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AUTHOR Malpass, John R.; And Others
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ABSTRACT

This study used a structural equation paradigm to investigate the effects of self-regulated learning, self-efficacy, learning goal orientation, and worry on high-stakes mathematics achievement in a sample of (n=144) mathematically gifted high school students in southern California. Sex and prior math achievement (the Mathematics-Scholastic Achievement Test) were used as control variables. The self-report instrument used was the Self-Regulation Questionnaire by O'Neil, Sugrue, Abedi, Baker, and Golan (1992). Analyses showed that self-regulation was negatively related to worry, and surprisingly, not related to either prior or post mathematics achievement. Other results indicated that (1) self-efficacy mediates the relationship between prior and post mathematics achievement, is related to self-regulation, and is highly and negatively related to worry; (2) learning goal orientation is positively related to self-regulation and worry, and is not related to self-efficacy or Advanced Placement mathematics achievement; (3) the Math-Scholastic Achievement Test is related to Advanced Placement math achievement; and (4) worry is negatively related to Advanced Placement mathematics achievement. With respect to gender, boys were less worried and had higher self-efficacy than girls. Contains 80 references. (Author/MKR)

Self-Regulation, Goal Orientation, Self-Efficacy, Worry, and Math Achievement

John R. Malpass
University of Phoenix

Harold F. O'Neil, Jr.
University of Southern California

Dennis Hocevar
University of Southern California

Malpass, J. R., O'Neil, H. F., Jr., & Hocevar, D. (1996, April). Self-Regulation, Goal Orientation, Self-Efficacy, Worry, and Math Achievement. Paper presented at the annual meeting of the American Educational Research Association, New York City.

Abstract

Our study used a structural equation paradigm to investigate the effects of self-regulated learning, self-efficacy, learning goal orientation, and worry on high-stakes mathematics achievement in a sample of 144 mathematically gifted high school students. Sex and prior math achievement (the Mathematics-Scholastic Achievement Test) were used as control variables. The self-report instrument used was the Self-Regulation Questionnaire by O'Neil, Sugrue, Abedi, Baker, and Golan (1992). Our analyses showed that self-regulation was negatively related to worry, and surprisingly, not related to either prior or post mathematics achievement. Other results indicated that (a) self-efficacy mediates the relationship between prior and post math achievement, is related to self-regulation, and is highly and negatively related to worry, (b) learning goal orientation is positively related to self-regulation and worry, and is not related to self-efficacy or Advanced Placement mathematics achievement, (c) the Math-Scholastic Achievement Test is related to Advanced Placement math achievement, and (d) worry is negatively related to Advanced Placement mathematics achievement. With respect to sex, boys were less worried and had higher self-efficacy than girls.

Self-Regulation, Goal Orientation, Self-Efficacy, Worry, and Math Achievement

Self-regulating students are goal directed, have a desire to learn,have knowledge of several learning strategies (declarative knowledge), know how to use them (procedural knowledge) and when and why each may be used in the appropriate context (conditional knowledge); and believe they can be successful in the implementation of a self-regulatory response (Zimmerman, 1989). Research conducted by Zimmerman and Martinez-Pons (1992) has shown that self-regulated learners see learning as "a strategically controllable process and accept greater responsibility for achievement outcomes" (p.187). Zimmerman (1986) posited that students are self-regulated to the degree they are metacognitively, motivationally, and behaviorally proactive participants in their own academic learning processes. With respect to these metacognitive and motivational processes, Zimmerman and Martinez-Pons (1988) claimed that self-regulated learners (a) plan, organize, self-instruct, and self-evaluate at various stages during the acquisition process; (b) perceive themselves as self-efficacious, autonomous, and intrinsically motivated; and (c) are academically superior to poor self-regulators (Zimmerman, 1989). Self-regulated learning theoretically accounts for students' active participation in and goal-directed governance of learning processes (Howard-Rose & Winne, 1993). Self-regulated learning may be facilitated by teachers with methods that co-construct knowledge and motivation, help students choose higher order learning strategies, and involve students "in academic tasks for the intrinsic satisfaction derived from engagement, mastery, and success" (Paris & Newman, 1990, p.100).

