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ABSTRACT

The aim of this study was to report the development and testing of a model explaining gender differences in the interrelationships among aptitude measures, high school mathematics and science preparation, college academic level, motivational and self-regulatory variables, and grade point average using structural equation modeling and multiple groups analysis for undergraduate females (n=312) and males (n=158). Data were gathered using a new instrument entitled Learning Strategies and Study Skills survey (Ruban and Reis, 1999). First, the study investigated gender differences in precollege scholastic and academic factors, motivation, self-regulation, and academic achievement of postsecondary students. Second, the study simultaneously examined the interrelationships among these cognitive and noncognitive variables for the entire sample of students and for males and females within the structural modeling framework. Tests of interrelationships helped to attain a more complete understanding of the factors that impact college students academic performance, and whether these factors exert similar or differential influence on the academic attainment of males and females. Results of the study provide support for gender invariance for the measurement and structural model for males and females. Even though no gender differences were found, interesting patterns emerged regarding the impacts of precollege scholastic and academic factors and self-regulated learning factors on college academic achievement among male and females collegians. These paths of influence are interpreted in terms of social cognitive theory and research conducted within the framework of gender differences. (Contains 2 figures, 6 tables, and 92 references.) (Author/SLD)

Gender Invariance in the Impacts of Pre-College Scholastic Factors and Self-Regulated Learning Variables on the Academic Attainment of Undergraduate Students

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Abstract

The aim of the present study was to report the development and testing of a model explaining gender differences in the interrelationships among aptitude measures, high school math and science preparation, college academic level, motivational and self-regulatory variables and GPA using structural equation modeling and multiple groups analysis for undergraduate females (n=312) and males (n= 158). Data were gathered using a new instrument entitled *Learning Strategies and Study Skills* survey (LSSS, Ruban & Reis, 1999). The purpose of this study was two-fold. First, the present study investigated gender differences in pre-college scholastic and academic factors, motivation, self-regulation, and academic achievement of postsecondary students. Second, the study examined simultaneously the interrelationships among these cognitive and non-cognitive variables (a) for the entire sample of students, and then (b) for males and females within the structural modeling framework. Tests of interrelationships helped to attain a more complete understanding of what factors impact college students' academic performance, and whether these factors exert similar or differential influence on the academic attainment of males and females. With respect to the first research question, interesting patterns of mean differences on pre-college factors and self-regulated learning variables emerged. With respect to the second and third research question, the results of this study provided support for the gender invariance for the measurement and structural model for males and females. Even though no gender differences were found, interesting patterns emerged regarding the impacts of the pre-college scholastic and academic factors and self-regulated learning factors on the college academic achievement among male and female collegians. These paths of influence were interpreted in terms of social cognitive theory and research conducted within the framework of gender differences.

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Voluminous research has been conducted in the area of gender differences. Researchers in the field of education, educational psychology and psychology, in particular, have examined gender differences in levels of math and verbal aptitude (Bridgeman & Lewis, 1996; Langenfeld, 1997; Wainer & Steinberg, 1992), academic achievement among males and females in school (Hyde, Fennema, & Lamon, 1990) and college settings (Erekson, 1992), particularly with regards to math and science participation and achievement (Nora & Rendon, 1990; Updegraph, Eccles, Barber, & O'Brien, 1996), as well as predictive validity of standardized aptitude measures in explaining gender variations in academic attainment in postsecondary settings (Baron & Norman, 1992; Linn, 1990).

Much of the research provided evidence of a limited predictive validity of standardized aptitude and achievement tests, such as the SAT and ACT. In particular, Linn (1990) explained that colleges rely heavily in their admissions decisions on the use of aptitude tests, such as the Scholastic Aptitude Test (or SAT). The SAT test was designed measure general abilities that are not tied to a specific subject matter, and the purpose of the test is to predict academic achievement in college. However, the average amount of variance explained by these tests is only 10-25%, with these values decreasing dramatically when high school grade point average or high school rank are entered into the prediction model (see, for example, Neisser et al., 1996). Naumann (1998) cited Crouse and Trusheim (1988) who stated that only 10% of college admissions decisions change when SAT is added to the decision making process. Put differently, these researchers contend that knowing students' SAT scores adds very little additional information to improve substantially the accuracy of the decision-making process. Critiques of overreliance on standardized aptitude measures emphasized that these tests are static measures of students' ability to perform an academic task at a particular point in time (Wilson, 1983) and that the belief that these tests can provide an accurate picture of the learner's potential does not reflect reality (Barron & Norman, 1992; Linn, 1990). A growing number of research studies provide compelling evidence that assessments of students need to better identify the building blocks of effective, self-regulated learners, so that more students are afforded greater opportunities for higher education and adult accomplishment (Schunk & Zimmerman, 1994; Zimmerman & Schunk, 1998). Schunk (1998) characterized learners as actively processing information and adapting to their environment, and as a consequence, argued that identifying and measuring variables that enhance and facilitate learning may serve as more effective indicators of future academic and even professional success (see, for example, Zimmerman, 1998). These measures may actually become better predictors of future success than tests that measure only the current level of knowledge in a specific subject matter at a particular point in time (Lidz, 1987).

Recently, the research base investigating the psychometric properties and predictive validity of traditional standardized measures such as the SAT or ACT (Baron & Norman, 1992; Royer & Pitoniak, 2001), has been supplemented by new lines of research gaining prominence in the last quarter century, particularly, research examining models of learning that include self-regulated learning variables. Within the self-regulated learning framework, current research had documented the importance of both cognitive and motivational variables as essential components of successful academic performance (Garcia & Pintrich, 1994; Pintrich & De Groot, 1990; Schunk & Zimmerman, 1989; Zimmerman & Schunk, 1998). Cognitive models supply information regarding the "how" of students' academic experiences, including the description of how learners develop an understanding and demonstrate mastery of content through the use of self-regulated learning strategies (Zimmerman & Martinez-Pons, 1986, 1988) or cognitive strategies (Garcia & Pintrich, 1994). The complimenting and very important role of the models of motivation relates to the description of the "why" of the learning process, or, in other words, explains what motivates students to engage and sustain their persistence in the face of competing alternatives (Bandura, 1997; Garcia & Pintrich, 1994).

Much of the research focusing on gender differences in the areas described above has afforded inconclusive evidence. In many cases, studies examined these variables in isolation using univariate or multivariate methods. On the other hand, structural equation modeling procedures allow to examine simultaneously complex interrelationships among a system of variables. In addition, multiple groups analysis permits an examination of the invariance in the measurement and structural models for different groups. As a consequence, there is a need to examine whether pre-college academic and scholastic factors, as well as motivational and self-regulated learning factors provide a differential prediction of academic attainment for male and female collegians.

Academic Self-Regulation

According to Bandura (1997), one of the major advances in the study of lifelong cognitive development relates to the mechanisms of self-regulated learning in academic settings. *Academic self-regulation* refers to the process in which students activate and sustain cognitions, behaviors, and affects that are systematically oriented toward the attainment of goals (Zimmerman, 1989; 1998a, 1998b). Self-regulated learners are generally characterized as active learners who efficiently and effectively manage their learning with respect to metacognitive, motivational, and behavioral aspects (Zimmerman, 1989). Zimmerman identified the hallmarks of academic self-regulation to include: academic time management, practice, mastery of learning methods, goal-directedness, and robust sense of self-efficacy. The construct of academic self-regulation has gained increasing attention in the last two decades, resulting in numerous studies conducted in a variety of settings with individuals representing different age and achievement groups (for reviews, see Schunk & Zimmerman, 1994 and Zimmerman & Schunk, 1998), as well as several longitudinal studies (e.g., Vermetten et al., 1999). Self-regulated learning is an important component for college students. In contrast to K-12 students, most college students have a great deal of control over their own time management and schoolwork schedules as well as over how they structure their studying and learning activities (Pintrich, 1995). More generally, models of self-regulated learning provide a very useful description of what effective learners do in college courses (Pressley & McGormick, 1995).

Self-Regulated Learning Strategies and Academic Achievement

A major component of academic self-regulation is self-regulated learning strategies defined by Zimmerman (1989) as "actions and processes directed at acquiring information or skills that involve agency, purpose, and instrumentality perceptions by the learners" (p. 329). Zimmerman and Martinez-Pons (1986), using interviews with high school students, found evidence of 14 types of self-regulated learning strategies including such methods as organizing and transforming information, self-consequating, seeking information, and rehearsing and using memory aids. Students' use of these strategies was highly correlated with their achievement and with teachers' ratings of their self-regulation in a class setting. In fact, students' reports of their use of these self-regulated learning strategies predicted their achievement track in school with 93% accuracy, and 13 of the 14 strategies discriminated significantly between students from the upper achievement track and students from lower tracks. The self-regulated learning strategies described by Zimmerman (1989) encompass three classes of strategies that all students use to improve self-regulation of their (a) personal functioning; (b) academic behavioral performance; and (c) learning environment (Bandura, 1986; Zimmerman, 1989).

Motivation and Academic Self-Regulation

Students' Regulation of Their Motivation. In addition to monitoring and controlling cognitive and metacognitive strategies, self-regulated learners also actively manage other important aspects of their classroom learning (Wolters, 1998). In particular, according to the social cognitive theory of academic self-regulation, students regulate the motivational, affective, and social determinants of their intellectual functioning as well as the cognitive aspects (Zimmerman, 1986; 1990; Zimmerman & Bandura, 1994). In fact, Bandura (1997) contended that the cognitive aspects of self-regulated learning cannot be viewed separately from the motivational aspects. For example, a student may have adaptive cognitive and metacognitive skills, but they will exert little influence on academic performance if he or she fails to use them. As a consequence, motivation, characterized as a student's willingness or desire to be engaged and commit effort to completing a task, is an important component of classroom learning that students may choose to self-regulate (Wolters, 1998). Pintrich and Schrauben (1992) explained that in behavioral terms, motivation is indicated by a student's choice to engage in a particular activity and the intensity of his or her effort and persistence for that activity. As a consequence, self-regulated students are generally regarded as highly motivated students because they exhibit greater levels of engagement, effort and persistence for learning tasks than their peers who do not self-regulate (Zimmerman, 1989, 1990).

