanticipated problems involving risks to subjects or others to the IRB Manager at 301-405-0678 or redson@umresearch.umd.edu.

Student Researchers: Unless otherwise requested, this IRB approval document was sent to the Principal Investigator (PI). The PI should pass on the approval document or a copy to the student researchers. This IRB approval document may be a requirement for student researchers applying for graduation. The IRB may not be able to provide copies of the approval documents if several years have passed since the date of the original approval.

Additional Information: Please contact the IRB Office at 301-405-4212 if you have any IRB-related questions or concerns.

Informed Consent Form

Project Title:	First-Year MSEC ACPI Experiences Focus Group Interview
Statement of Age:	I state that I am over 18 years of age and wish to participate in the program of research being conducted by Dr. Jeffrey F. Milem and Kadian M. Howell in the College of Education at the University of Maryland, College Park, MD 20742
Purpose:	This study examines the nature of first-year students' experiences learning mathematics with peers and how participation in these experiences (both in and outside of class) relate to students' academic achievement in precalculus or calculus courses and their retention in math-based programs. The results of this study will provide valuable information about the learning experiences, achievement, and retention of undergraduate students in math-based majors. Your participation is important to us; but it is voluntary and you do not have to answer questions that make you feel uncomfortable.
Procedures:	Participation in this aspect of the study involves being interviewed along with other students by researchers from the University of Maryland. The interview will last approximately 1 ½ hours. Interview questions will explore the nature of students' learning experiences and the sense that they make of these experiences. It will also examines the role of race/ethnicity, gender, and ability in students' experiences learning math with peers and how these experiences influence students' decisions to continue pursuing a degree in a math- or science-based field. Notes will be written during the interview. An audiotape of the interview and subsequent dialogue will be made. If I don't want to be taped, I will not be able to participate in the focus groups. All audiotapes and transcripts will be kept in locked storage and only the researchers will have access to the data. **Audiotapes will be destroyed five years after the focus group interviews have been conducted**.
Confidentiality:	I understand that the researchers will not identify me by name in any reports using information obtained from this interview, and that my confidentiality as a participant in the study will remain secure. Subsequent uses of records and data will be subject to standard data use policies that protect the identity of individuals and institutions.
Risks:	Participation in this study poses no risk greater than that posed by everyday life.

This is page 1 of 2: Initial here

Benefits:	I understand that there are no direct benefits to students who participate in this study. The purpose of the study is to learn more about students' experiences learning mathematics during the first year of undergraduate study and how interacting with others influences these experiences.
Freedom to Withdraw, & Ask Questions:	My participation in this study is voluntary and I understand that I am free to ask questions or withdraw from participation at any time without penalty and without loss of benefits to which I am otherwise entitled. Declining to participate in the study will not influence my grades or standing in my courses, program, or the University.
Contact Information Of Investigators:	If you have any questions or concerns regarding your participation in this study, please contact Professor Jeffrey F. Milem, 2205 Benjamin Building, University of Maryland, College Park, MD, 20742; (e-mail) Email: jfmilem@umd.edu; (telephone) 301-405-2875 or Kadian M. Howell, Doctoral Fellow, Mid-Atlantic Center for Mathematics Teaching and Learning, 2311 Benjamin Building, University of Maryland, College Park, MD 20742 (e-mail) kmhowell@wam.umd.edu; (telephone) 410-992-9518.
Contact Information Of Institutional Review Board:	If you have questions about your rights as a research subject or wish to report a research-related injury, please contact: **Institutional Review Board Office, University of Maryland, College Park, MD, 20742; (e-mail) irb@deans.umd.edu; (telephone) 301-405-4212**

By signing this consent form, I indicate that I have read and understand the explanation provided above. I agree that I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study and that I have been given a copy of this consent form.

_________________________ My Printed Name	_________________________ Date
_________________________ My Signature	_________________________ Signature of the Investigator

This is page 2 of 2

IRB APPROVED
VALID UNTIL
JAN - 6 2006
UNIVERSITY OF MARYLAND
COLLEGE PARK

Appendix B: Email Invitation

Memorandum:

TO: CMPS and Engineering Students in the Entering Class of 2004

FROM: Denny Gulick, Associate Chair of Undergraduate Studies
Kadian M. Howell, Doctoral Student in Math Education

RE: We Need You to Participate in a Research Study

We are writing to request your participation in a questionnaire that investigates first-year CMPS and Engineering students' experiences learning mathematics with others, both in and outside of the classroom setting. This study is important because the information it provides can be used to improve students' undergraduate experiences in math-based programs.

This study is not tied to a particular math course and therefore does not affect your grade in any math course. Your responses will be kept confidential, and no information that would allow you to be personally identified will be released.

EVERYONE WHO COMPLETES THE SURVEY WILL BE ENTERED INTO A LOTTERY TO WIN ONE OF FIFTEEN CASH PRIZES OF $50. Lottery selections will occur in March 2005 and selected students will be notified via email by March 31, 2005. At a later date, you may also be contacted and asked to participate in a 90-minute focus group to discuss your experiences learning mathematics. Food will be provided for focus group sessions.

I recognize that this request comes at a busy time for you, but I ask that you to take the 15 minutes I estimate that it will take you to complete this 4-page survey. Please complete the survey as soon as possible.
To make your participation a little easier, you can follow this link to access the survey or simply enter this URL into a web browser:

https://www.surveymonkey.com/s.asp?u=66251814914

Thank you in advance for your cooperation.

If you have any questions about the study, please contact the study director:
Kadian M. Howell, Doctoral Student
Mid-Atlantic Center for Mathematics Teaching and Learning
College of Education, UMCP
410.992.9518 TEL 301.314.9055 FAX
kmhowell@wam.umd.edu

Appendix C: Instrumentation

Electronic MSEC ACPI Experience Survey

Informed Consent Form
Project Title: First-Year MSEC ACPI Experiences Survey

Statement of Age: I state that I am over 18 years of age and wish to participate in the program of research being conducted by Dr. Jeffrey F. Milem and Kadian M. Howell in the College of Education at the University of Maryland, College Park, MD 20742.

Purpose: This study examines the nature of first-year students' experiences learning mathematics with peers and how participation in these experiences (both in and outside of class) relate to students' academic achievement in pre-calculus or calculus courses and their retention in math-based programs. The results of this study will provide valuable information about the learning experiences, achievement, and retention of undergraduate students in math-based majors. Your participation is important to us; but it is voluntary and you do not have to answer questions that make you feel uncomfortable. Thank you in advance for your assistance in this important work.

Procedures: I understand that the procedures of this study involve completing the electronic MSEC ACPI Experiences Survey that follows this consent form. The MSEC ACPI Experience Survey asks questions about my experiences learning mathematics with other students both in and outside of classroom settings. I understand that it will take me approximately 15 minutes to complete this survey. I understand that the unique identifier that I provide as my electronic signature (either my University ID (UID), Directory ID (LDAP), or Student ID (SID)) will be used only for the purpose of linking my responses to other academic data kept in institutional databases. Academic data that will be collected includes my math SAT or ACT score; high school GPA; fall 2004 major, math course enrollment, and math grades; spring 2005 math course enrollment and math grades; and fall 2005 major and course enrollment. The data I provide will be grouped with data others provide for reporting and presentation and neither my name nor other personally identifiable information will be included. At the end of the survey, I will be asked to indicate my willingness to participate in focus group interviews during April 2005. If I agree, I will be included in the pool of participants who may be invited to attend one of the focus group interview sessions.

Confidentiality: I understand that my responses are strictly confidential. I also understand that after all data have been merged my name and unique identifier will be removed from the data set. All data will be kept in locked storage and only the researchers will have access to the data.

Risks: Participation in this study poses no risk greater than that posed by everyday life.

Benefits: I understand that the study is not designed to help me personally. However, I understand that by completing the survey I will be entered into a lottery to receive one of fifteen $50.00 cash prizes. Lottery selections will occur in March 2005 and selected students will be notified via email by March 31, 2005.

Freedom to Withdraw & Ask Questions: My participation in this study is voluntary and I understand that I am free to ask questions or withdraw from participation at any time without penalty and without loss of benefits to which I am otherwise entitled. Declining to participate in the study will not influence my grades or standing in my courses, program, or the University.

Contact Information Of Investigators: If you have any questions or concerns regarding your participation in this study, please contact Professor Jeffrey F. Milem, 2205 Benjamin Building, University of Maryland, College Park, MD, 20742; (e-mail) Email: jfmilem@umd.edu; (telephone) 301-405-2875 or Kadian M. Howell, Doctoral Fellow, Mid-Atlantic Center for Mathematics Teaching and Learning, 2311 Benjamin Building, University of Maryland, College Park, MD 20742 (e-mail) kmhowell@wam.umd.edu; (telephone) 410-992-9518.

Contact Information Of Institutional Review Board: If you have questions about your rights as a research subject or wish to report a research-related injury, please contact: Institutional Review Board Office, University of Maryland, College Park, MD, 20742; (e-mail) irb@deans.umd.edu; (telephone) 301-405-4212

I understand that by participating in this survey I agree with the above statements and give my informed consent.

NOTE: Your Directory ID (LDAP), University ID (UID), or Student ID (SID) will serve as your electronic signature. The Directory ID is usually the same as your University of Maryland email name - if you are unsure, you can look it up at https://www.ldap.umd.edu/

* 1. Please select your electronic signature type.

* 2. Please enter your Directory ID (LDAP), University ID (UID), or Student ID (SID)

* 3. Please enter a valid email address. Lottery winners will be contacted via email.