Zimmerman (1994) identified four self-regulatory attributes. First, the self-regulated student is self-motivated. According to Zimmerman (1994), social-cognitive theorists prefer the term "self-motivated" to "intrinsically motivated" because the latter implies the motivation is derived from the task, rather than from the self-efficacious perceptions and use of self-regulatory learning processes, such as setting goals. The second attribute is the reliance on a planned or automated method of learning. These planned approaches have often been called learning strategies (O'Neil, 1978; O'Neil & Spielberger, 1979); and are defined as systematic plans that help learners encode information and perform a task (Weinstein, Goetz, & Alexander, 1988).

Weinstein and Mayer (1986) defined two major classes of learning strategies: those associated with product or outcome goals and those associated with process goals. The latter strategies, such as monitoring, controlling, planning, organizing, transforming, rehearsing, and memorizing have been defined by Zimmerman and Martinez-Pons (1986) as self-regulation. Pintrich and DeGroot (1990) included several of these strategies in their Self-Regulated Learning Strategies scale (from the Motivated Strategies for Learning Questionnaire [MSLQ]; Pintrich, Garcia, & McKeachie, 1991). In the current study, several of these self-regulatory strategies are included as questionnaire items to measure the metacognitive components of self-regulated learning. (Note, however, that effort is not included in the (1986) Zimmerman and Martinez-Pons' list of self-regulatory strategies, but in this study effort is considered an essential component of self-regulation.) The third attribute of students' self-regulation is closely linked with self-awareness or self-monitoring [awareness and self-checking, two of the components of self-regulated learning in this study].[1] Last, self-regulated students are distinguished by their ability to manipulate their social and physical environment; they selectively seek help from people who are known to be capable, and they organize and restructure their study area to optimize leaning (Zimmerman, 1994).

Although there have been numerous theoretical and empirical articles about self-regulated learning (Garcia, 1995; Garcia & Pintrich, 1991, 1994, 1995; Pintrich and Garcia, 1991; Schunk & Zimmerman, 1994; Zimmerman, 1994) few have explicitly linked the components of self-regulated learning to student performance or academic achievement. In those studies that have explicitly investigated these components, the correlational relationships tend to be marginal (e.g., Pintrich & DeGroot, 1990 [r=.20 and r=.28]; Yap, 1993 [r = .26]). The aforementioned studies have assumed the components of self-regulated learning to include metacognition, effort, and cognitive strategies. In general, the components in these studies were found to be positively related to each other.

[1]Brackets are intended to point out to the reader the nomenclature used by the authors of this study.

Although different theoretical orientations of researchers have often caused differing operational definitions, the common conceptualization of self-regulating learners is that they are active participants in their own learning (Zimmerman, 1990). The research agrees on at least two major findings with respect to self-regulation and academic achievement: (a) that self-regulated learning is comprised of several components, such as cognitive strategies and effort (Miller, Behrens, Greene, & Newman, 1993) or metacognition and effort (Pintrich & DeGroot; 1990; Yap, 1993), although the specific components were not always identical; and (b) students who employed metacognition and exerted effort perform more successfully (Pintrich & DeGroot, 1990; Zimmerman, 1986; Zimmerman & Martinez-Pons, 1986, 1988). To summarize, Zimmerman (1990) said that (a) the key feature in most definitions of self-regulated learning is the systematic use of metacognitive, motivational, and/or behavioral strategies, and (b) self-regulated learners are distinguished by both (1) awareness of the relationship between strategic regulatory processes and learning outcomes, and (2) the use of these strategies to achieve academic goals.