Motivation in Using Self-Regulated Learning Strategies as a Function of their Utility. Utility in the context of this investigation encompassed several issues. First, personal utility refers to students' personal and informal assessment of the usefulness of a particular learning strategy or method in their own academic work. Simply put, if students do not find ways to internalize a particular learning strategy and apply it consistently in their courses, they will not use it (Garner, 1990; Nolen & Flaladyna, 1990). Another aspect of the utility of learning strategies relates to the generalizability of these strategies across settings. It appears that certain kinds of learning strategies may be useful in school settings, but may have limited generalizability beyond academic settings. For example, the use of routine memorization may help some students get good grades in certain courses, but it may turn out to be of limited practical utility to them in professional or authentic settings that may place more emphasis on creative and critical thinking abilities, and problem solving (see, for example, Zimmerman, 1998a).

Motivation as a Function of Students' Level of Academic Dedication. Lahmers and Zulauf (2000) argued that academic involvement has a positive relationship with college students' GPA. They cited Astin (1984) who suggested that academic involvement has both quantitative and qualitative characteristics. A quantitative measure of academic involvement, or a proxy for student effort expenditure, concerns the amount of studying, or the number of hours that students spend on their academic work in class and outside of class. Arguably, such quantitative measures also reflect the interest of students in academics, because greater interest in and dedication to scholastic work should result in a greater amount of time students may choose to spend on academics, despite other competing alternatives in the environment (Bandura, 1997; Zimmerman & Bandura, 1994). Zulauf and Lahmers (2000) cited several studies that provided evidence of the relationship between academic time use and college students' academic achievement. Among recent studies conducted with college students in a variety of majors and courses, contradictory results emerged concerning the relationship between time spent on academic pursuits and student academic achievement or their course grades, with several studies reporting a significant positive relationship (e.g., Di, 1996; Miethe, 1989), and other studies finding either a very small relationship (e.g., Lahmars & Zulauf, 2000) or no relationship (e.g., Kember, Jamieson, Pomfret, & Wong, 1995). Lahmers and Zulauf (2000), along with other researchers, suggested that including a measure of time management ability would help clarify these contradictory results. In a study of 470 university students, which comprised the same sample used in the present study, Ruban (2000) found that academic dedication (i.e., the number of hours spent studying outside of class time) provided an incremental validity of 1% hierarchical regression analysis, above and beyond the variance explained in students' GPA by the collection of demographic and academic variables (i.e., gender and academic level in college) and students' self-reported use of self-regulated learning strategies.

Research on Gender Differences in Self-Regulated Learning

Much of the research has documented the importance of self-regulated learning strategies and motivation for academic success in school and college settings (e.g., Bandura, 1997; Garcia & Pintrich, 1994; Paris, Lipson, & Wixon, 1983; Pintrich & De Groot, 1990; Schunk & Zimmerman, 1994). Researchers examining the way males and females go about self-regulating their learning reported mixed findings. Gender differences were found in diverse aspects relating to motivational constructs such as self-efficacy (Zimmerman & Martinez-Pons, 1990); task value (Wigfield & Eccles, 1992; Yu, 1996), intrinsic goal orientation (Pintrich & Schrauben, 1992; Pintrich & Schunk, 1996) and test anxiety (Hembree, 1988; Pintrich & Schunk, 1996), and strategy selection (Zimmerman & Martinez-Pons, 1990), to name a few.

General literature on gender differences indicates that boys ordinarily exhibit greater math ability than girls, however, girls surpass males in verbal ability (Willingham & Cole, 1997). However, in a study of elementary, middle, and high school gifted and non-gifted students, Zimmerman and Martinez-Pons (1990) found that boys perceived significantly greater verbal self-efficacy than girls and similar mathematics self-efficacy. Their analysis of gender differences in strategy selection and use indicated that despite being lower than boys in verbal self-efficacy, girls reported significantly more record keeping and monitoring, environmental structuring, and goal-setting and planning. These unexpected findings led the researchers to describe girls as greater strategy users and boys as more self-efficacious. Wolters and Pintrich (1998) examined contextual differences in student motivation and self-regulated learning in seventh- and eighth-grade mathematics, social studies and English and found differences by subject area and gender in motivation and cognitive strategy use. Furthermore, Ablard and Lipschultz (1998) studied relations of self-regulated learning to advanced reasoning, achievement goals, and gender in middle school high achieving students. Major findings revealed a lot of heterogeneity among the students in their use of SRL strategies (i.e., implying that not all SRL strategies are necessary for high achievement), as well as differences in relationships among goal orientation, gender, and self-regulated learning among high achievers.

Studies conducted in postsecondary settings report enlightening findings as well as well. For instance, Light (1990) contended that males and females differ in their ideas about the benefits afforded from attending college, and in the way they prioritize their academic and other tasks and activities. Literature provides inconclusive findings with respect to the relationship between gender and academic performance, with reports of no gender differences in academic performance (e.g., Michaels & Miethe, 1989; Pappalardo, 1986), differences favoring males (Bridgeman & Lewis, 1996), and differences favoring females (e.g., Erekson, 1992). Hogrebe et al. (1985) found that levels of academic achievement were a function of different variables for males and females, which led the researcher to conclude that there is a link between students' gender and their academic performance. Miller, Finley, and McKinley (1990) linked gender differences in academic performance to differences in learning behaviors among male and female collegians, concluding that: (a) both males and females appear to possess adaptive and maladaptive learning approaches and motives, (b) the former were overall at higher risk academically than the latter; and (c) gender differences in academic achievement among males and females are at least partially a function of their learning styles, approaches, and motives. In particular, Miller et al. (1990) reported that women were more intrinsically motivated and more strategic and organized in their approach to learning, and they integrated new information to their existing schemata more than men did. On the other hand, in their study men surpassed females on measures of deep processing, deep approach, comprehension learning, and use of evidence, which, in combination, relate to high levels of comprehension and understanding. Even though men were found to score higher on achievement motives (i.e. seeking high grades and academic rewards), Miller at al. (1990) cautioned that achievement motives may not result in higher levels of comprehension and understanding, unless the motives are inextricably linked to hallmarks of academic self-regulation, such as deep processing styles or elaborative approaches and an organized approach to learning.

In her review of literature on gender and ethnic differences in college science and math achievement, Yu (1996) pointed out that, despite voluminous research on academic self-regulation, few studies examined psychological aspects of gender differences in learning strategies. Earlier, Miller et al. (1990) argued that the developmental perspective on gender differences in learning approaches and motivation has not received much attention, however, the few studies that did examine these differences reported conflicting findings. For example, several studies reported no differences between men and women (e.g., Miller, Alway, & McKinley, 1987; Schmeck & Ribich, 1978), while others found differences in various aspects of academic self-regulation. Miller et al. (1990) cited earlier findings from Australian studies indicating sex differences with respect to academic self-regulation. In particular, in Biggs's (1970) study, females were organized in their learning approaches and study behaviors. Watkins and Hattie (1981) found that female students demonstrated higher interest in their courses, more organized approach to learning, and the use of deep processing approach to learning as compared to males. In contrast, male students were more worried about their work, and were more pragmatic in their learning orientations and study behaviors. Watkins and Hattie (1981) linked these patterns of self-regulated learning to students' academic achievement, arguing that men's lower grades were linked to their adoption of ineffective learning approaches, which had a negative relationship with their academic performance.

Academic Level, Students' Regulation of Their Learning, and Achievement in College

Previous research supports the existence of positive relationship between college students' academic level and their academic achievement (e.g., Van Etten, Pressley, & Freebern, 1999; Vermetten, Vermunt, & Lodewijks, 1999). Several studies have examined the relationship between study time and GPA as a function of students' academic level. Michaels and Miethe (1989) found that the amount of time spent on academics was associated with higher grades for lower academic division students (i.e., freshman and sophomores), but had little impact on the academic achievement for juniors and seniors. Erekson (1992) reported that freshman students earn a significantly lower GPA than students of other academic levels. Several researchers who conducted longitudinal, within-subjects studies (e.g., Vermetten et al., 1999) have formulated a *developmental hypothesis*, meaning that, as students progress through academic levels in college, their learning strategies, mental learning models, and learning orientations become more complex and more focused, and reveal stronger relationship to their academic achievement. Vermetten et al. (1999) in their longitudinal study of college students found that students as a group improved their reported quality of learning within the first few years of a university study, as evidenced by the considerable changes in their reported use of learning strategies. In particular, students reported greater use of strategies representative of a meaning-directed learning style. Notably, several cross-sectional studies conducted by other researchers (e.g., Busato, Prins, Elshout & Hamaker, 1998; Lonka & Lindblom-Ylänne, 1996) did not detect differences in learning style dimensions in a cross-sectional design, but found an increase in reported use of meaning-directed learning style in a longitudinal design (Vermetten et al., 1999). Watkins and Hattie (1985) also reported significant positive changes in the use of self-regulated learning strategies in a longitudinal study. Vermetten et al. explained that, from the perspective of higher education, which aims at generating more advanced and deep-level learners who are self-regulating, these results are very satisfying. As stated above, accumulated research evidence supports a strong positive relationship between students' use of self-regulated learning strategies and their academic achievement (Pintrich & De Groot, 1990; Zimmerman & Martinez-Pons, 1986, 1988). Few empirical studies examined gender differences in the relationship between students' regulation of their motivation and their academic achievement, when it is examined as a function of the students' academic level in college. Therefore, more research is needed before any strong conclusions can be made (Vermetten et al., 1999).

High School Mathematics and Science Preparation and College Participation

Accumulated research evidence links the type and extent of student academic preparation to college mathematics and science participation and achievement (Nora and Rendon, 1990; Updegraff, Eccles, Barber, & O'Brien, 1996). Nora and Rendon (1990) asserted that students in high school academic programs, compared to those in general and vocational programs, are more likely to study engineering or biological science. Similarly, students who concentrate on mathematics and science majors take more courses in those disciplines and tend to earn higher overall grades than non-participants (Malcom, 1983; NSF, 1994; West, 1985). Earlier research documented that, in general, female students tend to avoid taking mathematics and science courses in high school and select themselves out of higher-level courses. As a consequence, limited math and science exposure decreases their mathematics and science achievement and curtails their opportunities in college (Davis, 1986; Ethington & Wolfe, 1986; West, 1985). Nora and Rendon (1990) found that in their study, white females with little or adequate preparation received the lowest grades, had taken the fewest number of science courses in high school, and received the least amount of encouragement from significant others to attend college. Extensive evidence documented underrepresentation of females in advanced math courses, which, in turn, effectively blocks doors to math-related occupations and college majors (Fennema & Sherman, 1978).