Background and Career Aspirations (p. 1 of 4)

4. Please indicate your sex. (Mark ONE)

Male Female

5. Please indicate your racial/ethnic background. (Mark ALL that apply)

African American/Black
American Indian/Alaska Native
Asian American/Asian
Mexican American/Chicano
Native Hawaiian/Pacific Islander
Puerto Rican
Other Latino
White/Caucasian
Other (please specify) ___________________________

6. What year did you graduate from high school? (Mark ONE)

2001 or earlier 2002 2003
2004 I am still in high school

7. How old were you on December 31st 2004? (Enter age)

8. What is the highest level of formal education obtained by your parents or guardians? (Select ONE in each applicable row)

Mother

Grammar school or less	Some high school
Certificate of Completion/GED	High school graduate
Postsecondary school other than college	Some college
Associate's degree (A.A., A.S, etc.)	Bachelor's degree (B.A., B.S, etc.)
Master's degree (M.A., M.S., M.B.A., etc.)	Ph.D. or Ed.D.
M.D., D.O., D.D.S., or D.V.M.	LL.B. or J.D. (Law)
Pharm.D. (Doctorate of Pharmacy)	Other (Please specify) ___________

Father

Grammar school or less	Some high school
Certificate of Completion/GED	High school graduate
Postsecondary school other than college	Some college
Associate's degree (A.A., A.S, etc.)	Bachelor's degree (B.A., B.S, etc.)
Master's degree (M.A., M.S., M.B.A., etc.)	Ph.D. or Ed.D.
M.D., D.O., D.D.S., or D.V.M.	LL.B. or J.D. (Law)
Pharm.D. (Doctorate of Pharmacy)	Other (Please specify) ___________

Guardian

Grammar school or less	Some high school
Certificate of Completion/GED	High school graduate
Postsecondary school other than college	Some college
Associate's degree (A.A., A.S, etc.)	Bachelor's degree (B.A., B.S, etc.)
Master's degree (M.A., M.S., M.B.A., etc.)	Ph.D. or Ed.D.
M.D., D.O., D.D.S., or D.V.M.	LL.B. or J.D. (Law)
Pharm.D. (Doctorate of Pharmacy)	Other (Please specify) __________

9. Which of the following most closely describes your current living situation?
(Select ONE)

With my family or other relatives
Other private home, apartment, or room off campus
On campus honors housing
College Park Scholars/On campus living learning community
Other dormitory/residence hall
Fraternity or sorority house
On-campus apartments;
Other on-campus housing
Other

10. Please identify your current major(s) from the following list
(Mark ALL that apply)

Astronomy
Computer Science/Computer Engineering
Geology
Mathematics
Meteorology
Physics/Physical Sciences
Aerospace Engineering
Chemical Engineering
Civil and Environmental Engineering
Electrical and Computer Engineering
Fire Protection Engineering
Materials Science and Engineering
Mechanical Engineering
Mechanical Engineering
Other (please specify)

11. What is the highest degree you plan to obtain in any field?
(Mark ALL that apply)

None
Vocational, Associate (A.A. or equivalent)

Bachelor's degree (B.A., B.S, etc.)
Master's degree (M.A., M.S., M.B.A., etc.)
Ph.D. or Ed.D.
M.D., D.O., D.D.S., or D.V.M.
LL.B. or J.D. (Law)
Pharm.D. (Doctorate of Pharmacy)

12. How likely are you to continue pursuing a degree in your current major? (Mark ONE)

very unlikely somewhat unlikely somewhat likely very likely

Career Aspirations Continued (p. 2 of 4)

13. Please identify majors to which you are considering switching. (Mark ALL that apply)

Astronomy
Computer Science/Computer Engineering
Geology
Mathematics
Meteorology
Physics/Physical Sciences
Aerospace Engineering
Chemical Engineering
Civil and Environmental Engineering
Electrical and Computer Engineering
Fire Protection Engineering
Materials Science and Engineering
Mechanical Engineering
Mechanical Engineering
Other major outside of CMPS or Engineering
I plan to drop out of school

14. Please indicate how influential each of the following is regarding your consideration to switch to a major outside of CMPS and Engineering (ENGR). (Mark ONE answer for each possible reason)

CMPS or ENGR faculty are unapproachable or unfriendly
Not influential at all Some influence Very influential Critical

CMPS or ENGR faculty do not explain material in a way that I can understand
Not influential at all Some influence Very influential Critical

CMPS or ENGR faculty do not care whether students learn anything
Not influential at all Some influence Very influential Critical

In a typical class, CMPS or ENGR faculty move too fast or cover too much material
Not influential at all Some influence Very influential Critical

CMPS or ENGR graduate student teaching assistants (TAs) are unapproachable or unfriendly
Not influential at all Some influence Very influential Critical

CMPS or ENGR graduate student TAs do not explain material in a way that I can understand
Not influential at all Some influence Very influential Critical

CMPS or ENGR graduate student TAs do not care whether students learn anything

Not influential at all   Some influence   Very influential   Critical

CMPS or ENGR students are unapproachable or unfriendly
Not influential at all   Some influence   Very influential   Critical

I have a hard time finding CMPS or ENGR students with whom I can study
Not influential at all   Some influence   Very influential   Critical

I feel isolated or alienated from other CMPS or ENGR students
Not influential at all   Some influence   Very influential   Critical

There is not adequate advising or help when I have academic questions or problems
Not influential at all   Some influence   Very influential   Critical

There are not enough good mentors to give advice about CMPS or ENGR majors
Not influential at all   Some influence   Very influential   Critical

15. Please indicate how influential each of the following is regarding your consideration to switch to a major outside of CMPS and Engineering (ENGR).
(Mark ONE answer for each possible reason)

I have lost interest in CMPS OR ENGR fields of study
Not influential at all   Some influence   Very influential   Critical

The competitive culture in CMPS or ENGR is discouraging
Not influential at all   Some influence   Very influential   Critical

CMPS or ENGR career options/rewards are not worth the effort to get the degree
Not influential at all   Some influence   Very influential   Critical

A major outside of CMPS or ENGR is more interesting
Not influential at all   Some influence   Very influential   Critical

I do not know how to study for CMPS or ENGR courses
Not influential at all   Some influence   Very influential   Critical

I have become discouraged because of low grades in CMPS or ENGR courses
Not influential at all   Some influence   Very influential   Critical

Adequate tutoring for my courses is not available
Not influential at all   Some influence   Very influential   Critical

I do better in courses outside of CMPS or ENGR
Not influential at all   Some influence   Very influential   Critical

CMPS or ENGR classes are too lecture-oriented

Not influential at all Some influence Very influential Critical

CMPS or ENGR classes are boring

Not influential at all Some influence Very influential Critical

Lecture sections are too large

Not influential at all Some influence Very influential Critical

Recitation/discussion sections are too large

Not influential at all Some influence Very influential Critical

I have financial challenges that make it difficult for me to complete my degree

Not influential at all Some influence Very influential Critical

Learning Experiences (p. 3 of 4)
16. Please indicate which of the following Pre-Calculus or Calculus courses you took DURING THE FALL 2004 SEMESTER. (Select ONE)

MATH 115
MATH 115B
MATH 140
MATH 140H
MATH 141
MATH 141H
MATH 241
MATH 241H
MATH 340
I was not enrolled in any of these courses during the Fall 2004 semester.

17. Please indicate how frequently the following activities occurred during the Pre-Calculus or Calculus course (lecture and recitation) you took DURING THE FALL 2004 SEMESTER. (Mark ONE response for each item)

Students listened to and evaluated each others' ideas, solutions, or points of view
Not at All   About Once a Month   Once or Twice a Week
Three or More Times a Week

Students were challenged to defend, extend, clarify, or explain how they derived their answers or ideas
Not at All   About Once a Month   Once or Twice a Week
Three or More Times a Week

Students were expected to "investigate" or "discover" mathematical principles and ideas
Not at All   About Once a Month   Once or Twice a Week
Three or More Times a Week

Students worked together to explore new ideas/concepts through problems or examples
Not at All   About Once a Month   Once or Twice a Week
Three or More Times a Week

Students shared strategies for approaching or solving a problem
Not at All   About Once a Month   Once or Twice a Week
Three or More Times a Week

Students justified their reasoning in a problem or steps in a proof
Not at All   About Once a Month   Once or Twice a Week
Three or More Times a Week

Students discussed connections between mathematical ideas/concepts
Not at All   About Once a Month   Once or Twice a Week

Three or More Times a Week

Students worked together to evaluate or construct proofs or make conjectures/propositions

Not at All   About Once a Month   Once or Twice a Week

Three or More Times a Week

When students were working together, they were encouraged to admit confusion and ask questions

Not at All   About Once a Month   Once or Twice a Week

Three or More Times a Week

Students taught a particular mathematical idea to the class

Not at All   About Once a Month   Once or Twice a Week

Three or More Times a Week

Students directed questions to each other about mathematical ideas/concepts

Not at All   About Once a Month   Once or Twice a Week

Three or More Times a Week

Students put individual or group work on the board for classmates to examine or comment on

Not at All   About Once a Month   Once or Twice a Week

Three or More Times a Week

Students worked in groups on projects to be turned in for a grade or extra credit

Not at All   About Once a Month   Once or Twice a Week

Three or More Times a Week

18. Please enter your responses to the following items. (Enter a number for each item)

Including yourself what is the typical size of math study groups of which you are a member?

In a typical week, how many hours do you spend outside of class studying math, reading a math text, or preparing for math class by yourself?

In a typical week, how many hours do you spend socializing with other students (not necessarily in CMPS or Engineering)?

Please use the following definitions for the remaining items in this section.

FORMALLY ORGANIZED, UNIVERSITY-SANCTIONED OPPORTUNITIES: Non-required programs that are funded and/or provided by the institution to support students' academic success and persistence at the institution (e.g., Women in Science and Engineering, mathematics tutoring room, SCORE, Bridge, living-learning communities, Undergraduate Research Experience, NSBE, Honor program, etc.).

INFORMALLY ORGANIZED, ACADEMIC-CENTERED OPPORTUNITIES: Activities that are informally organized primarily for an academic purpose (e.g., tutoring, study sessions, group project meetings, working on homework together, etc.).

19. Please indicate the frequency with which you participate in the following activities as part of a formally organized, university-sanctioned opportunity or as part of an informally organized, academic-centered opportunity. (For each item, mark ONE response for formally organized and ONE response for informally organized)

Reviewing math coursework or working on homework problems

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Working on supplemental math problems

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Working on math- or science-based research projects

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Tutoring or mentoring students for a math- or science-based course

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Receiving supplemental instruction or tutoring for math or science-based courses

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Discussing how to succeed in math- or science-based majors

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Reading math, science, engineering, or computer science textbooks

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Discussing careers in math, science, engineering, or computer science

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Participating in math- or science-based internship or externship experiences

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Attending meetings for math, science, engineering, or computer science organizations

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Attending math, science, engineering, or computer science lectures/seminars/social events

Formally Organized	*Informally Organized*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

20. Please indicate with whom you participate in the following activities as part of a formally organized, university-sanctioned opportunity or as part of an informally organized, academic-centered opportunity.
(For each item, mark ALL that apply)

Reviewing math coursework or working on homework problems

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Working on supplemental math problems

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Working on math- or science-based research projects

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week
With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Tutoring or mentoring students for a math- or science-based course

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week
With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Receiving supplemental instruction or tutoring for math or science-based courses

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week
With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Discussing how to succeed in math- or science-based majors

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Reading math, science, engineering, or computer science textbooks

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Discussing careers in math, science, engineering, or computer science

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Participating in math- or science-based internship or externship experiences

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Attending meetings for math, science, engineering, or computer science organizations

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Attending math, science, engineering, or computer science lectures/seminars/social events

By Yourself	*With another CMPS or ENGR Undergraduate*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

With a CMPS or ENGR Graduate Student	*With a CMPS or ENGR Professor*
Not at All	Not at All
About Once a Month	About Once a Month
Once or Twice a Week	Once or Twice a Week
Three or More Times a Week	Three or More Times a Week

Learning Preferences (p. 4 of 4)
21. Please mark your level of agreement with the following statements.
(Mark ONE answer for each possible response)

I learn more when students teach each other rather than when instructors lecture
Strongly Disagree Somewhat Disagree Neutral
Somewhat Agree Strongly Agree

I prefer to learn math in groups with other students rather than learning math from lectures
Strongly Disagree Somewhat Disagree Neutral
Somewhat Agree Strongly Agree

I enjoy discussing mathematical concepts with other students during class
Strongly Disagree Somewhat Disagree Neutral
Somewhat Agree Strongly Agree

I learn a great deal of mathematics when I participate in study groups outside of class
Strongly Disagree Somewhat Disagree Neutral
Somewhat Agree Strongly Agree

I feel comfortable participating in discussions about math during class
Strongly Disagree Somewhat Disagree Neutral
Somewhat Agree Strongly Agree

I prefer to study math on my own rather than studying with other people
Strongly Disagree Somewhat Disagree Neutral
Somewhat Agree Strongly Agree

22. Please indicate whether you would be willing to be contacted at a later date to participate in a 90 minute focus group about your experiences learning mathematics with peers. FOOD WILL BE PROVIDED!! (Mark ONE)
No, thank you.
Yes.