Recent reports have extended the concern more broadly to both males and females (NSF, 1994), with several reports of the educational status of American students pointing to fairly low levels of math proficiency in school settings (National Excellence Report, 1994). Some researchers (e.g., see Matthews, 2000) link student exposure to challenging high school classes in mathematics and science with the acquisition of valuable self-regulatory skills by school students, which become critically important for their subsequent academic careers. In particular, researcher Clifford Adelman, in his study "*Answers in the Tool Box*," examined academic records of a large cohort of 13,000 students who were followed from the tenth grade in 1980 until they were about 30 in 1993. It showed that despite the emphasis college admissions officers place on high school grades, scores and class rank, the strongest predictors of college completion were challenging classes. What mattered was how rigorous and challenging students' high school courses were, no matter what grades they received. Notably, these classes were the most important factor in predicting the success of minority students. Adelman explained that courses like Advanced Placement (AP) and International Baccalaureate (IB) help develop "self-directed learning skills," which have a positive relationship with adaptive outcomes in academic settings.

Further, Royer et al. (1996), in their comprehensive review of literature on gender differences in math performance, cited findings from numerous studies documenting these differences with respect to math and verbal aptitude, as well as math performance and academic achievement in school and college settings. In particular, according to the researchers, accumulated body of evidence consistently indicates that males score much higher on the mathematics section of the Standardized Aptitude Test (SAT), and that the average difference of 40 points between the genders has remained constant over several decades (Langenfeld, 1997). With respect to SAT-Verbal scores, literature on sex differences indicates that males often surpass females in mathematics but not in verbal ability (e.g., Langenfeld, 1997; Maccoby & Jacklin, 1974). With respect to gender differences in grades and academic accomplishment, research reviewed by Royer et al. (1996) concludes that gender differences in math grades tend to appear more reliably in junior high school, with girls outperforming boys (Kimball, 1989; Willingham & Cole, 1997). In particular, Kimball found that girls receive better grades in specific junior high school courses and obtain higher cumulative mathematics grade point average. Findings at the university level are less conclusive, with reports ranging from finding no differences or concluding that females surpass males in terms of mathematics achievement. Further, research on select populations such as Benbow and Stanley's (1982) study of

SMPY students reported a significant SAT-Math performance advantage for males in middle and high school grades, but a significant grade advantage for females.

On the college level, Royer et al. (1996) cited findings from Bridgeman and Lewis' (1996) study of 30,000 students found interesting gender patterns in the relationship between SAT-Math scores and college calculus achievement when the math aptitude data was disaggregated into high, middle, and lower groups. Bridgeman and Lewis (1996) reported that females obtained a higher calculus grade advantage in college calculus classes when females and males from the upper and middle SAT-M groups were compared. Specifically, males scoring 700+ on the SAT-Math obtained slightly lower calculus grades in college (2.94 for males vs. 2.98 for females). Males who received scores of 650-699 on SAT-Math, received an average grade of 2.63, in contrast to a grade of 2.71 for comparable females. However, this pattern was reversed for the lowest-scoring SAT-M group (scores of 500 and lower), whereby males (1.95) surpassed females (1.84). In addition, the same researchers re-analyzed the data to examine the question of whether male and female student who achieved the same grade and in the same class, also differed in SAT-M scores. The emerging picture of males consistently surpassing females in math aptitude at every grade division was provocative. Specifically, males who received an A had a mean score of 647, whereas females receiving A in the same class scored only 613.

Traditional Prediction of College Achievement Using Standardized Tests

Prediction of academic achievement has been a pervasive topic in American education, with emphasis on the relationship between scholastic aptitude and academic attainment. Proliferation of research studies conducted within this paradigm have proposed a large number of variables which can potentially explain academic achievement in K-12 and postsecondary settings. Naumann (1998) pointed out that the validity of academic assessment inevitably becomes an essential issue when educational measures are used in "high stakes" test environments where the decision-making process may have a long-term impact on an individual's life. For instance, the results of such tests have serious implications for persons trying to secure a particular job, qualify for certain educational programs or attain admittance into college. She contended that it is unreasonable for measurement specialists or college admission personnel to be satisfied with a scale that is able to predict only 15-20% of the variance in college performance. The researcher cited several studies that examined the amount of variance in academic performance that these tests are able to explain. For example, the average amount of variance in the first-year grade-point average explained by the SAT or the ACT is only 25%, with most studies reporting values slightly above 10% (Linn, 1990). These values remain fairly stable when cumulative grade point average after four year of college is used as a criterion variable (Wilson, 1983). In contrast, these values decrease dramatically when high school grade point average or class ranks are added into the prediction equation (Neisser et al., 1996).

In addition, using a large sample of college students, Baron and Norman (1992) found that the SAT scores were able to provide extremely small incremental validity, adding only about 4% increase (i.e., a small effect size according to Cohen's 1988 guidelines) in the prediction of the variance in the cumulative GPA after four years of college above and beyond the amount predicted by high school grade point average. Crouse and Trusheim (1988) supported these findings, providing evidence that high school grade point average may be a better predictor of college GPA, and that the SAT does not provide significant incremental validity to the prediction, after controlling for the effects of high school rank. Furthermore, research conducted within the social cognitive theory framework questions the predictive power of standardized aptitude measures in predicting college attainment. For example, Zimmerman and Bandura (1994) examined the impact of self-regulatory influences on writing course attainment in a selective postsecondary institution. They found that students' verbal aptitude (i.e., SAT-Verbal scores) did not have any direct impact on course grades when self-regulatory factors were included. Verbal aptitude affected writing course outcomes only indirectly by its influence on self-evaluative standards and personal goal setting. Importantly, the self-regulatory factors in the path model not only mediated the influence of verbal aptitude but also provided an incremental contribution of 29% in the prediction of the final grades in the writing course.

Much of the research focusing on gender differences in the areas described above has afforded inconclusive evidence. As a consequence, there is a need to examine whether pre-college academic and scholastic factors, as well as motivational and self-regulated learning factors provide a differential prediction of academic attainment for male and female collegians. In many cases, studies examined these variables in isolation using univariate or multivariate methods. On the other hand, structural equation modeling procedures allow researcher tosimultaneously examine complex interrelationships among a system of variables. In addition, multiple groups analysis permits an examination of the invariance in the measurement and structural models for members of different groups.

This study examined the relationships among standardized aptitude measures (the SAT, or the Scholastic Aptitude Test), academic level, high school mathematics and science preparation, motivation, self-reported use of academic self-regulatory methods and academic achievement among university undergraduates using structural equation modeling approach. Furthermore, we examined simultaneously the differential impact of these variables on the academic achievement of males and females using multiple groups analysis. Identifying differences and similarities in the strength and direction of the standardized aptitude measures, high school academic preparation, motivation, and academic self-regulation on the academic achievement of undergraduate students may increase our understanding of the differential impacts of these variables on the academic attainment of males and females. This study sought to provide answers to the following research questions:

1. Are there gender differences in pre-college academic and scholastic factors (e.g., high school rank, standardized math and verbal aptitude scores, and high school math and science preparation), college academic level, motivation for and the use of self-regulated learning strategies, and academic achievement between male and female collegians?
2. What is the relationship among standardized aptitude measures, high school math and science preparation, college academic level, motivation, self-reported use of self-regulated learning strategies and academic achievement among undergraduate students?
3. Are there differential impacts of the standardized aptitude measures, high school math and science preparation, college academic level, motivation, self-reported use of self-regulated learning strategies on the academic achievement of undergraduate males and females?

Methods and Procedures

Research Design

In the present study, survey research design, a form of descriptive research, provided an overarching framework for this investigation, which was conducted in a higher educational setting (Light, Singer, & Willett, 1990). Survey research methods were used to gather data about demographic characteristics, study practices, and student self-reported use of self-regulated learning strategies and study skills among university students. University electronic database THESIS was used to gather data about SAT scores and high school math and science preparation.

Sample

The final sample in this survey research study included respondents from four groups of undergraduate students from a large research university in the northeast (N=470): low achieving students (n=102), normal achieving students (n=89), high achieving students (n=226), and students with learning disabilities (n=53). The low achieving group was initially comprised of 238 students who participated in a university program for students who are at-risk academically, in the fall of 1999 and spring of 2000. These students were placed on academic probation because they had failed to meet the University's minimum academic standards during the semester prior to enrollment in this program. A combination of two consecutive waves of mailed surveys and distribution of surveys through the facilitators who worked with the students resulted in a total of 102 surveys, or a 51% rate. A random sample of 300 high achieving students were drawn from all 838 students who participated in a university program for Honors Scholars in the 1999-2000 academic year. This program enables intellectually gifted and highly motivated students to receive a challenging and rewarding university experience. All undergraduate students are eligible to participate, however, the admission standards are rigorous. Students need at least a 3.2 grade point average to be considered for the program (3.4 for transfer students), they must be in the top 8% of their graduating high school class and have generally scored a minimum of 1320 on the SAT's to be considered for the Honors Program. Two consecutive waves and distribution of surveys in class resulted in 226 returned surveys, for a 75% response rate. A convenience sample of 89 undergraduate education majors in an introductory learning class represented a normal achieving group. Students who participated in an intervention program for college students with learning disabilities (LD) comprised the LD group. Of the total of 119 program participants, 53 students returned surveys, for a 45% response rate. The overall response rate from all the groups was 68.9%. The study participants represented a variety of academic levels and majors, had a range of academic achievement as measured by their cumulative GPA, had variability in their SAT scores and different levels of high school math and science preparation. The demographic and academic characteristics of the males and females in the total sample of 470 participants are presented in Table 1.