THANK YOU FOR COMPLETING THE MSEC ACPI EXPERIENCES SURVEY!!

LOTTERY WINNERS WILL BE NOTIFIED VIA EMAIL BY MARCH 31, 2005.

HAVE A WONDERFUL DAY!

Focus Group Interview Protocol

Introduction
Welcome and thank you for taking the time to attend this focus group. The purpose of this meeting is to discuss your ideas, opinions, and experiences learning mathematics during your first year as a CMPS or Engineering major at the University of Maryland. You are participating in a very important research project that can contribute to improving the learning experiences of future students in math- or science-based majors. This research is about you, and what you discuss here today will be important in helping me to understand what your first year experiences are like in CMPS and Engineering programs.

The idea of the group discussion is to allow you to share your views in a relaxed and informal environment. There are no right or wrong answers, but rather different points of view. All points of view, and both positive and negative comments, are important. Of course, what to say, how to say it, and how much to say is up to you. You should not worry about what you are expected to say, whether you are on the right track, or whether you should reach consensus. But please speak from your own experiences, make sure that you allow others to speak, do not talk at the same time, and do not interrupt others.

So I don't miss any of your comments, I would like to tape record our discussion. This will make my research work much easier, and does not rely on my memory of what was said during the discussion. I do, however, what to assure you that your contributions will be anonymous and confidential, and any research findings that are shared will contain only changed names.

Hit high points of Informed Consent Form - **ASK PARTICIPANTS TO SIGN INFORMED CONSENT FORM**
Let participants know that they should help themselves to the food and drinks that are available

Our discussion will last about one hour and a half. During that time, I would like to explore a number of issues related to your experiences learning math both in and outside of class, and would like to hear everyone's responses. Throughout our discussion, please feel free to ask questions relating to the topics of discussion; however, if you have questions about this research project, I would prefer to discuss them at the end.

Opening Question
I would like to start by asking you to introduce yourself to everyone, by telling us your first name, where you are from, and what you do for fun.

Introductory Questions
- Why did you decide to major in CMPS or Engineering? Who or what influenced your decision?
- How have your experiences during your first year influenced your decision to continue pursuing a degree in CMPS or Engineering? Positive or negative influences?

Key Questions

- Think back to your experiences in your first math lecture course as a CMPS or Engineering major, what were your first impressions?
    - What were your impressions of the course structure, material, expectations, and pedagogy?
    - How did your experiences in recitation/discussion differ from your experiences in lecture?
- What types of opportunities did you have in either your math lecture course or recitation/discussion section to talk about mathematical ideas with other students?
    - What did you think about those experiences? How did they facilitate your understanding of the mathematics you were studying?
    - What was particularly helpful about those experiences?
    - What was particularly frustrating about those experiences?
- How have your in-class learning experiences changed since your 1st math course?
    - What are your experiences with the course structure, material, expectations, and pedagogy like?
    - How do you feel about the opportunities you have to discuss mathematics with other students in your current math course?
- What do you do outside of the classroom setting to support your academic success in CMPS or Engineering?
    - What types of behaviors, habits, or activities do you participate in?
    - What do you do when you are not in class and working on a math problem, proof, or reading something in a math text that you don't understand? What resource do you utilize? Who do you talk to?
- What are your experiences with other CMPS or Engineering undergraduate students like outside of the classroom setting?
    - How do these experiences contribute to your success in CMPS or Engineering?
    - How do these experiences hinder your success in CMPS or Engineering?
- What are your experiences with CMPS or Engineering graduate students or professors like outside of the classroom setting?
    - What do you like best/least about your interactions with CMPS or Engineering graduate students or professors outside of class?

Ending Questions

- There are over 35 different formally organized, university-sanctioned programs at Maryland that are designed to support students' success in the sciences (e.g., SCORE, WISE, BRIDGE, Math Tutoring Center), yet many students indicated on the online survey that they do not participate in the activities sponsored by these programs.
    - What are some factors that influence your participation in these types of programs?
    - If you had a chance to give advice to the organizers of these programs about how to best support the success of first year students, what would you tell them?
- I started this discussion by stating that I wanted to understand more about your experiences learning math both in and outside of class during your first year as a CMPS or Engineering major. Is there anything that I should have asked you that I didn't?

Appendix D: Concept Models

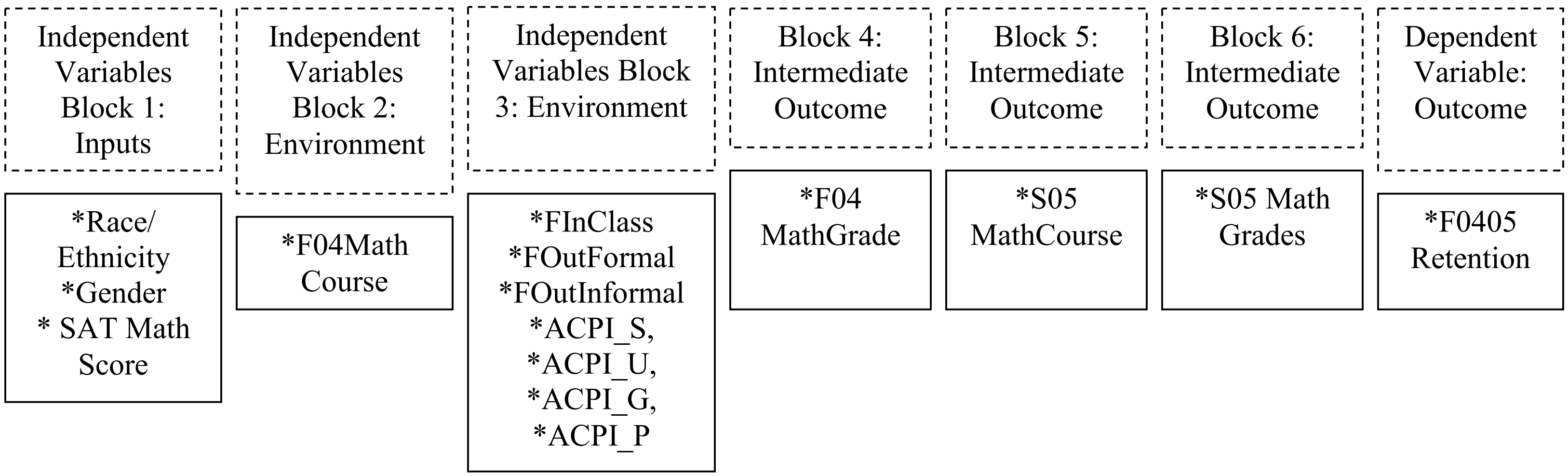
Conceptual Model for Predicting Students' Fall 2004 Math Course GPA

Independent Variables Block 1: Inputs	Independent Variables Block 2: Environment	Independent Variables Block 3: Environment	Dependent Variable: Outcome
*Race/Ethnicity *Gender * SAT Math Score	*F04MathCourse	*FInClass *FOutFormal *FOutInformal *ACPI_S, ACPI_U, ACPI_G, ACPI_P	*F04MathGrade

Conceptual Model for Predicting Students' Spring 2005 Math Course GPA

Independent Variables Block 1: Inputs	Independent Variables Block 2: Environment	Independent Variables Block 3: Environment	Block 4: Intermediate Outcome	Block 5: Intermediate Outcome	Dependent Variable: Outcome
*Race/Ethnicity *Gender * SAT Math Score	*F04MathCourse	*FInClass *FOutFormal *FOutInformal *ACPI_S, *ACPI_U, *ACPI_G, *ACPI_P	*F04 MathGrade	*S05 MathCourse	*S05 MathGrade

Conceptual Model for Predicting Students' Fall 2004 – Fall 2005 MSEC Program Retention



Appendix E: Descriptive Statistics and Pearson's Correlations

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
White/Caucasian	202	0	1	.60	.491
Asian American/Asian	202	0	1	.22	.417
African American/Black	202	0	1	.06	.237
Hispanic/Latino	202	0	1	.06	.246
Other Race/Ethnicity	202	0	1	.05	.227
Gender	202	0	1	.31	.464
F04MajorCat	202	0	1	.69	.462
Precalculus	202	0	1	.14	.346
Calculus 1	202	0	1	.45	.498
Calculus 2	202	0	1	.18	.384
Calculus 3+	202	0	1	.24	.427
HousingCat	202	0	1	.18	.384
SAT Math Score	202	550	800	695.84	67.142
HighestDeg	194	0	10	7.29	1.138
MomEd	194	0	10	5.71	1.869
DadEd	194	0	10	5.98	1.914
Guardian	9	1	10	6.22	3.270
Precalculus	202	0	1	.04	.196
Calculus 1	202	0	1	.11	.312
Calculus 2	202	0	1	.47	.500
Calculus 3+	202	0	1	.31	.464
F05MajorCat	202	0	2	.76	.567
F0405Retention	202	0	1	.14	.352
ListEval	202	0	3	1.35	1.012
Explain	202	0	3	1.40	.932
Discover	202	0	3	1.40	.936
PrblmEx	202	0	3	1.46	.847
Strategy	202	0	3	1.50	.921
Just	202	0	3	1.16	1.002
Connect	202	0	3	1.25	.864
Proof	202	0	3	.70	.829
Question1	202	0	3	1.63	1.029
Teach	202	0	3	.46	.815
Question2	202	0	3	1.19	1.035
BoardWork	202	0	3	.89	.963
PrjWork	202	0	3	.68	.913

	N	Minimum	Maximum	Mean	Std. Deviation
ReviewF	202	0	3	.50	.808
SuppF	202	0	3	.42	.779
PrjF	202	0	3	.25	.626
TutMenF	202	0	3	.11	.433
SIF	202	0	3	.29	.628
SucceedF	202	0	3	.28	.589
ReadingF	202	0	3	.51	.896
CareerF	202	0	3	.42	.661
IEExpF	202	0	3	.15	.503
MeetingF	202	0	3	.43	.664
EventsF	202	0	3	.59	.822
ReviewInF	202	0	3	1.34	.964
SuppInF	202	0	3	.87	.947
PrjInF	202	0	3	.30	.615
TutMenInF	202	0	3	.68	.889
SIInF	202	0	3	.49	.730
SucceedInF	202	0	3	.50	.709
ReadingInF	202	0	3	1.66	1.072
CareerInF	202	0	3	.85	.852
IEExpInF	202	0	3	.14	.479
MeetingInF	202	0	3	.27	.529
EventsInF	202	0	3	.29	.684
ACPI_S	202	0	11	5.19	2.833
ACPI_U	202	0	11	3.37	2.838
ACPI_G	202	0	7	.91	1.507
ACPI_P	202	0	9	.86	1.575
FInClass	202	-2.17417	2.37605	.0018295	1.00214384
FOutFormal	202	-1.48120	4.40026	-.0080958	.99579303
FOutInformal	202	-1.79614	3.40711	-.0060195	.99879078
ACPI Tot	202	.00	61.00	26.4315	12.85712
F04MathGrade	197	0	4	2.85	1.032
S05MathGrade	180	0	4	2.79	1.039
F0405Retention	202	0	1	.14	.352