< Insert Table 1 About Here >

Males. One-third of the students in the entire sample (n=158) were male (33.6%), with an average age of 21 years old. The majority of the students were Caucasian (76.6%) and they represented a variety of academic levels (freshman, 31.6%; sophomores, 29.1%; juniors, 25.3%; and seniors, 14.0%). With respect to pre-college academic characteristics, males' SAT-Verbal scores ranged 350 – 800 (M = 588; SD = 103); their SAT-Math scores had a greater range 200 – 800 (M = 607; SD = 105). Their average high school rank was 77.85 (SD = 18.81); they took on average three or more math classes and science classes in high school (M = 3.76; SD = 1.33; and M = 3.09, SD = 1.11, respectively). Their cumulative grade point average (GPA) ranged from a low of .42 to a high of 4.00 (M = 2.79; SD = .89). They reported studying on average 16 - 19 hours outside of their class time (M = 3.46, SD = 1.50). (See Tables 4 and 5)

Females. The majority, or two-thirds (n=312) of the students in the sample were females (66.4%); the mean age of this group was 21 years old. Most female participants were white (77.2%), and they tended to be mostly sophomores or juniors (freshman, 20.9%; sophomores, 29.6%; juniors, 29.6%; about one-fifths of the female students seniors, 19.6%). Their self-reported GPA ranged 1.70 – 3.80 (M = 2.77; SD = .58). Their SAT-Verbal scores ranged between 340 and 800, with a mean of 598 and standard deviation 99. Their SAT-Math scores had a similar range (320 - 800) and variability (M = 594; SD = 98). The females had a fairly high average high school rank (M = 85.25, SD = 99) and a fairly high cumulative GPA in college (M = 3.15, SD = .75). They reported studying on average 16 - 19 hours outside of their class time (M = 3.59, SD = 1.42). (See Tables 4 and 5)

Instrumentation

A new 58-item instrument entitled Learning Strategies and Study Skills Survey (LSSS, Ruban & Reis, 1999) was developed for this study to assess students' self-reported use of self-regulated learning strategies and compensation strategies in their academic work across academic settings. This instrument was developed using Zimmerman's (Zimmerman, 1989; Zimmerman & Martinez-Pons, 1986, 1988) work on self-regulated learning strategies used by school students, and Reis, Neu, and McGuire's work on compensation strategies used by academically successful university students with learning disabilities (LD) (Reis et al., 2000; Reis, Neu, & McGuire, 1997). The first three factors corresponded to standard study skills and learning strategies used by a general population university students. The last three factors represented compensation strategies used primarily by students with LD. Alpha reliabilities on the six factors of the LSSS survey ranged from .70 to .92. The instrument utilized a five-point Likert summated ratings scale with only the end points labeled, from "1" = "Not At All Typical of Me" to "5" = "Very Typical of Me." Therefore, students' use of self-regulated learning strategies, as measured by the LSSS, is indicated along a continuum, as high scores indicate a more frequent use of learning strategies, and low scores suggest that a student generally does not use learning strategies in his or her academic work. For the purposes of this study, three self-regulatory factors were in the structural equation modeling analysis: Conceptual Skills, Routine Memorization, and Compensation Strategies (see Table 2).

Data Analyses

Confirmatory factor analysis (CFA) and structural equation modeling analysis (SEM) were used to assess psychometric properties of the *LSSS* survey, and to assess the extent of the differential impact of the standardized aptitude measures, academic level, perceived usefulness and the use of standard self-regulated learning strategies and compensation strategies on the academic achievement of university students with and without learning disabilities. Data analyses were conducted using EQS 5.7b program for Windows (Bentler & Wu, 1995).

Confirmatory Factor Analysis. Support for the construct validity of the instrument was obtained through the use of a confirmatory factor analysis (CFA), which permits an examination of the psychometric adequacy of an instrument and can aid in item evaluation and construct development (Kenny, Kashy, & Bolger, 1998). The confirmatory factor analysis utilized a "model generation strategy" (McCallum, 1995) to improve fit to the data and achieve parsimony. The CFA analysis found sufficient support for the final measurement model. The final three-factor measurement model, consisting of 19 items, exhibited a significant chi-square, χ^2 (147) = 241.0, $p < .001$. In confirmatory factor analysis, where a non-significant value in the chi-square test supports the hypothesized model, the likelihood of rejecting a true model increases with the use of large sample sizes (Marsh, Balla, & McDonald, 1988). Therefore, the results were interpreted based on the following fit indices: Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). The obtained results supported the existence of a three-factor structure on the LSSS survey (TLI = .95, CFI = .96, RMSEA = 0.037). The standardized loadings for the final measurement model were in the moderate to high range (.38 - .85), and all Cronbach alpha reliabilities were in the range recommended by Gable and Wolf (1993), i.e., .70 and above. The correlations among the factors ranged from non-significant to moderate (.02 to -.37). Table 2 presents students' mean scores on the self-regulated learning factors, Cronbach's alpha reliabilities, and goodness of fit summary indices for the confirmatory factor analysis.

Omnibus Run and Multiple Groups Analysis. To examine relationships among standardized aptitude scores, academic level, motivation, conceptual skills, routine memorization skills, compensation strategies, and students' GPA, a structural equation model for the entire sample of males and females (N = 470) was tested. Researchers assessed global fit of the structural model using the Tucker-Lewis index (TLI), the comparative fit index (CFI), and the root mean square approximation error (RMSEA). The TLI and CFI values above .90, in conjunction of RMSEA values below .05 indicate a good fit of the model. In addition, standardized residuals and modification indices were inspected for evidence of local fit. We also examined the differential effects of the standardized aptitude measures, high school academic preparation, high school rank, college academic level, motivation, and self-regulated learning factors for males and females. A multiple groups structural analysis was conducted to ascertain whether the structural model that was developed differed across these two groups of students. Equality constraints were imposed to test for the invariance of the parameters between the two groups.

Measurement of Variables in the Model. Variables representing the pre-college block of exogenous predictor variables were obtained from the university electronic database: Standardized aptitude measures (i.e., SAT-Verbal and SAT-Math scores), high school rank (HSRank), high school math preparation (HS Math), and high school science preparation (HS Science). SAT scores and high school rank were measured as continuous variables, whereas HS Math and HS Science were created as composite variables by adding up the number of math and science courses students enrolled in high school. The three factors (Conceptual Skills, Routine Memorization, and Compensatory Supports) represented latent variables in the structural equation model created in this study, with items serving as indicators. Students' cumulative grade point average (GPA) obtained from the university electronic database during he semester that students responded to the survey served as the observed dependent variable in this study. The latent variable Motivation was measured by combining three questions on the *Learning Strategies and Study Skills* (LSSS, Ruban & Reis, 1999) survey. The first indicator Perceived Usefulness was measured by a composite variable comprised of ratings on six dichotomized items, which asked students to indicate why they choose to use (1) or not to use (0) learning strategies and study skills in their academic work (range 0 – 6). The rationale for including this variable in the study was research indicating that students will be more motivated to use self-regulated learning strategies if they perceive that the strategies are useful in their academic work (Garner, 1990; Nolen & Flaladyna, 1990). The second indicator Perceived Benefits was measured by a four-point Likert-type item, which asked students to rate the degree to which they consider the use of study skills and learning strategies to be beneficial in their work, from "1" = "Not Beneficial," to "4" = "Very Beneficial." The third indicator named Academic Dedication was an ordinal variable representing number of hours per week students spent on homework assignments and projects outside of class time, from "1" = "0 – 4 hours" to "7" = "over 30 hours." This variable was used as a proxy for students' academic involvement.

Procedure

Several data collection procedures were used in this study, in order to ensure the highest response rate and obtain accurate data. These strategies included mailed surveys, distribution of the surveys through the personnel working with the students in their respective programs (i.e., *The Honors Scholars Program, The University Program for College Students with Learning Disabilities,* and *The Scholastic Probation Program*), distribution of surveys in class, direct phone calls and e-mail messages to students. A cover letter and a post-paid return envelope, when appropriate, were sent along with a questionnaire. Students were offered incentives to participate in the study, namely, (a) the respondents' names were entered in a random *drawing* of gift certificates from the campus bookstore; and (b) students who filled out surveys in class were given extra credit. Students were assured of anonymity and that only the investigator would have access to the data. Students signed informed consent allowing researcher access to their academic records.

Results

Demographic and Academic Characteristics of the Males and Females

T-tests were conducted on selected demographic, academic and self-regulated learning variables to assess whether there were differences among males and females. Using Bonferroni adjustment, testwise alpha was adjusted to in order to compensate for conducting a series of t-tests and alleviate the concern with Type I error (Tabachnick & Fidell, 2001). Males (n=158) and females (n=312) as a group differed on several demographic, academic, and self-regulated learning characteristics. With respect to pre-college block of variables, there were no gender differences on SAT-Verbal or SAT-Math scores; males and females did not differ in high school academic preparation, or the average number of math and science courses they enrolled in high school. However, females had a significantly higher high school rank [$t\ (434) = -3.84$, $p < .001$] and college cumulative GPA [$t\ (434) = -4.00$, $p < .001$]. With regard to the motivational and self-regulated learning aspects, males and females reported similar levels of academic dedication (or amounts of study time outside of class) and similar use of self-regulated learning strategies, with the exception of routine memorization whereby females reported greater use [$t\ (467) = -3.84$, $p < .001$. In addition, females also reported higher levels of the perceived usefulness of the use of self-regulated learning strategies [$t\ (438) = -3.34$, $p < .01$] and their global assessment of the benefits derived from the use of SRL strategies in their academic work in general [$t\ (467) = -2.89$, $p < .01$]. (See Tables 4-5 for details about means and standard deviations)

Omnibus Run for the Entire Sample

In the initial hypothesized model, the SAT-Verbal, SAT-Math, High School Rank, High School Math, High School Science Preparation, and Academic Level predicted student motivation to use learning strategies, their use of self-regulated learning strategies, which in turn predicted student academic achievement (GPA). First, the structural model was tested on the entire sample of students.

Contrary to our expectations, HS Math and HS Science, had no relationship with other variables in the model. These predictors were therefore dropped from the final omnibus run (as well as from the multiple groups analysis). The structural model was tested on the entire sample of students. Because of missing data, the initial sample size of 470 students was reduced to 312. (See results in Figure 1)

<Fig. 1 here>

The chi-square for this model was χ^2 (309) = 556.3, p < .001. Although the final chi-square was significant, this statistic is extremely sensitive to sample size (Kline, 1998). Conventional practice in structural equation modeling suggests that values of CFI and TLI above .90 (Kline, 1998) and values of RMSEA below .05 (Maruyama, 1998) provide evidence of a good fitting model. The comparative fit index (CFI) was .923, the Tucker Lewis index (TLI) was .913, and the root mean squared error of approximation (RMSEA) was 0.047 (90% confidence interval of RMSEA = .040 to .053). The fit indices indicated that the data provided adequate evidence of reasonable fit to the final specified model. This omnibus model explained 63.5% of the variance in students' self-reported cumulative GPAs. Only one of the three self-regulated learning factors, the compensation strategies factor was a significant predictor of GPA. However, the path from compensation strategies to GPA was negative (β = -.11), suggesting that after controlling for the other variables in the model, students who reported using more compensation strategies tended to have slightly lower GPAs than students who reported using fewer compensation strategies. The motivation factor had a significant direct path to GPA (β = .33). This suggests that after controlling for the other variables in the model, students who report perceiving greater benefits from using self-regulated learning strategies also tend to report having higher GPAs. In addition, there was no direct path from the motivation factor to the compensation strategies factor. This suggests that the use of compensation strategies is essentially unrelated to the perceived usefulness of self-regulated learning strategies, as operationalized in this model. Academic level was significantly related to compensatory strategies (ß = -.11), and GPA (ß = .22). In other words, upper classmen tended to have higher GPA's and use fewer compensation strategies. Motivation partially mediated the effect of academic level on GPA, namely, students who have been in college longer and who have higher levels of motivation for using self-regulated learning strategies have higher GPAs. SAT-Math (ß = .166), SAT-V (ß = .274), and high school class rank (ß = .238) were significantly related to GPA. The total effect of the SAT-V on GPA was .346.