Pearson's Correlations

	White/Caucasian	Asian American/Asian	African American/Black	Hispanic/Latino	Other Race/Ethnicity	Gender
White/Caucasian	1					
Asian American/Asian	-.654**	1				
African American/Black	-.307**	-.135	1			
Hispanic/Latino	-.321**	-.140*	-.066	1		
Other Race/Ethnicity	-.293**	-.128	-.060	-.063	1	
Gender	-.125	.128	.102	-.046	-.020	1
F04MajorCat	-.194**	.098	.122	.131	-.030	.031
Precalculus	-.169*	.267**	-.101	-.105	.093	-.270**
Calculus 1	.286**	-.193**	-.057	-.113	-.083	-.087
Calculus 2	.117	-.063	-.008	-.017	-.112	.161*
Calculus 3+	-.303**	.064	.155*	.233**	.122	.176*
HousingCat	-.200**	-.032	.211**	.141*	.116	.105
SAT Math Score	-.003	.150*	-.210**	-.077	.031	-.295**
HighestDeg	-.110	.075	.010	.029	.055	-.070
MomEd	.098	-.097	.051	-.046	-.033	-.111
DadEd	.108	-.111	.072	.002	-.103	-.087
Guardian	-.210	-.357	.433	.433	.(a)	-.280
S05Precal	-.041	.135	-.051	-.053	-.049	-.137
S05Cal 1	-.135	.195**	-.088	-.092	.126	-.235**
S05Cal 2	.298**	-.189**	-.067	-.123	-.093	-.028
S05Cal 3+	-.212**	.025	.147*	.172*	.074	.170*
F05MajorCat	-.147*	.120	.069	.075	-.053	.037
ListEval	.185**	-.127	.016	-.151*	-.019	-.181**

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	White/Caucasian	Asian American/Asian	African American/Black	Hispanic/Latino	Other Race/Ethnicity	Gender
Explain	.125	-.141*	.049	-.091	.037	-.175*
Discover	.069	-.089	-.018	-.004	.037	.009
PrblmEx	.094	.035	-.036	-.094	-.129	-.097
Strategy	.230**	-.087	-.093	-.056	-.179*	-.114
Just	.194**	-.147*	.001	-.164*	.026	-.025
Connect	.040	-.088	.048	.017	.006	-.073
Proof	.048	-.067	-.087	-.077	.192**	-.068
Question1	.072	-.110	.028	-.005	.022	-.124
Teach	-.002	-.022	-.038	-.023	.107	-.153*
Question2	.173*	-.169*	-.027	-.010	-.024	-.053
BoardWork	.176*	-.048	-.145*	-.137	.006	-.098
PrjWork	.037	-.023	-.074	.003	.036	-.012
ReviewF	.088	.042	-.129	-.061	-.067	-.073
SuppF	-.038	.033	-.056	-.013	.094	.029
PrjF	.060	-.051	-.067	.056	-.026	.002
TutMenF	-.053	.009	-.065	-.068	.241**	-.017
SIF	-.047	.066	-.118	.006	.096	.042
SucceedF	-.005	-.032	.022	.046	-.004	-.094
ReadingF	.076	-.016	-.098	.007	-.040	-.011
CareerF	.012	-.047	-.033	.016	.078	-.105
IEExpF	-.034	.050	.008	-.038	.015	.009
MeetingF	.089	-.060	.027	.043	-.156*	.036
EventsF	.000	-.041	.023	.082	-.040	-.027
ReviewInF	-.022	.019	-.068	.116	-.041	.075

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	White/Caucasian	Asian American/Asian	African American/Black	Hispanic/Latino	Other Race/Ethnicity	Gender
SuppInF	-.029	.027	-.033	.014	.032	-.041
PrjInF	-.127	.084	-.053	.038	.134	.031
TutMenInF	-.099	.027	-.050	.187**	.014	-.056
SIInF	.091	-.032	-.082	-.065	.019	-.013
SucceedInF	.041	-.033	-.088	.044	.016	-.113
ReadingInF	-.094	.040	-.057	.197**	-.025	-.010
CareerInF	-.034	.049	-.128	.117	-.009	.003
IEExpInF	.096	-.083	-.076	-.079	.110	-.084
MeetingInF	.131	-.117	-.088	-.095	.126	-.060
EventsInF	.156*	-.018	-.077	-.112	-.103	-.015
ACPI_S	-.144*	.090	.042	.053	.045	.109
ACPI_U	-.065	-.031	-.040	.244**	-.023	-.038
ACPI_G	-.015	-.039	-.097	.109	.087	-.053
ACPI_P	.028	-.110	-.084	.140*	.077	-.027
FInClass	.195**	-.146*	-.005	-.119	-.019	-.135
FOutFormal	.028	-.005	-.073	-.005	.031	-.027
FOutInformal	-.071	.045	-.134	.126	.074	-.019
ACPI Tot	.117	-.081	-.100	-.018	.021	-.109
F04MathGrade	-.045	-.077	.078	.038	.123	.085
S05MathGrade	-.209**	.084	.095	.048	.140	.113
F0405Retention	.018	.018	.017	-.107	.026	-.032

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	F04MajorCat	Precalculus	Calculus 1	Calculus 2	Calculus 3+	HousingCat	SAT Math Score
F04MajorCat	1						
Precalculus	.174*	1					
Calculus 1	-.095	-.360**	1				
Calculus 2	-.027	-.187**	-.417**	1			
Calculus 3+	-.007	-.224**	-.500**	-.260**	1		
HousingCat	-.027	-.187**	-.417**	-.217**	.834**	1	
SAT Math Score	-.037	.256**	.142*	-.232**	-.165*	-.162*	1
HighestDeg	-.111	.076	.111	-.048	-.146*	-.075	.033
MomEd	-.011	.191**	.147*	-.063	-.268**	-.302**	.226**
DadEd	-.104	.065	.089	-.080	-.083	-.093	.155*
Guardian	-.135	.(a)	-.280	.371	-.125	.433	-.537
S05Precal	.080	.506**	-.182**	-.095	-.113	-.095	.107
S05Cal 1	.164*	.780**	-.249**	-.163*	-.195**	-.163*	.219**
S05Cal 2	-.175*	-.374**	.921**	-.305**	-.498**	-.434**	.136
S05Cal 3+	-.015	-.270**	-.603**	.357**	.603**	.524**	-.317**
F05MajorCat	.669**	.042	-.028	.036	-.033	-.010	-.037
ListEval	-.077	.045	.349**	-.188**	-.275**	-.098	.025
Explain	-.059	.012	.235**	-.103	-.191**	.022	.051
Discover	.000	.058	.181**	-.134	-.139*	.008	.066
PrblmEx	-.010	.072	.401**	-.282**	-.274**	-.113	.103
Strategy	-.008	-.002	.310**	-.073	-.294**	-.073	-.006
Just	-.020	-.008	.242**	-.076	-.208**	-.050	-.020
Connect	.033	-.018	.153*	-.091	-.083	.134	.074
Proof	-.018	.057	.214**	-.161*	-.151*	-.114	.070
Question1	-.091	.045	.330**	-.124	-.311**	-.161*	-.091

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

	F04MajorCat	Precalculus	Calculus 1	Calculus 2	Calculus 3+	HousingCat	SAT Math Score
Teach	-.069	.128	.147*	-.102	-.184**	-.118	.085
Question2	-.021	-.033	.247**	-.062	-.206**	-.049	-.015
BoardWork	-.079	.122	.324**	-.241**	-.261**	-.147*	.076
PrjWork	-.067	-.126	.289**	-.236**	-.023	.091	.004
ReviewF	.017	.144*	.033	.093	-.239**	-.170*	.094
SuppF	.100	.261**	-.044	-.011	-.151*	-.084	.000
PrjF	.066	-.023	.090	-.056	-.036	.022	-.026
TutMenF	-.055	.028	.104	-.031	-.116	-.089	.047
SIF	.148*	.269**	-.025	-.007	-.183**	-.131	.138
SucceedF	.063	.076	.048	-.114	-.016	.057	-.080
ReadingF	.102	.170*	.052	-.028	-.174*	-.105	.058
CareerF	.069	.113	-.020	-.137	.055	.160*	-.002
IEExpF	.085	.023	.052	-.088	-.001	.046	.009
MeetingF	.148*	-.044	.015	-.042	.056	.163*	-.085
EventsF	.141*	.043	.035	-.092	.007	.120	-.057
ReviewInF	.080	.005	-.034	-.053	.083	.175*	-.019
SuppInF	-.023	.190**	.027	.020	-.204**	-.083	.050
PrjInF	.017	.017	-.132	-.113	.242**	.048	.058
TutMenInF	.075	.034	-.108	.046	.058	.007	.041
SIInF	-.020	.125	.116	-.021	-.217**	-.138	.074
SucceedInF	.097	.062	.166*	-.063	-.188**	-.100	.129
ReadingInF	.053	-.113	.102	-.060	.027	-.080	.051
CareerInF	.139*	.020	.157*	-.184**	-.034	-.065	.059
IEExpInF	.050	-.031	.139*	-.054	-.089	-.052	.068
MeetingInF	-.025	-.068	.198**	-.137	-.054	.019	.025
EventsInF	.032	-.025	.127	-.004	-.125	-.072	-.004

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

	F04MajorCat	Precalculus	Calculus 1	Calculus 2	Calculus 3+	HousingCat	SAT Math Score
ACPI_S	.140*	.109	-.100	-.046	.069	.051	.019
ACPI_U	.094	.100	-.123	.027	.039	.040	-.004
ACPI_G	-.018	.176*	-.119	-.058	.049	-.093	.116
ACPI_P	-.061	.018	-.051	-.089	.125	-.007	.054
FInClass	-.086	.030	.404**	-.185**	-.329**	-.077	.033
FOutFormal	.129	.102	.037	-.075	-.058	.014	.005
FOutInformal	.047	.035	.040	-.063	-.018	-.081	.110
ACPI Tot	.044	.099	.306**	-.193**	-.264**	-.072	.064
F04MathGrade	-.018	-.301**	.119	-.127	.219**	.183	-.073
S05MathGrade	-.020	-.137	-.149*	.002	.299**	.218**	-.097
F0405Retention	-.064	-.042	.031	-.006	.004	.031	-.156*

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	HighestDeg	MomEd	DadEd	Guardian	S05Precal	S05Cal 1	S05Cal 2	S05Cal 3+
HighestDeg	1							
MomEd	.182*	1						
DadEd	.064	.646**	1					
Guardian	.004	.661	.690*	1				
S05Precal	.039	.060	.124	.(a)	1			
S05Cal 1	.067	.196**	-.006	.(a)	-.071	1		
S05Cal 2	.118	.148*	.089	-.280	-.189**	-.326**	1	
S05Cal 3+	-.138	-.233**	-.104	.280	-.137	-.235**	-.628**	1
F05MajorCat	-.089	-.103	-.109	-.135	.040	.035	-.064	-.019
ListEval	.115	.058	.062	.255	.080	-.012	.314**	-.330**
Explain	.063	-.042	-.049	.320	.049	.003	.153*	-.164*
Discover	.057	-.001	.101	.382	.076	.021	.111	-.142*
PrblmEx	.101	.174*	.122	.088	.011	.094	.331**	-.350**
Strategy	.107	.079	.007	.280	-.112	.067	.276**	-.254**
Just	.065	.008	.077	-.246	-.084	.022	.225**	-.228**
Connect	.083	-.015	.046	.588	-.001	-.029	.141*	-.110
Proof	.048	.033	.004	-.385	.042	.049	.179*	-.223**
Question1	.121	.060	-.035	.599	.023	.063	.294**	-.291**
Teach	.116	.132	.126	.089	.074	.078	.161*	-.193**
Question2	.168*	.118	.058	.226	-.038	-.035	.248**	-.167*
BoardWork	.131	.143*	.013	.089	-.002	.141*	.286**	-.354**
PrjWork	.145*	.007	-.001	-.071	-.066	-.053	.258**	-.165*
ReviewF	.107	.066	.056	.089	.096	.081	.045	-.164*
SuppF	.068	.128	.059	.456	.086	.219**	-.040	-.136
PrjF	.008	.014	.074	.457	.000	-.038	.074	-.023

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

	HighestDeg	MomEd	DadEd	Guardian	S05Precal	S05Cal 1	S05Cal 2	S05Cal 3+
TutMenF	.049	.027	-.107	.(a)	-.053	.056	.093	-.099
SIF	.068	.107	.059	.089	.270**	.115	-.028	-.188**
SucceedF	.048	.029	-.048	.613	.075	.021	.029	-.073
ReadingF	.069	.061	.050	.644	-.003	.172*	.063	-.174*
CareerF	.025	-.001	.014	.628	-.014	.114	-.046	-.081
IEExpF	-.033	-.009	.062	.433	.142*	-.073	.040	-.091
MeetingF	-.115	-.054	.029	.635	-.055	-.035	.005	.033
EventsF	.040	-.028	.017	.053	.009	.020	.018	-.026
ReviewInF	.009	-.125	-.137	.164	-.046	.024	-.028	.024
SuppInF	.057	-.006	-.112	.322	.054	.164*	.032	-.166*
PrjInF	.023	.004	-.014	.089	.026	-.013	-.118	.097
TutMenInF	-.005	.030	-.006	.235	-.040	.056	-.138*	.093
SIInF	-.018	.030	.023	.144	.143*	.028	.089	-.184**
SucceedInF	-.009	.133	.042	.187	.037	.046	.124	-.188**
ReadingInF	.047	-.018	-.045	.040	-.101	-.081	.114	.013
CareerInF	.040	.057	.042	.510	-.024	.005	.140*	-.147*
IEExpInF	-.035	.054	.027	.089	.098	-.072	.106	-.148*
MeetingInF	-.074	.090	.081	.089	-.007	-.057	.158*	-.129
EventsInF	-.055	.007	.021	-.594	.136	-.127	.110	-.085
ACPI_S	-.155*	.044	.016	-.311	.103	.055	-.099	-.046
ACPI_U	-.020	-.020	.047	.353	.054	.039	-.114	.098
ACPI_G	.047	.091	.039	.570	.215**	.074	-.116	.026
ACPI_P	.043	.071	.085	.637	.035	-.019	-.047	.082
FInClass	.146*	.065	.046	.431	-.008	.048	.352**	-.341**
FOutFormal	.009	.061	.064	.412	.078	.045	.026	-.110
FOutInformal	.002	.033	-.060	.001	.012	.021	.027	-.057
ACPI Tot	.119	.083	.043	.548	.041	.071	.262**	-.316**

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	HighestDeg	MomEd	DadEd	Guardian	S05Precal	S05Cal 1	S05Cal 2	S05Cal 3+
F04MathGrade	.011	-.112	-.099	.180	-.319**	-.215**	.114	.149*
S05MathGrade	-.029	-.098	-.104	-.114	-.321**	.009	-.110	.253**
F0405Retention	.102	-.077	-.104	.433	-.083	-.007	.043	-.001

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	F05MajorCat	ListEval	Explain	Discover	PrblmEx	Strategy	Just	Connect
F05MajorCat	1							
ListEval	-.018	1						
Explain	-.054	.609**	1					
Discover	-.029	.395**	.435**	1				
PrblmEx	-.064	.398**	.303**	.315**	1			
Strategy	.002	.534**	.464**	.259**	.610**	1		
Just	-.028	.385**	.340**	.403**	.323**	.428**	1	
Connect	.011	.438**	.436**	.497**	.386**	.458**	.429**	1
Proof	.029	.404**	.400**	.456**	.300**	.295**	.448**	.438**
Question1	-.082	.411**	.299**	.367**	.552**	.448**	.251**	.367**
Teach	-.039	.359**	.308**	.197**	.260**	.216**	.128	.288**
Question2	-.023	.305**	.280**	.301**	.478**	.513**	.358**	.462**
BoardWork	-.086	.419**	.428**	.317**	.448**	.391**	.298**	.208**
PrjWork	-.060	.212**	.214**	.251**	.299**	.179*	.122	.267**
ReviewF	.064	.122	.122	.082	.110	.229**	-.038	.083
SuppF	.123	.160*	.114	.020	.144*	.311**	.118	.072
PrjF	.023	.174*	.085	.008	.143*	.266**	.109	.057
TutMenF	-.056	.121	.204**	.129	.047	.064	.077	.093
SIF	.075	.190**	.139*	.126	.031	.133	-.073	.008
SucceedF	.126	.294**	.223**	.063	.177*	.307**	.137	.133
ReadingF	.101	.238**	.212**	.172*	.132	.320**	.098	.221**
CareerF	.050	.198**	.172*	.081	.155*	.284**	.071	.106
IEExpF	.058	.262**	.193**	.116	.066	.195**	.080	.156*
MeetingF	.160*	.196**	.151*	.056	.096	.321**	.189**	.193**
EventsF	.133	.092	.059	.135	.181**	.286**	.081	.128

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	F05MajorCat	ListEval	Explain	Discover	PrblmEx	Strategy	Just	Connect
ReviewInF	.003	.054	-.004	.176**	.182**	.126	.052	.150**
SuppInF	-.002	.187**	.225**	.271**	.178**	.188**	.093	.213**
PrjInF	-.002	-.163**	-.131	-.042	-.113	-.179**	-.017	-.149**
TutMenInF	-.015	-.042	-.016	.074	.064	.048	-.074	-.006
SIInF	-.015	.219**	.199**	.089	.194**	.094	.040	-.048
SucceedInF	.064	.240**	.284**	.288**	.196**	.241**	.107	.099
ReadingInF	.000	.029	-.003	.046	.158**	.089	-.069	-.054
CareerInF	.135	.208**	.124	.136	.285**	.218**	.057	.097
IEExpInF	.004	.110	.136	.133	.060	.061	-.029	.076
MeetingInF	-.043	.319**	.316**	.221**	.164**	.216**	.180**	.134
EventsInF	-.007	.168**	.206**	.084	.151**	.184**	.120	.058
ACPI_S	.106	.001	-.013	.133	-.124	-.139**	-.150**	.008
ACPI_U	.057	.092	.072	.113	.112	.186**	.168**	.197**
ACPI_G	-.042	.047	.001	-.042	-.108	.011	-.050	-.090
ACPI_P	-.122	-.021	-.015	.003	-.063	.043	-.080	-.039
FInClass	-.071	.692**	.657**	.639**	.676**	.683**	.633**	.726**
FOutFormal	.131	.239**	.181**	.007	.076	.307**	.041	.062
FOutInformal	-.017	-.013	.024	.150**	.121	-.055	-.135	-.105
ACPI Tot	.025	.609**	.558**	.518**	.577**	.650**	.428**	.511**
F04MathGrade	.047	.037	.018	-.088	-.012	-.034	.048	-.060
S05MathGrade	-.002	-.155*	-.091	-.059	-.010	-.102	.049	-.010
F0405Retention	.322**	.081	-.025	.048	-.020	-.010	-.010	-.038

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

	Proof	Question1	Teach	Question2	BoardWork	PrjWork	ReviewF	SuppF	PrjF
Proof	1								
Question1	.297**	1							
Teach	.503**	.223**	1						
Question2	.345**	.422**	.290**	1					
BoardWork	.400**	.344**	.504**	.292**	1				
PrjWork	.310**	.264**	.350**	.286**	.338**	1			
ReviewF	.074	.074	.268**	.113	.175*	.192**	1		
SuppF	.120	.123	.233**	.236**	.224**	.122	.545**	1	
PrjF	.077	.079	.199**	.126	.105	.281**	.264**	.493**	1
TutMenF	.288**	.127	.379**	.106	.317**	.349**	.117	.278**	.203**
SIF	.120	.106	.151*	-.033	.168*	.113	.411**	.398**	.225**
SucceedF	.129	.173*	.154*	.205**	.166*	.190**	.149*	.435**	.344**
ReadingF	.198**	.144*	.271**	.299**	.376**	.249**	.418**	.435**	.219**
CareerF	.135	.050	.252**	.210**	.316**	.270**	.205**	.444**	.334**
IEExpF	.281**	.012	.251**	.014	.101	.258**	.228**	.251**	.517**
MeetingF	.147*	.024	.105	.142*	.106	.133	.153*	.322**	.257**
EventsF	-.045	.148*	-.037	.210**	.058	.145*	.135	.305**	.244**
ReviewInF	.104	.138	-.028	.168*	.078	.084	.076	.064	-.105
SuppInF	.221**	.297**	.150*	.195**	.208**	.096	.127	.066	.003
PrjInF	.091	-.079	.038	.050	.026	.108	-.081	-.060	.114
TutMenInF	.004	-.074	.075	.092	-.001	.048	-.013	.005	.051
SIInF	.096	.113	.161*	.259**	.250**	.046	.078	.088	-.007
SucceedInF	.207**	.223**	.273**	.251**	.275**	.201**	.131	.144*	.177*
ReadingInF	.116	.079	.144*	.159*	.120	.057	.141*	.069	.099
CareerInF	.125	.154*	.131	.203**	.239**	.202**	.200**	.222**	.228**
IEExpInF	.272**	.037	.300**	.104	.163*	.307**	.105	.094	.149*
MeetingInF	.452**	.129	.352**	.070	.298**	.312**	.061	.216**	.255**