Multiple Groups Structural Models for Males and Females

In the multiple groups structural model, academic level, SAT-Verbal, and SAT-Math, high school class rank, motivation, and the three self-regulated learning factors were used to predict students' college cumulative GPA. For females (n=253), the structural equation model accounted for 64% of the variance in their cumulative GPA. For males (n=119), the structural equation model accounted for 57% of the variance in cumulative GPA. In the multiple groups analysis, the patterns of the magnitude and direction of the standardized parameters were similar to that of the omnibus analysis (see Figure 1), implying similar interpretations of the relationships among the variables. Of note is the importance of high school rank as a predictor variable, namely, high school rank had significant relationships with all endongenous variables in the model. Students' higher school rank was related to higher levels of motivation, use of conceptual skills and routine memorization, and cumulative GPA in college. The pattern was reversed in the case of compensatory supports, in other words, students who had higher high school rank reported using fewer compensatory supports in college. The only other exogenous variable that had an impact on student motivation to use SRL strategies was their academic level in college, with older students reporting greater levels of motivation. Motivation partially mediated the relationship of HS Rank and Academic Level with cumulative GPA for both males and females. Motivation exerted positive influence on students use of conceptual skills and routine memorization for both groups; however, it was unrelated to students' use of compensatory strategies. Contrary to the hypothesized relationships, conceptual skills and routine memorization did not have relationship with students' cumulative GPA, after accounting for the effects of the pre-college factors, college academic level, motivation, and compensatory strategies.

Notably, neither of the standardized aptitude measures had relationship with motivation either for males or females. High School Rank, SAT scores and Academic Level) had a positive direct relationship with GPA, with the SAT-Math exerting the smallest influence on GPA of the four exogenous variables in the model for males. Interestingly, SAT-Math had a negative relationship with the use of conceptual skills (ß = -.153 and ß = -.175 for males and females, correspondingly). In other words, students who obtained higher SAT-Math scores reported lower use of conceptual skills in college after controlling for the effects of SAT-Verbal and high school class rank. The largest effects in the models for both genders were those of SAT-Verbal on conceptual skills (ß = .584 for males and females) and on compensatory supports (ß = -.526 and ß = -.507 for males and females, respectively).

In the multiple groups model, all factor loadings and structural paths were constrained to be equal. The chi-square for this constrained model was χ^2 (600) = 899.2, p < .001 (TLI=.90, CFI=.91, RMSEA=.037). None of the χ^2 for the constraints for the measurement model were statistically significantor the structural model were statistically significant. These results suggest that boys and girls exhibited both similar factor structure on the *LSSS* questionnaire and similar patterns of relationships among the variables in the specified structural model.

<Fig. 2 here>

<Fig. 3 here>

Limitations

This section discusses the factors that limit the generalizability of the results in the present study. Broadly speaking, three major categories of limitations corresponded to the three sources of measurement error in survey research: (a) instrumentation; (b) respondents; and (c) data collection techniques (Simsek & Veiga, 2000). In addition, some of the limitations related to the conceptualization of the research design and the theoretical framework of the study. First, students were asked to provide a self-report on their use of self-regulatory methods across academic contexts. It should be noted that students' self-report of their study behaviors in generic learning contexts may not reflect how they study for particular courses, and may also largely depend on the domain (King, 1992a, 1992b). Therefore, a scale that measures students' general academic practices may be a rough approximation of the way in which students use self-regulated learning in different courses (Bol, Warkentin, Nunnery, & O'Connell, 1999). Some researchers argue that students' self-regulated learning strategy use should be studied with reference to a specific subject matter and certain timeframe (e.g., Bol, Warkentin, Nunnery, & O'Connell, 1999). Another issue relates to the nature of the self-report data, which do not reveal what the students report they do when asked to report their academic behaviors on the survey, and what they actually do in real academic contexts (Perry, 2002). With respect to respondents, there was a certain degree of heterogeneity and in our sample. The entire sample was comprised of students representing different achievement groups and disability status, i.e., low-, normal-, and high-achieving students and students with learning disabilities, with higher achievers comprising almost half of the sample. In addition, low achieving group was mostly represented by males, and high achieving group was mostly comprised of females, which poses threats of selection bias and limits the generalizability of the findings. Another issue relates to the availability of data for students' high school rank. Because 98 students did not have data on this variable, they were not included in the structural equation modeling analysis. Overall, these limitations preclude generalizability of the study's findings to the general population of students at a research university.

Discussion

The purpose of this study was two-fold. First, the present study investigated gender differences in pre-college scholastic and academic factors, motivation, self-regulation, and academic achievement of postsecondary students. Second, the study examined simultaneously the interrelationships among these cognitive and non-cognitive variables for males and females within the structural modeling framework. Tests of interrelationships helped to attain a more complete understanding of what factors impact college students' academic performance, and whether these factors exert similar or differential influence on the academic attainment of males and females.

With respect to the group mean differences, interesting findings emerged. Females received higher grades both in high school and in college, and were not different from males in their standardized aptitude scores. Whereas the first finding was consistent with previous research showing that girls receive better grades in high school and often outperform males in college (Royer et al., 1996), the no-difference finding in their standardized aptitude scores appeared to be contrary to previous research documenting gender differences in that area. With respect to SAT-Verbal scores, literature on sex differences indicates that males often surpass females in mathematics but not in verbal ability (e.g., Langenfeld, 1997; Maccoby & Jacklin, 1974). However, the finding in this study might be at least partially a function of the sample heterogeneity (i.e., the sample was comprised of low-, high-, and normal-achieving students and students with learning disabilities) and selection bias (i.e., most study participants were female, and the majority of the high-achieving students were female).

Of note is the finding in this study that males and females did not differ in their average level of high school math and science preparation. On the one hand, the fact that male and females participants in this study on average enrolled in a similar number of semesters (i.e, 3 or 4) of math and science courses in high school represents a positive finding. Approximately equal proportions of male and female students enrolled in algebra I and algebra II, and a slightly greater proportion of females enrolled in calculus (39% for females vs. 31% for males). On the other hand, slightly more males than females enrolled in high school physics (63% vs. 53%, respectively). However, the finding in this study that less than half of the students (regardless of gender) chose to take calculus when they were in high school is quite alarming, given previous research showing that course enrollment decisions are among the most influential self-regulatory behaviors students exhibit in high school, as the type and extent of student academic preparation has been linked to mathematics and science participation and achievement (Nora & Rendon, 1990; Updegraff et al. (1996); West, 1985).

Women and men who participated in this study as a group differed on several motivational and self-regulated learning variables. In particular, women reported higher levels of both perceived usefulness and appraisal of benefits derived from the use of self-regulated learning (SRL) strategies. Regarding the actual use of SRL strategies, women were higher only on the use of routine memorization. There were no gender differences in academic dedication (or the amount of time students spent studying outside of class time), the use of conceptual skills and compensatory supports. Perhaps women in this study were intrinsically more motivated and more strategic in their approach to learning than males were. In the present study, females may have had higher achievement motives, which, paired with their greater levels of positive appraisal of the use of self-regulated strategies, resulted in higher levels of academic achievement in college. Females in this study received significantly higher cumulative grade point averages, corroborating previous research showing than females often outperform males in postsecondary settings (see, for example, Ereckson, 1992). Again, these findings may have been partially a function of the sample and selection bias, as a large proportion of the entire sample were high achieving females.

This study went beyond descriptive results and utilized structural equation modeling procedures to examine whether pre-college scholastic and academic factors (i.e., standardized aptitude scores, high school rank, high school math and science preparation), college academic level, motivation and self-regulated learning variables provide a differential prediction of college academic achievement for males and females. We found no gender differences in the impacts of the pre-college scholastic and academic factors and self-regulated learning factors on the college academic achievement among male and female collegians. This "no-differences" finding may be regarded as both positive and notable, given prior research showing gender differences in such diverse academic areas as: performance on standardized aptitude tests (especially SAT-Math) (Baron & Norman, 1992; Linn, 1990), academic performance in high school and in college settings (Royer et al. 1996) , differential prediction of college academic performance for males and females using SAT-Math scores when the data is disaggregated into upper and lower quartiles (e.g., Bridgeman & Lewis, 1996); enrollment patterns in math- and science-related majors (Updegraph et al., 1996); and motivation (Pintrich & Garcia, 1994) and academic self-regulation (Schunk & Zimmerman, 1994; Zimmerman & Schunk, 1998).

Even though there were no gender differences in the structural models for males and females, several patterns of interrelationships among the cognitive and non-cognitive variables deserve consideration. Among some of the most interesting relationships were impacts of the High School Rank and the SAT-Verbal on the other variables in the model, whereby the former impacted all the endogenous variables in the model and the latter had no relationship with motivation for using SRL variables and routine memorization. Motivation and compensatory supports mediated the relationship between high school rank and cumulative college GPA. Much of the research provided evidence of a limited predictive validity of standardized aptitude and achievement tests, such as the SAT and ACT.

It stands to reason that SAT-Verbal is a good test of students' reasoning ability, which is certainly impacted by a variety of factors. Thus, being a measure of verbal ability, SAT-Verbal test does not assess students' regulation of their motivation, their self-efficacy for or use of self-regulated learning strategies, or their study habits in general. As a consequence, there is no reason to expect a positive or negative relationship between students' scores on the verbal aptitude test and their motivation for self-regulated learning. Therefore, the absence of any relationship between SAT-Verbal and motivation for self-regulated learning in the present study is not entirely unexpected. This finding is particularly notable in light of the role of high school rank in the structural model for males and females, whereby high school rank had a positive and significant relationship with motivation, SRL strategies, and cumulative college GPA. The direct positive relationship between high school rank and college GPA is supported by a large body of research conducted within the framework of social cognitive theory which indicates that the best predictor of future performance is past performance (Bandura, 1986; 1997). Put differently, students who receive high grades in high school ordinarily achieve at higher levels in college settings as well (Royer et al., 1996).