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	Proof	Question1	Teach	Question2	BoardWork	PrjWork	ReviewF	SuppF	PrjF
EventsInF	.112	-.026	.056	.159*	.035	.134	.020	.039	.104
ACPI_S	.137	-.073	.018	-.074	.012	.101	.036	.083	.082
ACPI_U	.118	.053	.040	.342**	-.016	.040	.061	.227**	.202**
ACPI_G	.070	-.114	-.003	-.002	-.024	-.109	-.048	.046	-.014
ACPI_P	-.002	-.119	.067	.087	-.034	-.019	.001	.008	.024
FInClass	.614**	.654**	.414**	.618**	.558**	.341**	.076	.095	.041
FOutFormal	.162*	.014	.315**	.104	.237**	.334**	.480**	.688**	.645**
FOutInformal	.168*	.078	.204**	.174*	.212**	.158*	.029	-.053	-.079
ACPI Tot	.571**	.507**	.528**	.589**	.599**	.495**	.373**	.467**	.389**
F04MathGrade	.015	-.051	.005	.130	.009	-.058	-.153*	-.091	.041
S05MathGrade	.043	-.124	-.035	.049	-.029	.029	-.093	.004	-.109
F0405Retention	.045	.064	-.021	-.104	.034	.018	.038	.060	-.090

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	TutMenF	SIF	SucceedF	ReadingF	CareerF	IEExpF	MeetingF	EventsF
TutMenF	1							
SIF	.356**	1						
SucceedF	.310**	.195**	1					
ReadingF	.254**	.258**	.374**	1				
CareerF	.323**	.216**	.501**	.451**	1			
IEExpF	.289**	.424**	.271**	.169*	.237**	1		
MeetingF	.238**	.243**	.503**	.226**	.450**	.380**	1	
EventsF	.071	.163*	.292**	.139*	.309**	.207**	.471**	1
ReviewInF	-.020	-.019	.137	.173*	.045	-.152*	.123	.138
SuppInF	.133	.132	.056	.206**	.034	-.105	-.009	.036
PrjInF	.045	-.080	-.052	.035	.088	.052	-.097	-.103
TutMenInF	.097	.058	-.028	.028	.090	-.074	.030	.062
SIInF	.162*	.214**	.094	.065	.151*	-.046	.070	-.082
SucceedInF	.317**	.302**	.336**	.220**	.230**	.248**	.178*	.044
ReadingInF	.068	.051	.157*	.152*	.138	.047	.123	.100
CareerInF	.208**	.238**	.335**	.327**	.270**	.237**	.324**	.231**
IEExpInF	.261**	.194**	.178*	.228**	.255**	.388**	.079	-.006
MeetingInF	.479**	.300**	.329**	.151*	.316**	.438**	.434**	.122
EventsInF	.031	.079	.170*	.005	.033	.228**	.183**	.246**
ACPI_S	.148*	.289**	-.039	-.033	.075	.222**	.161*	.112
ACPI_U	-.022	-.049	.270**	.123	.153*	-.039	.392**	.253**
ACPI_G	-.074	.088	.194**	.061	.007	-.106	.064	-.022
ACPI_P	-.054	-.025	.221**	.082	.130	-.088	.098	-.004
FInClass	.117	-.001	.157*	.244**	.108	.070	.103	.107
FOutFormal	.488**	.557**	.627**	.487**	.641**	.676**	.633**	.439**
FOutInformal	.239**	.125	.083	.162*	.118	-.086	-.017	-.086
ACPI Tot	.420**	.365**	.495**	.531**	.492**	.387**	.437**	.343**

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	TutMenF	SIF	SucceedF	ReadingF	CareerF	IEExpF	MeetingF	EventsF
F0405Retention	.090	-.038	.104	.033	.037	-.026	.033	.015
F04MathGrade	-.054	-.227**	.003	-.024	.012	-.086	-.016	.031
S05MathGrade	.028	-.208**	.046	.011	.125	-.210**	.051	.013

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	ReviewInF	SuppInF	PrjInF	TutMenInF	SIInF	SucceedInF	ReadingInF	CareerInF	IEExpInF
ReviewInF	1								
SuppInF	.503**	1							
PrjInF	-.051	-.006	1						
TutMenInF	.201**	.094	.136	1					
SIInF	.132	.233**	.156*	.169*	1				
SucceedInF	.203**	.189**	.165*	.317**	.391**	1			
ReadingInF	.444**	.243**	.104	.299**	.168*	.334**	1		
CareerInF	.230**	.009	.090	.217**	.230**	.532**	.370**	1	
IEExpInF	.112	.192**	.045	-.024	.046	.324**	.229**	.075	1
MeetingInF	.022	.026	.083	.113	.249**	.495**	.263**	.351**	.384**
EventsInF	.137	.069	.024	-.046	.110	.252**	.187**	.231**	.166*
ACPI_S	.005	.077	.028	.120	.042	.260**	.049	.168*	.134
ACPI_U	.364**	.179*	.165*	.308**	.271**	.222**	.228**	.341**	-.219**
ACPI_G	.016	.067	.211**	.116	.193**	.108	.232**	.101	-.017
ACPI_P	-.015	-.001	.164*	.107	.119	.138*	.201**	.129	.034
FInClass	.168*	.346**	-.169*	-.064	.153*	.205**	-.003	.114	.086
FOutFormal	-.091	-.094	-.002	-.007	.049	.332**	.119	.423**	.332**
FOutInformal	.557**	.447**	.336**	.523**	.518**	.643**	.675**	.456**	.316**
ACPI Tot	.332**	.397**	.040	.193**	.336**	.570**	.366**	.513**	.345**
F04MathGrade	.026	-.053	.139	.052	-.002	-.028	.133	.087	-.048
S05MathGrade	.110	.023	.184*	.022	-.170*	-.084	.041	.034	-.091
F0405Retention	-.014	-.020	-.093	-.094	-.051	-.014	-.115	.097	-.005

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

	MeetingInF	EventsInF	ACPI_S	ACPI_U	ACPI_G	ACPI_P	FInClass	FOutFormal	FOutInformal	ACPI Tot
MeetingInF	1									
EventsInF	.401**	1								
ACPI_S	.179*	.036	1							
ACPI_U	.098	.157*	.038	1						
ACPI_G	.151*	.115	-.004	.271**	1					
ACPI_P	.105	.079	-.073	.271**	.770**	1				
FInClass	.210**	.123	-.094	.139*	-.084	-.070	1			
FOutFormal	.536**	.220**	.192**	.146*	.039	.076	.003	1		
FOutInformal	.349**	.206**	.166*	.288**	.231**	.192**	.002	-.010	1	
ACPI Tot	.553**	.302**	.102	.342**	.061	.071	.707**	.569**	.405**	1
F04MathGrade	-.073	-.040	-.090	-.018	-.073	.009	-.004	-.082	.065	-.013
S05MathGrade	-.021	-.089	.029	.088	.005	.027	-.050	-.068	.049	-.045
F0405Retention	-.036	-.081	-.018	-.068	-.079	-.061	.014	.039	-.071	-.008

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

	F0405Retention	F04MathGrade	S05MathGrade
F0405Retention	1		
F04MathGrade	.073	1	
S05MathGrade	.080	.190*	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

References

Alexander, B., Burda, A. & Millar, S. (1996). *A community approach to learning calculus: Fostering success for underrepresented ethnic minorities in an emerging scholars program.* (Report number SE060269). University of Wisconsin-Madison: LEAD Center. (ERIC Document Reproduction Service No. ED408180)

Asera, R. (2001). *Calculus and community: A history of the emerging scholars program*. College Entrance Examination Board. New York: NY.

Astin, A. (1984). Student involvement: A developmental theory for higher education. *Journal of College Student Personnel* 25, 298-307.

Astin, A. (1991). *Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education*. New York, NY: McMillan Publishing.

Astin, A. (1993a). *What matters in college? Four critical years revisited*. San Francisco, CA: Jossey-Bass Publishers.

Astin, A. (1993b). What matters in college? *Liberal Education*, 79(4), 4-15.

Astin, A. (1996). Involvement in learning revisited: Lessons we have learned. *Journal of College Student Development*, 37(2), 123-133.

Astin, A. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development*, 40(5), 518-529.

Astin, A., & Astin, H. (1992). *Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences. Final Report*. California University, LA: Higher Education Research Institute.

Atwater, M. M. (1994). Research on cultural diversity in the classroom. In D. Gabel (Ed.) *Handbook of Research on Science Teaching and Learning*. New York, NY: MacMillian.

Bank, B. J. Slavings, R. L., & Biddle, B. J. (1990). Effects of peer, faculty , and parental influences on students' persistence. *Sociology of Education*, 63(3), 208-225.

Barton, P. (2002). Meeting the need for scientists, engineers, and an educated citizenry in a technological society. Educational Testing Service. New Jersey: ETS.

Barton, P. (2003). Hispanics in science and engineering: A matter of assistance and persistence. Educational Testing Service. New Jersey: ETS.

Bauersfeld, H. (1995). The structuring of the structures: Development and function of mathematizing as a social practice. In L. Steffe, & P. Thompson (Eds.), *Radical constructivism in action: Building on the pioneering work of Ernest von Glasersfeld*. New York: Rutledge.

Becker, J. R. (1992). Graduate education in the mathematical sciences. In L. Burton (Ed.) *Gender and Mathematics: An International Perspective*. Britian: Cassell

Becker, J. R. (1995) Women's ways of knowing mathematics. In P. Rogers and G. Kaiser (Eds.) *Equity in Mathematics Education: Influences of Feminism and Culture*. London: Falmer Press.

Berger, J., & Milem, J. (1999). The role of student involvement and perceptions of integration in a causal model of student persistence. *Research in Higher Education*, 40, 641-665.

Bianchini, J. A., Cavazos, L. M., & Helms, J. V. (2000). From professional lives to inclusive practice: Science teachers and scientists' views of gender and ethnicity in science education. *Journal of Research in Science Teaching*, 37(6), 511-547.

Biggs, E., & MacLean, J. R., (1969). *Freedom to learn: Active learning approach in mathematics*. Boston, MA: Addison-Wesley

Bogdan, R. C., & Biklen, S. K. (2003) *Qualitative research for education: An introduction to theory and methods. Fourth Edition*. Boston, MA: Pearson Education Group, Inc.

Bonsangue, M. V. (1992). *The effects of calculus workshop groups on minority achievement and persistence in mathematics, science, and engineering*. Unpublished doctoral dissertation. Claremont Graduate School, Claremont, California.

Bonwell C. C., & Sutherland, T. E. (1996). The active learning continuum: Choosing activities to engage students in the classroom. *New Directions for Teaching and Learning*, 67, 3-16.

Bonwell, C. C. (1996). Enhancing the lecture: Revitalizing a traditional format. *New Directions for Teaching and Learning*, 67, 31- 44.

Bonwell, C. C., & Eison, J. A. (1991). *Active learning: Creating excitement in the classroom.* ASHE-ERIC Higher Education Report No. 1. Washington, DC.

Braxton, J. M., Milem, J. F., & Sullivan, A. S. (2000). The influence of active learning on the college student departure process: Toward a revision of Tinto's theory. [Electronic version]. *The Journal of Higher Education*, 71(5), 569-590.

Brown, A.L. & Palinscar, A.S. (1989). Guided, cooperative learning and individual knowledge acquisition. In Resnick (Ed.) *Knowing, Learning, and Instruction*. Hillsdale, NJ: Erlbaum.

Bryant, D.B. (1998). *The small group instruction method in calculus compared with the traditional method of teaching college level calculus and effects on cognitive development, mathematical self-concept and mathematical achievement with respect to gender and race.* Unpublished Dissertation. University of Maryland, College Park.

Cabrera, A. F., Crissman, J. L., Bernal, E. M., Nora, A., Terenzini, P. T., & Pascarella, E. T. (2002). Collaborative learning: Its impact on college students' development and diversity.

Cerrito, P. B., & Levi, I. (1999). An investigation of student habits in mathematics courses. *College Student Journal*, 33(4), 584-589.

Cobb, P. (2000). Constructivism in social context. In L. Steffe, & P. Thompson (Eds.), *Radical constructivism in action: Building on the pioneering work of Ernest von Glasersfeld*. New York: Rutledge.

Cobb, P., & Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychologist*, 31(3/4), 175-190.

Cohen, D. W. (1982). A modified Moore method for teaching undergraduates. *The American Mathematical Monthly*, 89(7), 473-474; 487-490.

College Board (1999) *Reaching the top: A report of the national task force on minority high achievement*. New York, NY: College Board.

Conference Board of the Mathematical Sciences. (2001). *The mathematical education of teachers: Vol. 11. Issues in mathematics education.* Providence, RI: American Mathematical Society.

Cooper, J. L., & Robinson, P. (2000). Getting started: Informal small-group strategies in large classes. *New Directions for Teaching and Learning*, 81, 17-85.

Couco, A., Goldenberg, E. P., & Mark, J. (1996). Habits of mind: An organizing principle for mathematics curricula. *Journal of Mathematical Behavior*, 15, 375-402.

Creswell, J. W. (1994). *Research design: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (Second Edition ed.). London: Sage Publications.

Creswell, J. W., Plano Clark, V. L., Gutman, M. L., & Hanson, W. E. (2003). Advanced mixed methods research designs. In A. Tashakkori, & C. Teddlie (Eds.), *Handbook of Mixed Methods in Social & Behavioral Research*. (pp. 209-240). Thousand Oaks, CA: Sage Publications, Inc.

Dancis, J. (n.d.). *A hybrid small-group guided-discovery method of instruction: A non-extremist approach*. Unpublished Manuscript, University of Maryland at College Park.

Davidson, N. (1970). *The small-group discovery method of mathematics instruction as applied in calculus*. Doctoral Dissertation, University of Wisconsin..

Davidson, N. (1971). The small group-discovery method as applied to calculus instruction. *The American Mathematical Monthly*, 78(7), 789-791.

Dees, R.L. (1991). The role of cooperative learning in increasing problem-solving ability in a college remedial course. *Journal for Research in Mathematics Education*, 22(5), 409-421.

Dennis, E.C. (2001). *An investigation of the numerical experience associated with the global behavior of polynomial functions in the traditional lecture method and cooperative learning method classes*. Unpublished Dissertation. University of New Orleans.

Duncan, H. & Dick, T. (2000). Collaborative workshops and student academic performance in introductory college mathematics courses: A study of a Treisman model math excel program. [Electronic version]. *School Science and Mathematics*, 100(7), 365-373.

Ebert-May, D., & Brewer, C. (1997). Innovation in large lectures – Teaching for active learning. [Electronic Version] *Bioscience*, 47(9), 601-608.

Eisenberg, T. A., & Browne, J. B. (1973). Using student tutors in pre-calculus instruction. *The American Mathematical Monthly*, 80(6), 685-688.

Fernandez, Y. M., Whitlock, E. R., Martin, C., & VanEarden. K. (1998). *Evaluation of a first-year pilot program for academically underprepared students at a private liberal arts college*. (Report number HE031838). University of Wisconsin-Madison: LEAD Center. (ERIC Document Reproduction Service No. ED426680)

Fox, L. H., & Soller, J. F. (2001). Psychosocial Dimensions of Gender Differences in Mathematics. In W. Secede, J. Jacobs, J. Becker, & G. Gilmer (Eds.), *Changing the faces of mathematics: Perspectives on gender* (pp. 9-24). Reston, VA: National Council of Teachers of Mathematics.

Fries-Britt, S. (1998). Moving beyond black achiever isolation: Experiences of gifted black collegians [Electronic version]. *Journal of Higher Education*, 69(5). 556-576.

Frye-Lucas, S. (2003). *Factors associated with African American engineering student success in first-year college calculus*. Unpublished Dissertation. University of California, Davis.

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction* (6th ed.). New York,NY: Longham.

Gandara, P. & Maxwell-Jolly, J. (1999). *Priming the pump: Strategies for increasing the achievement of underrepresented minority undergraduates*. New York, NY: College Entrance Examination Board.

Ganter, S. L. (Ed.). (2001). *Changing calculus: A report on evaluation efforts and national impact from 1988-1998*. MAA Notes, No. 56. Washington, DC: The Mathematical Association of America, 2001.

Gersting, J. L., & Kuczkowski, J. E. (1977). Why and how to use small groups in the mathematics classroom. *The Two-Year College Mathematics Journal*, 8(5), 270-274.

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *The Journal of Higher Education*, 69(6), 589-620. Retrieved April 14, 2003 from FirstSearch database.

Hagedorn, L. S., Siadat, M. V., Nora, A., & Pascarella, E. T. (1996). *Factors leading to gains in mathematics during the first year of college: An analysis by gender and* *ethnicity*. Paper presented at the annual meeting of the American Educational Research Association, New York City, April 1996

Hilbert, S., Maceli, J., Robinson, E., Schwartz, D., & Seltzer, S. (1992). *Calculus: An active approach with projects*. (Report number JC920559). Ithaca College. (ERIC Document Reproduction Service No. ED351080)

Hobson, E. H. (1996). Encouraging self-assessment: Writing as active learning. *New Directions for Teaching and Learning. Using Active Learning in College Classes: A Range of Options for Faculty*, 67, 45-58.

Holton (Editor) 2001. The teaching and learning of mathematics at University Level: An ICIM Study

Holton, D. (2001). *The teaching and learning of mathematics at university level: An ICMI study*. London: Kluwer Academic Publishers.

Hoyles, C. (1985). What is the point of group discussion in mathematics? *Educational Studies in Mathematics*, 16(2), 205-214.

Hurley, E. (1982). *Peer teaching in a calculus classroom: The influence of ability*. Unpublished Dissertation. The University of Rochester, New York.

Hurtado, S., Carter, D. F. (1997). Effects of college transition and perceptions of the campus racial climate on Latino college students' sense of belonging. [Electronic Version] *Sociology of Education*, 70(4), 324-345.

Hurtado, S., Carter, D.F., Spuler, A., Dale, B., & Pipkin, A. (1994). *Latino student transition to college: Assessing difficulties and factors in successful college adjustment*. Paper presented at the Annual Forum of the Association for Institutional Research. (ERIC Document Reproduction Service No. ED373663)

Hurtado, S., Milem, J. F., Clayton-Pedersen, A. R., & Allen, W. R. (2002). *Enhancing campus climates for racial/ethnic diversity: Educational policy and practice.* In Racial and ethnic diversity in higher education. Second Edition. C.S. Turner, A.L. Antonio, M. Garcia, B.V. Laden, A. Nora, and C.L. Presley, (Eds.). ASHE Reader Series. Boston, MA: Pearson Custom Publishing.

Johnson, D.W., Johnson, R. T., & Smith, K. A. (1991). *Active learning: Cooperation in the college classroom*. Edina, MN: Interaction Book Company.

Kardash, C. M. (2000). Evaluation of an undergraduate research experience: Perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology*, 92(1), 191-201.

Kellermeier, J. (1996). Feminist pedagogy in teaching general education mathematics: Creating the riskable classroom. [Electronic Version] *Feminist Teacher*, 10(1), 8-12.

Kennedy, H. L., & Parks, J. (2000). Society cannot continue to exclude women from the fields of science and mathematics. *Education*. 120(3), 529-537.

Klawe, M., & Leveson, N. (1995). Women in computing: Where are we now? *Association for Computing Machinery. Communications of the ACM*, 38(1), 29-45.

Kozulin, A. (1998). *Psychological tools: A Sociocultural Approach to Education*. Cambridge, MA: Harvard University Press.

Krueger, R.A. (1998). *Analyzing & Reporting Focus Group Results*. Thousand Oaks, CA: Sage Publications

Kvam, P. H. (2000). The effect of active learning methods on student retention in engineering statistics. *The American Statistician*, 54(2), 136-140.

Lazar, A. M. (1993). *The construction of two college study groups*. Unpublished Dissertation. University of Pennsylvania.

Lee, W. Y. (1997). *Transitioning from high school to college: Surviving a clash of educational cultures*. (Report number HE030976). Albuquerque, NM: Paper presented at the Annual Meeting of the Association for the Study of Higher Education. (ERIC Document Reproduction Service No. ED415825)

Legrand, M. (2001). Scientific debate in mathematics courses. In D. Holton (Ed.), *The Teaching and Learning of Mathematics at University Level: An ICIM Study*. (pp. 127-135). Netherlands: Klumer Academic Publishers.

Lemke, J. L. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching*, 38(5), 296-316.

Linn, M. D., & Kessel, C. (1996). Success in mathematics: Increasing talent and gender diversity among college majors. In J. Kaput, A. H. Schoenfled, & E. Dubinsky (Eds.), *Issues in mathematics education, conference of the mathematical sciences, vol 6: Research in collegiate mathematics education II* (pp. 83-100). Providence, RI: American Mathematical Society.

Liu, R. & Liu, E. (2000). *Institutional integration: An analysis of tinto's theory*. (Report number HE033302). Cincinnati, Ohio: Paper presented as the Annual Forum of the Association for Institutional Research. (ERIC Document Reproduction Service No. ED44629)

Loo, C. M. & Rolison, G. (1986). Alienation of ethnic minority students at a predominantly white university. *Journal of Higher Education,* 57(1), 58-77.

Loomer, N. J. (1976). *A multidimensional exploratory investigation of small group-heuristic and expository learning in calculus*. Unpublished Dissertation. University of Wisconsin - Madison

Mangione, T. W. (1995). *Mail surveys: Improving the quality*. Thousand Oaks, CA: Sage.

Margolis, J. and Fisher, A. (2002). Unlocking the Clubhouse: Women in Computing. Cambridge, MA: MIT Press.

Mathematics Association of America (1998). *Quantitative reasoning for college graduates: A complement to the standards*. Retrieved June 23, 2004, from http://www.maa.org/past/ql/ql_toc.html#summary

Mau S. T., & Leitze, A. R. (2001). Powerless gender or genderless power? The promise of constructivism for females in the mathematics classroom. In W. Secada, J. Jacobs, J. Becker, & G. Gilmer (Eds.), *Changing the Faces of Mathematics: Perspectives on Gender* (pp. 37-41). Reston, VA: National Council of Teachers of Mathematics.