Whereas SAT-Verbal is a measure of reasoning ability, the construct of high school rank is less clear-cut. On the one hand, this variable may be regarded as somewhat problematic as a measure of students' academic achievement, because it depends on a heterogeneous collection of other factors, such as nature and rigor of high school courses, leniency of instructors, SES, and school and classroom factors. Moreover, some schools (especially many college preparatory schools) do not rank their students, which precludes assessing the impact of this variable on students' academic attainment in college settings. High school grades do not clearly measure any one ability or particular trait, such as reasoning ability, cognitive flexibility, attitude, self-efficacy, or motivation. The same logic applies to college grade point average, which is arguably a problematic measure of student academic achievement because of its inherent heterogeneous nature. In other words, college grades are a function of different academic experiences, such as the number, nature, and complexity of the courses taken in college, different domains or disciplines, different grading procedures used by instructors, student's intellectual capabilities, and students' motivation and use of self-regulatory strategies. High school rank and college GPA represent a "conglomerate" of both cognitive and non-cognitive factors, such as ability, motivation, and use of academic self-regulation. It is logical that brighter students are more likely to succeed in school, and students who are more motivated and who are better self-regulators achieve at higher levels in secondary and postsecondary school settings. Therefore, prior achievement, reasoning ability, motivation, and use of self-regulatory strategies are all important predictors of college success.

The fact that high school rank had impacted all other variables in the model, and that verbal aptitude was unrelated to student motivation for self-regulated learning actually represents a positive finding. Educators and scholars might agree that, whereas we cannot substantially impact students' innate ability, we can augment their motivation and self-regulation, which, in turn, has a direct positive relationship to their academic achievement. In particular, recent research (Pintrich & DeGroot, 1990; Schunk & Zimmerman, 1994) has shown that a common set of self-regulatory skills does exist, that these skills are highly predictive of students' academic success, and that these skills can be taught. Self-regulatory models have provided important implications for learning and instruction. A number of leading theorists (e.g., Bandura, 1997; Garcia & Pintrich, 1994; Schunk & Zimmerman, 1994) have provided empirical evidence that all students can be taught self-regulatory skills, which help them to succeed academically. As a consequence, it might not be an overstatement to say that individuals do need a certain level of ability (as measured by standardized aptitude or intelligence tests) to succeed in school; greater levels of ability presuppose greater likelihood of achieving at greater levels academically. However, beyond a certain level or cut-off score the relationship between ability and later achievement may be less strong or absent altogether, because other variables such as motivation, self-regulation, and environmental influences come into play and exert greater influence. This hypothesis is analogous to the so-called "threshold theory of creativity", which postulated that there is a direct positive relationship between creativity and intelligence up to an IQ score of 120. After this cut-off, there is virtually no relationship between one's level of intelligence and their levels of creativity. Of course, this lack of relationship is also affected by the restriction of range in the predictor.

With respect to SAT-Math, it was a fairly weak predictor of college GPA in the present study.

Counter-intuitively, math aptitude was negatively related to students' self-reported use of conceptual skills after controlling for the other variables in the model, even though the bivariate correlations among standardized verbal and aptitude scores, conceptual skills, and cumulative GPA were all positive and significant. This unexpected finding could be a statistical artifact of suppressor variables (Tabachnik & Fidell, 2001). Further research should investigate the impact of the math aptitude on the academic achievement in college, within the framework of complex interrelationships of cognitive and non-cognitive variables.

Of note in the present study was the negative impact of SAT-Verbal on the students' self-reported use of compensatory supports and positive impact on conceptual skills, which, incidentally, were the largest effects in the structural models for both males and females. Compensatory supports mediated the relationship of verbal aptitude on college academic achievement. The finding in this study that students with higher verbal aptitude also reported using more conceptual skills in their academic work appears logical because the latter measures analytical and verbal skills traditionally valued in academic settings and on standardized tests, such as making accurate inferences when reading texts, distinguishing between apparently similar ideas, and reading material critically. In contrast, a large direct negative effect of SAT-Verbal on compensatory supports, as well as the mediational effect of compensatory supports on GPA can be more fully understood in light of the research conducted in the field of leaning disabilities. Compensatory supports represent strategies that many students with learning disabilities resort to in order to compensate for their academic deficits in such areas as reading, writing, or comprehension (Crux, 1991; Reis, McGuire, & Neu, 2001). These strategies include, but are not limited, to using tape-recorders in class to supplement written notes, listening to textbooks to tape to aid comprehension of the reading material, and using computer graphic organizer programs to facilitate organization of written reports. Students who reported using more compensatory supports tended to obtain lower grades in college.

One of the most puzzling findings in the present study was the relationship among the verbal aptitude, conceptual skills, and academic achievement. It appeared counterintuitive at first, that there was a strong relationship between students' verbal aptitude and their use of conceptual skills, on the one hand, and no relationship between conceptual skills and cumulative GPA, after controlling for the effects of all other variables in the model, particularly in light of previous research emphasizing the string and positive link between students' use of self-regulated learning and their academic achievement (Schunk & Zimmerman, 1994; Zimmerman & Schunk, 1998). In addition, in an earlier study using the same sample of students, Ruban (2000) found that conceptual skills was the strongest predictor of students' cumulative GPA in the hierarchical regression model, which assessed the predictive power of demographic (e.g., gender, age), academic (e.g., academic level in college), motivational and self-regulated learning factors on students' academic achievement in college. These variables, taken collectively, explained 38% (large multivariate effect size, Cohen, 1988) of variance in students' GPA, with the conceptual skills explaining 18% (medium multivariate effect size) in the students' college grades. Of particular note in the present study is a large positive relationship between SAT-Verbal and conceptual skills, with a bivariate correlation of $r = .44$. Whereas SAT-Verbal test provides a good picture of students' verbal reasoning ability, conceptual skills assess students' ability to use and manipulate verbal input in the efficient manner. Whereas SAT-Verbal represents a fairly abstract measure of verbal aptitude, conceptual skills assess a more concrete factor, namely, students' ability to bring their verbal skills to bear on their academic work in college. The large positive path between verbal aptitude and conceptual skills in the structural models for both males and females indicates that there is a large overlap between these two measures, with SAT-Verbal predicting students' use of conceptual skills. This finding could be considered as evidence of criterion-related validity for the conceptual skills factor.

The relationship among academic level in college, motivation, and academic achievement was in the hypothesized direction, with motivation mediating the effect of academic level on cumulative GPA. Specifically, the pattern and magnitude of these interrelationships was the same for males and females, with students at higher academic levels reporting more motivation for self-regulated learning and obtaining higher grades in college. This supports the developmental hypothesis (Vermetten et al., 1999).

As far as the overall predictive validity of the structural model for both genders is concerned, the model explained 64% of the variance in the college academic achievement for females and 55% for males, both of which represent a large multivariate effect size (Cohen, 1988, 1992). The SEM model, on the whole, provided a slightly better prediction of academic achievement for females as compared to males; namely, the model for females explained 7% more variance on cumulative GPA, which corresponds to a small multivariate effect size (Cohen, 1988, 1992). Interestingly, the incremental contribution of motivation and three self-regulated learning factors above and beyond pre-college scholastic and academic factors and college academic level was 9% for females and 13% for males. Overall, a collection of cognitive and non-cognitive variables, namely, standardized aptitude measures, high school rank, college academic level, motivation, and self-regulated learning strategies explained more than half of the variance in the academic achievement of university students in this study. This finding supports suggestions made by a number of researchers that both cognitive and non-cognitive variables should be considered in making predictions about students' academic success in college (e.g., Baron & Norman, 1992; Crouse & Trusheim, 1988; Naumann, 1996).

Promising avenues for future research would involve utilizing both qualitative and quantitative methods, to add scope and breadth to the findings (Creswell, 1994; Patton, 1990; Salomon, 1991). In quantitative terms, the results summarized above indicate that variables deemed as important determinants of college academic success (i.e., standardized aptitude measures, high school rank, college academic level, motivation and self-regulated learning strategies) exerted similar influence on the academic achievement of undergraduate males and females who participated in this study. However, the generalizability of the findings is constrained by the research design. In addition, the differentiation in the effects of the collection of the variables on the academic achievement described above should be further studied with regard to the following six aspects: (a) interaction of SAT sub-groups (low vs. high) and gender; (b) interaction of high school rank sub-groups (low vs. high) and gender; (c) interaction of achievement groups in college (low vs. high vs. a random sample) and gender; and (d) examination of the differential impact of motivation on self-regulatory strategy use for males and females representing different achievement groups; and (e) studying the effects described in (a) through (d) with respect to a reference course or specific study context.

A number of leading theorists proposed that we should move beyond overreliance on hypothetico-deductive research paradigm, which utilizes primarily quantitative methods, and make greater use of theory generating methods, or qualitative research (see, for example, Van Etten, Pressley, & Freebern, 1999). The need for further qualitative research in the study of student motivation and academic achievement was affirmed in the latest special issue of the *Educational Psychologist* (2002), "Using Qualitative Methods to Enrich Understandings of Self-Regulated Learning." Articles in this volume reflect a growing interest among the researchers in searching for new ways to study the complex and multifaceted phenomenon of student self-regulated learning "in real contexts and in real time, in events rather than as aptitudes" (Perry, 2002, p. 1). Perry (2002) characterized research conducted in the past quarter century as relying primarily on survey self-report measures and aggregating data within and across different groupings of students. Even though the accumulated research evidence described many facets of self-regulated learning, these findings do not distinguish between what learners report they do and what they actually do in their academic pursuits, or how specific features of a learning context or situation impact students' self-regulation of their learning behavior.

According to Van Etten et al. (1999), inductive methods may help researchers map out the variables which can be potentially important determinants of students' motivation and academic achievement, which contrasts with the "fine-detailing" of the quantitative confirmatory research that uses variables that were *a priori* determined by researchers as potential predictors. It is imperative to go beyond the study of academic self-regulation as "relatively enduring attributes of an individual that can be aggregated over or abstracted from behavior across multiple events" (Perry, 2002, p. 1). Extrapolating from Renzulli and Reis' (1997) view of giftedness as occurring in "certain people, in certain places, under certain circumstances," we might utter a supposition that academic self-regulation plays a certain role for some individuals, some of the time, under certain circumstances. In sum, qualitative methods, such as experience sampling method developed by Csikzentmihalyi (Csikzentmihalyi & Larson, 1987), using participant observation and ethnographic research, and conducting longitudinal qualitative studies may afford a richer picture and provide more nuances of the idiosyncrasies of academic self-regulation for specific individuals.