Mayberry, M (1998). Reproductive and resistant pedagogies: The comparative roles of collaborative learning and feminist pedagogy in science education. [Electronic Version]. *Journal of Research in Science Teaching*, 35(4), 443-459.

McKeen, R. L., & Davidson, N. A. (1975). An alternative to individual instruction in mathematics, *The American Mathematical Monthly*, 82(10), 1006-1009.

Meyers, C. & Jones, T. B. (1993). *Promoting Active Learning: Strategies or the College Classroom.* San Francisco, CA: Jossey-Bass Publishers.

Milem, J. F., & Berger, J. B. (1997). A modified model of college student persistence: Exploring the relationship between Astin's theory of involvement and Tinto's theory of student departure. *Journal of College Student Development*, 38, 387-400.

Miller, P. H. (1993) Theories of developmental psychology. (3rd edition). New York: Worth

Millett, K.C. (2001). Making large lectures effective: An effort to increase student success. In D. Holton (Ed.), *The Teaching and Learning of Mathematics at University Level: An ICIM Study*. (pp. 137-152). Netherlands: Klumer Academic Publishers.

Moreno, S.E. & Muller, C. (1999). Success and diversity: The transition through first year calculus in the university [Electronic Version]. *American Journal of Education*, 108, 30-57.

National Center for Education Statistics. (2000). *Entry and persistence of women and minorities in college science and engineering education*. NCES 2000-601, by Gary Huang, Nebiyu Taddese, and Elizabeth Walter. Project Officer, Samuel S. Peng. Washington, DC: U.S. Department of Education.

National Center for Education Statistics. (2001). *Educational achievement and black-white inequality.* Statististical Analysis Report. NCES 2001-01. Office of Educational Research and Improvement. Washington, DC: U.S. Department of Education.

National Council of Teachers of Mathematics. (2000).*Principles and standards for school mathematics*. Reston, Virginia: National Council of Teac hers of School Mathematics.

National Science Foundation (1996). Shaping the future: New expectations for undergraduate education in science, mathematics, engineering, and technology. *A Report on its Review of Undergraduate Education by the Advisory Committee to the National Science Foundation Directorate for Education and Human Resources*. (NSF 96-139).

Nauta, M. M., Epperson, D. L., & Kahn, J. H. (1998). A multiple-groups analysis of predictors of higher level career aspirations among women in mathematics, science, and engineering majors. *Journal of Counseling Psychology*, 45(4), 483-496. Retrieved January 18, 2004, from EBSCOhost database.

Ortiz-Franco, L. & Flores, W.V. (2001). Sociocultural considerations and Latino mathematics achievement: A critical review. In B. Atweh, H. Forgasz, and B. Nebres, (Eds.), *Sociocultural Research on Mathematics Education: An International Perspective*. (pp 233-253). Mahwah, NJ:Erlbaum.

Page, W. (1979). A small group strategy for enhanced learning. *The American Mathematical Monthly*, 86(10), 856-858.

Pascarella, E.T. & Terenzini, P.T. (1991). *How college affects students: Findings and insights from twenty years of research*. San Francisco: Jossey Bass.

Pavel, M., Swisher, K., & Ward, M. (1994). Special focus: American Indian and Alaska Native demographic and educational trends. *Minorities in Higher Status Report*. (p. 35-39)

Pedhauzer, E. J. (1997). *Multiple regression in behavioral research. Third Edition*. United States: Wadsworth Thomson Learning.

Perna, L. W. (2002). *Differences in the decision to attend college among African Americans, Hispanics, and Whites.* In Racial and Ethnic Diversity in Higher Education. Second Edition. C.S. Turner, A.L. Antonio, M. Garcia, B.V. Laden, A. Nora, and C.L. Presley, (Eds.). ASHE Reader Series. Boston, MA: Pearson Custom Publishing.

Pett, M. A., Lackey, N .R., & Sullivan, J. J. (2003). *Making Sense of Factor Analysis*. Thousand Oaks, CA: Sage Publishing.

Pike, G. R. (1999). The effects of residential learning communities and traditional residential living arrangements on educational gains during the first year of college. *Journal of College Student Development*, 40(3), 269-283.

Powell, D. A. (2002). *Quantitative research methods II.*Unpublished manuscript, College Park, MD.

Quitadamo, I. J. (2002). *Critical thinking in higher education: The influence of teaching styles and peer collaboration on science and math learning*. Unpublished Dissertation. Washington State University.

Roddick, C. D. (1997). *A comparison study of students from two calculus sequences on their achievement in calculus-dependent courses*. Unpublished Dissertation. The Ohio State University.

Rogers, P. (1992). Thoughts on power and pedagogy. In L. Burton (Ed.) *Gender and Mathematics: An International Perspective*. Britain: Cassell.

Rogoff, B. (1999). Cognition as a collaborative process. In W. Damon, D. Kuhn, & R. Siegler (Eds.) *Handbook of Child Psychology* (Vol. 2). NY: Wiley.

Rosenthal, J. S. (1995). Active learning strategies in advanced mathematics classes. *Studies in Higher Education*, 20(2), 223-229.

Rosser, S. V. (1997). *Re-engineering Female Friendly Science*. New York: Teachers College Press.

Roth, K.J. (1990). Developing meaningful conceptual understanding in science. In Jones, B.F. & Idol, L. (Eds.), *Dimensions of Thinking and Cognitive Instruction*. (pp. 139-176). New Jersey: Lawrence Erlbaum Associates.

Ruland, J. P. (1999). *Relationship of classroom environment to growth in critical thinking ability of first year college students*. Unpublished Dissertation. University of New York, Albany.

Russell, R. V., & Stage, F. K. (1992). Triangulation: Intersecting assessment and research methods. In F. K. Stage (Ed.), *Diverse Methods for Research and Assessmetn of College Students*. (pp. 123-138). Alexandria, VA: American College Personnel Association.

Santa Rita, E., & Bacote, J. B. (1997). The benefits of college discovery prefreshman summer program for minority and low-income students. [Electronic Version] *College Student Journal*, 31, 161-173.

Sasse, C. M. (1997). *Authentic learning: What makes a classroom and its tasks authentic?* Unpublished Dissertation. University of Missouri-Columbia.

Seltzer, S., Hilbert, S., Maceli, J., Robinson, E., & Schwartz, D. (1996). An active approach to Calculus. *New Directions for Teaching and Learning. Bringing Problem Based Learning to Higher Education: Theory and Practice*, 68, 83-90.

Seymour, E., & Hewitt, N. M. (1997*). Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview Press.

Shannon, D. M., Twale, D. J., & Moore, M. S. (1998). TA teaching effectiveness: The impact of training and teaching experience [Electronic Version]. *The Journal of Higher Education*, 69(4), 440-466.

Silverman, S. L., & Casazza, M. E. (2000). *Learning & Development: Making Connections to Enhance Teaching*. San Francisco, CA: Jossey-Bass

Smedley, B. D., Myers, H. F., & Harrell, S. P. (1993). Minority-status stresses and the college adjustment of ethnic minority freshmen. [Electronic Version] *The Journal of Higher Education*, 64(4), 434-452.

Steel, J., James, J. B., & Barnett, R. C. (2002). Learning in a man's world: Examining the perceptions of undergraduate women in male-dominated academic areas. [Electronic Version]. *Psychology of Women Quarterly*, 26, 46-50.

Takaki, R. (1994) Reflection on racial patterns in America. Different Shores Perspectives on Race and Ethnicity in America. Second Edition. (p. 1-6)

Teddlie, C., & Tashakkori, A. (2003). Major issues and controversies in the use of mixed methods in the social and behavioral sciences. In A. Tashakkori, & C. Teddlie (Eds.), *Handbook of Mixed Methods in Social & Behavioral Research*. (pp. 3-50). Thousand Oaks, CA: Sage Publications, Inc.

Terenzini, P. T., Pascarella, E. T., & Blimling, G. S. (1996). Students' out-of-class experiences and their influence on learning and cognitive development: A literature review. *Journal of College Student Development*, 37(2), 149-163.

Terenzini, P. T., Springer, L., Pascarella, E. T., & Nora, A. (1995). Academic and out-of-class influences on students' intellectual orientations. *The Review of Higher Education*, 19(2), 23-44.

Thompson, C.E. & Fretz, B.R. (1991). Predicting the adjustment of black students at predominantly white institutions. *Journal of Higher Education*, 62(4), 437-450.

Thompson, M. D. (2001). Informal student-faculty interaction: Its relationship to educational gains in science and mathematics among community college students. *Community College Review*, 29(1), 35-58. Retrieved January 18, 2004, from EBSCOhost database.

Tinto, V., & Goodsell-Love, A. (1993). Building community. *Liberal Education*, 79(4), 16-22.

Treisman, P. M. (1985). *A study of the mathematics performance of black students at the university of California, Berkeley*. Unpublished Dissertation. University of California, Berkeley.

Treisman, U. (1992). Studying students studying calculus: A look at that lives of minority mathematics students in college. [Electronic version]. *The College Mathematics Journal*, 23(5), 362-372.

Valentino, V.R. (1988). *A study of achievement, anxiety, and attitude toward mathematics in college algebra students using small group instruction methods*. Unpublished Dissertation. West Virginia University, Wahlberg, M. (1997). Lecturing at the bored. *The American Mathematical Monthly*, 104(6), 551-556.

Weissglass, J. (1993). Small-group learning. *The American Mathematical Monthly*, 100(7), 662-668.

Weissman, Bulakowski, and Jumisko (1998). A study of white, black, and Hispanic students' transition to a community college. *Community College Review*, 26(2) p. 19-42. Retrieved April 9, 2003, from FirstSearch database.

Wertsch, J.V. (1985). *Vygotsky and the Social Formation of Mind*. Cambridge, MA: Harvard University Press.

Wheatland, J. A. (2000). *The relationship between attendance at a summer bridge program and academic performance and retention status of first-time freshman science, engineering, and mathematics students at morgan state university, an historically black university*. Unpublished Dissertation. Morgan State University, Baltimore, Maryland.

Whitt, E. J., Edison, M., Pascarella, E. T., Nora, A., & Terenzini, P. T. (1999). Interactions with peers and objective and self-reported cognitive outcomes across 3 years of college. Journal of College Student Development, 40(1), 61-78.

Wine, C. B., & Cooper, S. E. (1985). Do preprofessional minority enrichment programs really work? *Journal of College Student Personnel*, 26(5), 366-367.

Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education*, 27(4), 458-477.

Zevenbergen, R. (1996). Constructivism as a liberal bourgeois discourse. *Educational Studies in Mathematics*, 31, 95-113.

Zhao, C. & Kuh, G.D. (2004). Adding value: Learning communities and student engagement. *Research in Higher Education,* 45, 115-138.

Zunkel, K. A. (2002). Relationships among learning community participation, student self-efficacy, confidence, outcome expectations, and commitment. Unpublished Dissertation. Iowa State University.