In conclusion, the findings from this study support that we should not rely on standardized measures of students' aptitude and achievement for predicting academic success in postsecondary settings. Additional information afforded by including motivational and non-cognitive variables in the models of academic achievement lends credence to broadening our conception of variables viewed as important determinants in models of student leaning and achievement. Accumulated evidence indicates that in addition to acquiring knowledge, students should also develop self-regulatory competence to achieve at high levels in challenging postsecondary environments.

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Table 1

Demographic and academic characteristics of the entire sample of undergraduate males and females (N=470)

Category	Males (n=158)	Females (n=312)
Gender	33.6	66.4
Mean Age	20.58 (1.73)	20.48 (1.49)
Ethnicity	%	%
Caucasian	76.6	77.2
Asian	6.9	7.7
Hispanic or Puerto-Rican	3.7	3.8
Black	4.4	3.9
Other/ Not Reported	8.2	7.3
Academic Level	%	%
Freshman	31.6	20.9
Sophomore	29.1	29.6
Juniors	25.3	29.9
Seniors	14.0	19.6
School or College of Degree	%	%
Agriculture	1.9	1.3
Business Administration	11.4	5.5
Education	15.2	27.7
Engineering	8.9	2.6
Family Studies	1.9	1.3
Fine Arts	2.5	4.2
Liberal Arts & Sciences	57.0	55.0
Nursing	--	.6
Pharmacy	.6	1.9
Other/ Missing	.6	--

Note. The initial entire sample of 470 students (158 males and 312 females) was reduced during the execution of the structural equation modeling analyses because of missing data on high school rank for 98 students (39 males and 59 females).

Table 2. Confirmatory Factor Analysis: Maximum Likelihood Dimensions, Standardized Loadings, and Goodness of Fit Summary

Dimension/Item Stem	Conceptual Skills			Routine Memorization			Compensatory Supports		
	Factor Loadings	*M*	*SD*	Factor Loadings	*M*	*SD*	Factor Loadings	*M*	*SD*
Conceptual Skills									
Alpha Reliability: .85									
2. Make accurate inferences when I read texts.	.72	3.68	.88						
3. Understand what I read in challenging assignments.	.71	3.52	.97						
6. Find the right words to express my ideas.	.53	3.62	.99						
8. Read critically.	.72	3.54	.98						
9. Figure out the meaning of new words from their context.	.74	3.71	.96						
10. Think of practical applications of new concepts.	.54	3.54	.92						
11. Make a logical guess even when I don't know the answer.	.46	4.11	.83						
13. State the underlying message of readings.	.51	3.56	.97						
14. Distinguish between apparently similar ideas.	.54	3.56	.83						
Routine Memorization									
Alpha Reliability: .81									
4. Memorize formulas, names, and dates.				.60	3.45	1.13			
15. Memorize material when I don't understand all of it.				.71	2.93	1.19			
16. Memorize material from text.				.84	3.20	1.15			
17. Memorize material from class notes.				.74	3.72	1.11			

Dimension/Item Stem	Conceptual Skills			Routine Memorization			Compensatory Supports		
	Factor Loadings	*M*	*SD*	Factor Loadings	*M*	*SD*	Factor Loadings	*M*	*SD*
Compensatory Supports									
Alpha Reliability: .70									
46. Use a tape-recorder in some of my lecture classes as a supplement to my written notes.							.47	1.45	.99
47. Listen to textbooks on tape to help me understand text material.							.53	1.21	.66
49. Use campus resources to help me with my academic work.							.55	1.88	1.14
50. Use speech output, or screen reading on the computer to help me understand written material.							.59	1.47	.86
51. Use visual graphic computer programs, such as *Inspiration,* to enable me to organize written reports.							.62	1.25	.66
52. Utilize a portable words processor or a laptop computer to help me organize notes in class.							.49	1.29	.76

Goodness of Fit Summary	χ^2	df	χ^2/df	TLI	CFI	RMSEA	CI RMSEA[a]
	240.986*	147		.95	.96	0.037	0.028- 0.045

* $p < .001$.

[a] Confidence Interval of Root Mean Square Error of Approximation

Table 3

Correlations Among the Variables Used in the Structural Equation Modeling Analysis (N = 470).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1.Cumulative GPA[a]	1.00												
2. High School Rank	.56**	1.00											
3. SAT-Verbal	.60**	.56**	1.00										
4. SAT-Math	.52**	.60**	.70**	1.00									
5. Academic Level	.30**	.06	-.05	-.03	1.00								
6. High School Math	.25**	.38**	.32**	.43**	.03	1.00							
7. High School Science	.18**	.27**	.21**	.33**	.07	.26**	1.00						
8. Usefulness of SRL Strategies	.18**	.06	.02	.01	.09	-.01	.01	1.00					
9. Benefits of SRL Strategies	.17**	.02	-.12*	-.09	.13**	-.03	-.07	.32**	1.00				
10. Academic Dedication	.15**	.10*	-.07	-.03	.03	-.02	.06	.20**	.16**	1.00			
11. Conceptual Skills	.44**	.37**	.56**	.36**	.13**	.11*	.10*	.10*	.07	.05	1.00		
12. Routine Memorization	.17**	.12**	.02	.07	.09	.07	.04	.07	.11*	.03	.10*	1.00	
13. Compensatory Supports	-.35**	-.28**	-.41	-.31	-.16**	-.14**	-.12*	.07	.10*	.06	-.27*	-.01	1.00

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

Table 4

Students' unadjusted mean scores on the self-regulated learning factors, Cronbach alpha reliabilities, t-values, and goodness of fit summary indices.

Predictor Variables	Males (n=119)[1] Mean	Males (n=119)[1] SD	Females (n=253)[2] Mean	Females (n=253)[2] SD	t-value	Cronbach Alpha Reliability
Conceptual Skills[a]	3.57	.67	3.65	.59	-1.29	.85
Routine Memorization[a]	3.12*	.57	3.42*	.53	-3.43	.81
Compensation Strategies[a]	1.50	.49	1.38	.76	2.18	.70
Reading & Writing Metacognitive Strategies	2.97	.69	3.14	.73	-2.50	.70
Study Routines	2.91	.79	3.02	.75	-1.38	.80
Help Seeking	2.79	.83	2.83	.84	-.54	.70

Goodness of Fit Summary[a]	χ^2	df	χ^2/df	TLI	CFI	Conf. Interval RMSEA
	241.0*	147	1.6	.95	.96	0.033 – 0.046

Note. N = 375. 39 males and 55 females were missing information on High School Rank, which reduced the initial sample size for males (n=158) and for females (n=312).

[a] Goodness of fit summary values are based on three factors that became significant predictors in the structural equation analysis (i.e., Conceptual Skills, Study Routines, and Help Seeking).

* $p < .001$. This value represents testwise alpha adjusted for multiple t-tests.

Table 5

Students' unadjusted mean scores on the standardized aptitude scores, high school rank, motivational variables and grade point average by group

Predictor Variables	Males (n=119)		Females (n=253)		t-value
	Mean	Std. Dev.	Mean	Std. Dev.	
Academic Dedication (Study Time)[a]	3.46	1.50	3.59	1.42	-.98
Perceived Usefulness of SRL Strategies[b]	2.90*	1.47	3.34*	.98	-3.34
Perceived Benefits of SRL Strategies[c]	2.58*	1.01	2.86*	.98	-2.89
High School Math Preparation	3.76	1.33	3.84	1.32	-.64
High School Science Preparation	3.09	1.11	2.96	1.07	.96
Cumulative Grade Point Average	2.79*	.88	3.15*	.75	-4.10
High School Rank	77.85*	18.81	85.25*	16.65	-3.84
SAT-Verbal[a]	587.86	103.11	597.53	99.29	-.94
SAT-Math[a]	606.83	104.41	594.23	97.46	1.24

[a] Seventeen students did not have data on SAT-Verbal and SAT-Math.
* $p < .001$. This value represents testwise alpha adjusted for multiple t-tests.

Figure 2. Maximum-likelihood estimates for structural parameters of the model for males (n=119) representing relations amo pre-college variables, academic level, motivation, self-regulated learning strategies, and cumulative grade point average. All structural parameters were statistically significant and are represented in standard deviation units.

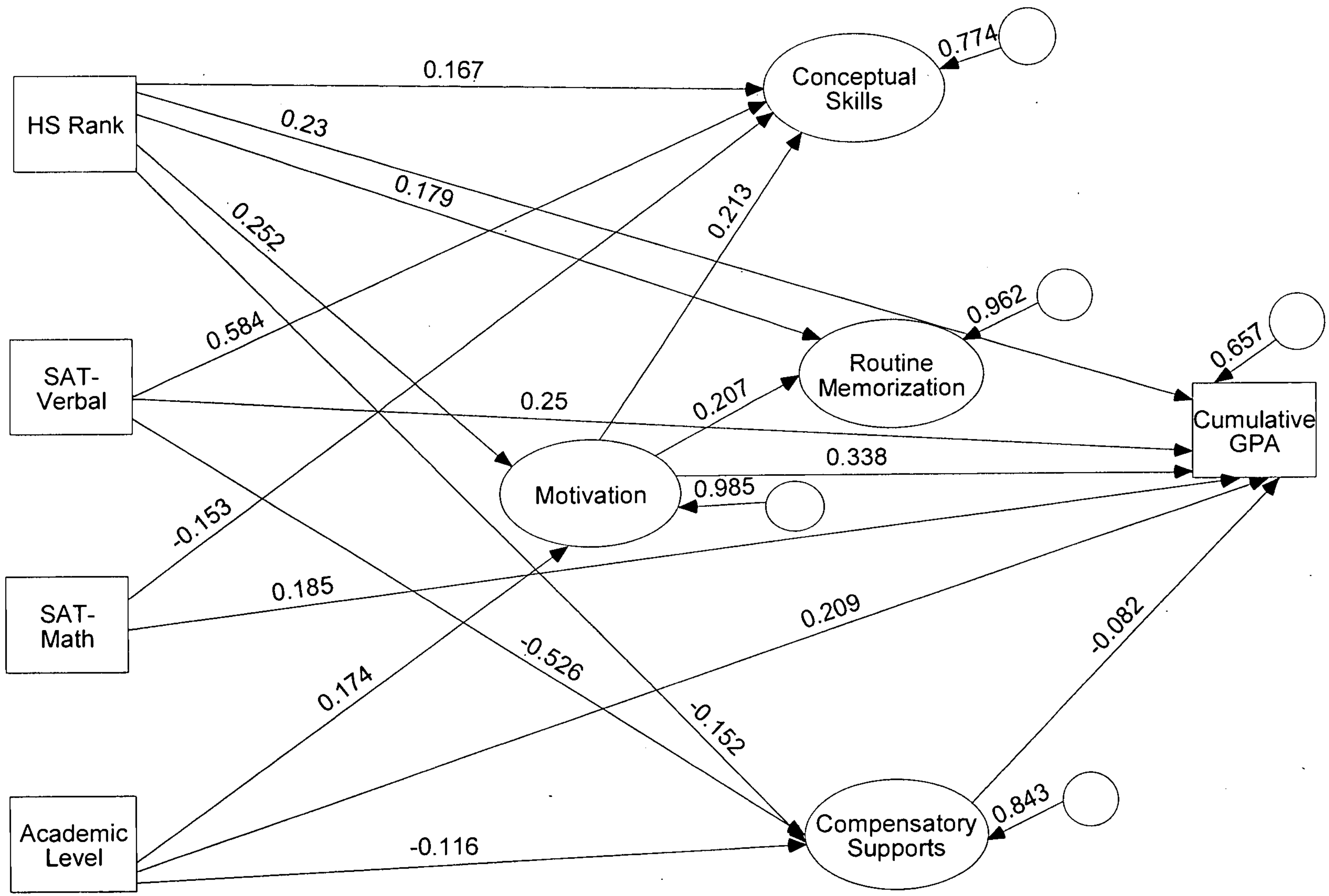


Table 6

Summary of global fit indices for structural models and proportion of variance in students' GPA accounted for by the three models: Omnibus run and multiple groups analysis for males and females.

Model	χ^2	df	TLI	CFI	RMSEA	Conf. Interval RMSEA
Entire Sample[a]	556.338*	309	.91	.92	0.047	0.040 – 0.053
Multiple Groups Model[b]	899.190*	600	.90	.91	0.037	0.032 – 0.041

Note. Because of the missing data, the initial sample size (N=470) was reduced to 372 students. Only cases with complete data were used in the structural equation modeling analysis.

[a] N = 372; for the entire model, R^2 = .63.5.

[b] n = 119; for males, R^2= .57

[c] n = 253; for females, R^2 = .64

* $p < .001$.

Figure 1. Omnubus Run: Structural model for the entire sample of university students (n=375). The model represents relationships among the constructs of standardized aptitude measures, high school rank, college academic level, motivation, self-regulated learning strategies, and cumulative grade point average.

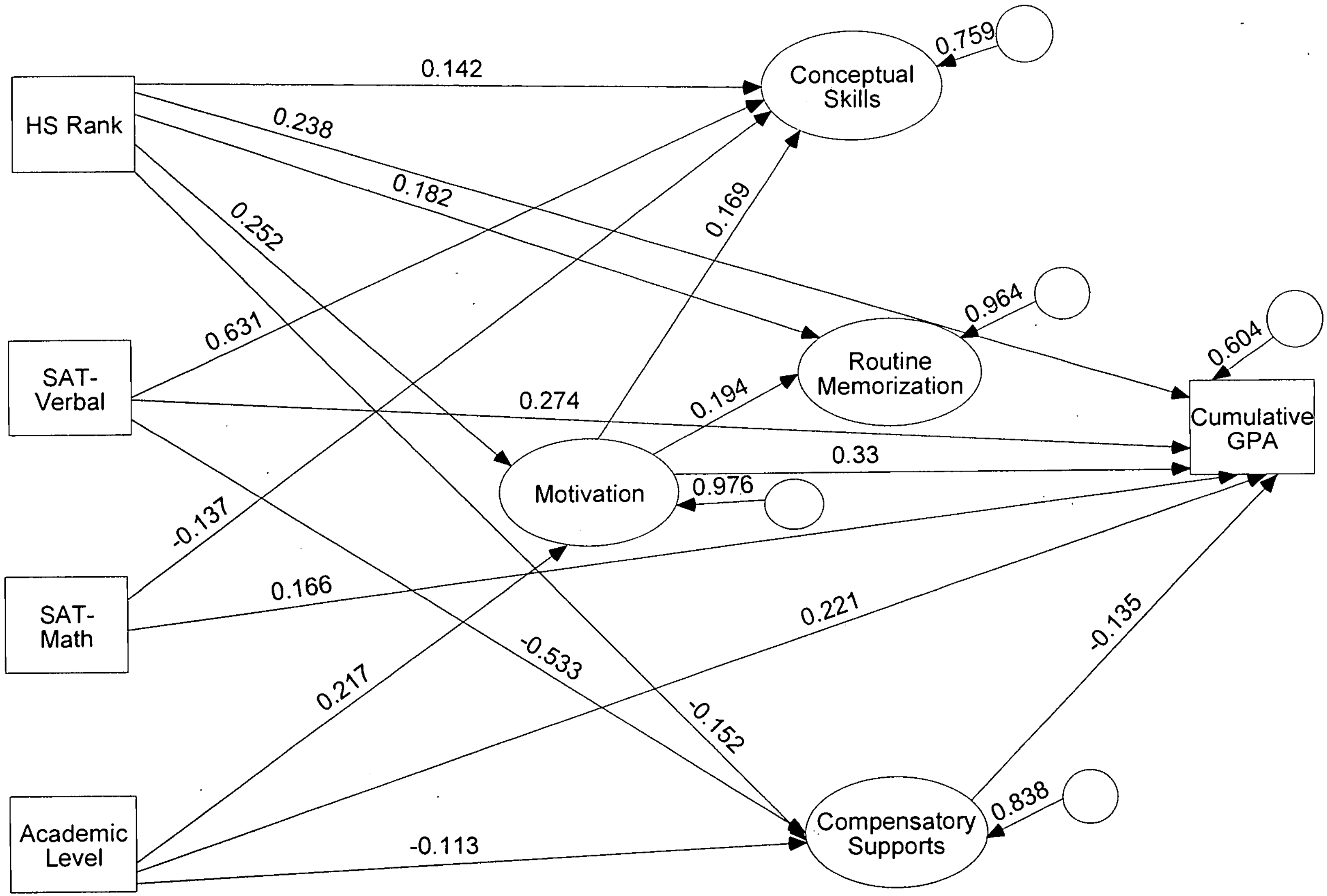
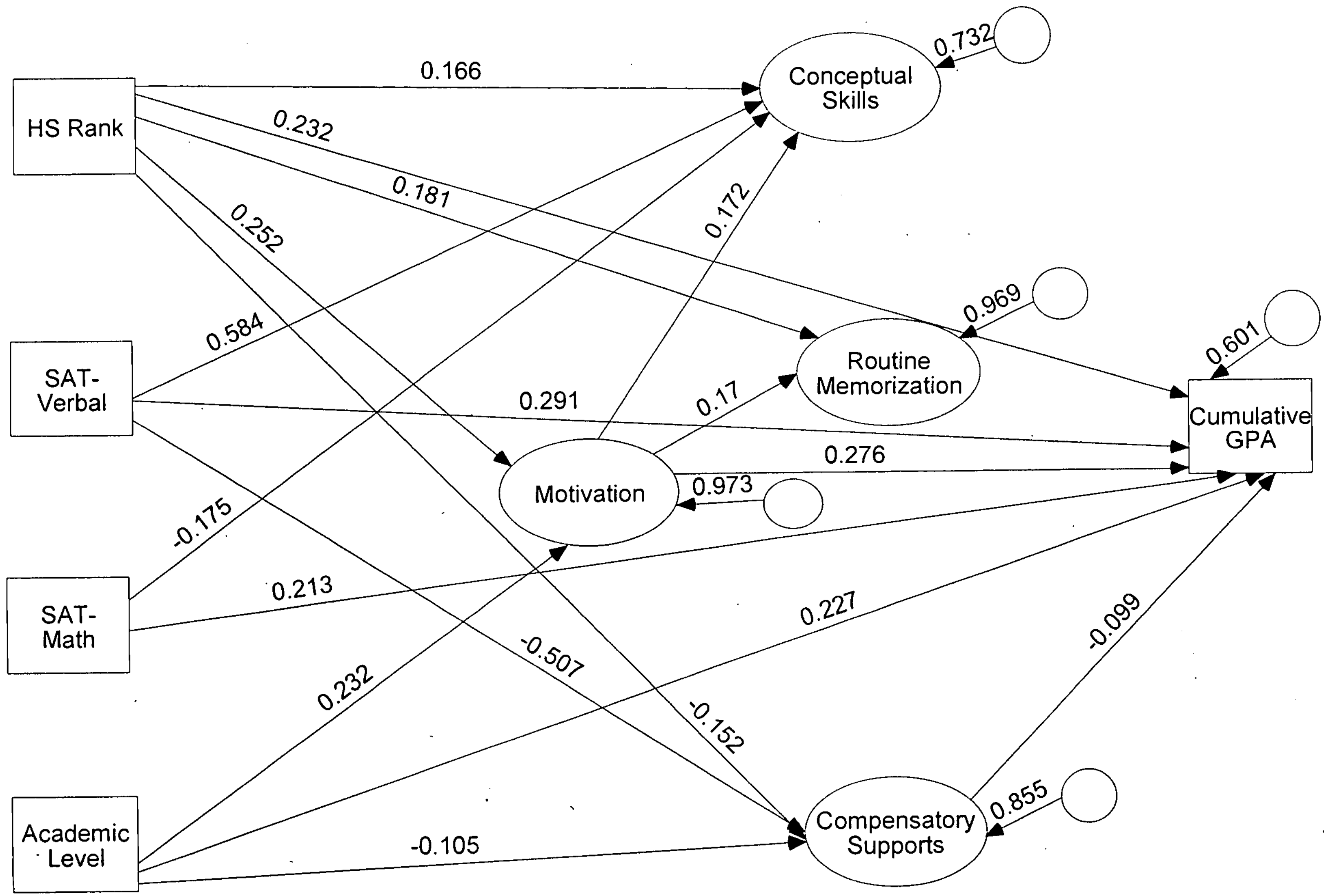


Figure 3. Maximum-likelihood estimates for structural parameters of the model for females (n=256) representing relations a pre-college variables, academic level, motivation, self-regulated learning strategies, and cumulative grade point average. All structural parameters were statistically significant and are represented in standard deviation units.



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