In the present study, similar to Yap's (1993) investigation, self-regulated learning is used to conjoin two major constructs: (a)metacognition, consisting of awareness (attention), planning (goal setting), self-checking (monitoring), and the cognitive strategies students use to learn, remember, and understand; and (b) management and control of effort. The current study additionally investigated the relationship of learning goal orientation, self-efficacy, and worry to high-stakes mathematics achievement. Each of the present study's variables will now be discussed in greater detail.

Metacognition

Ridley, Schutz, Glanz, and Weinstein (1992), posited that self-regulated learning consisted of three dimensions: (a)metacognition--awareness of self, environment, and situation [awareness]; (b) goal setting [planning] based on that awareness, and (c)monitoring [self-checking] one's actions. These dimensions were not considered to be separate components; rather, they were, "...seen as interactive facets of the same process" (p.294). Zimmerman and

Bandura (1994) asserted that, "In social cognitive theory, self-regulation operates through a set of psychological subfunctions [that] include self-monitoring of one's activities, [self-checking], applying personal standards for judging and directing one's performances [planning], enlisting self-reactive influences to guide and motivate one's efforts [awareness, effort], and employing appropriate strategies to achieve success [cognitive strategy use]" (p. 846).

Metacognition is defined as the conscious awareness and frequent self-checking to determine if one's learning goal has been achieved and, as necessary, selecting a more appropriate strategy to achieve that goal (O'Neil & Abedi, in press). Metacognition involves knowledge of cognitive states and abilities, and the affective and motivational characteristics of thinking (Paris & Winograd, 1990). Metacognition is essentially thinking about thinking, and is an important countenance of academic performance, problem solving, and student learning (Corno & Mandinach, 1983). State metacognition (i.e., varying in intensity and fluctuating over time, depending on the learning situation), consists of awareness (being aware of one's thoughts), planning (formulating a goal, then determining the method or procedure to successfully attain that goal), self-checking (monitoring one's work), and the use of task-relevant cognitive strategies (O'Neil & Abedi, in press; O'Neil et al., 1992). In this study, metacognition refers to the awareness, planning, self-checking, and cognitive learning strategies used by students to solve problems. Cognitive strategies are systematic plans that help the student encode information and perform the task (Zimmerman & Martinez-Pons, 1992), or skills that allow individuals to manipulate the learning situation (Brooks, Simutus, & O'Neil, 1985). Cognitive strategies may also be referred to as general and domain-specific problem solving skills used by the student in a learning situation and are a function of the student's processing speed and working memory capacity (Kyllonen & Woltz, 1988).

Shuell (1986) summed up the higher order process of metacognition by stating that there are two types of metacognitive activities involved in learning. The first type of activity is organizational: orchestrating activities and resources in order to achieve the learning goal, such as planning, predicting, and monitoring the learning process. The second type is concerned with what one knows and does not know about the material and/or the learning process--to include the knowledge of the relative worth of learning strategies and the knowledge of one's own skills and beliefs (De Corte, 1995; Schunk, 1992). In sum, there is much empirical evidence for the positive relationship of the components of self-regulated learning, but more theoretical than empirical evidence of the same positive relationship of self-regulated learning to academic achievement.

Effort

According to Bandura (1993), both effort and motivation influence self-regulated learning. He said that self-regulatory skills are meaningless if the students cannot apply themselves in a persistent manner in the face of difficulties, distractions, and stress, and that "self-directed learning requires motivation as well as cognitive and metacognitive strategies" (p. 136). Also, with respect to motivation and effort, Zimmerman (1990) observed that self-regulated learners display extraordinary effort and persistence during learning and that they report high self-efficacy, self-attributions, and intrinsic motivation. Additionally, Bandura (1993) has said that, "Self-efficacy beliefs contribute to motivation in several ways: They determine the goals people set for themselves, how much effort they expend, how long they persevere in the face of difficulties, and their resilience to failures" (p. 131).

Goal Orientation

Dweck (1990) found that, depending on their age, students will either choose performance goals, an attempt to obtain favorable (or to avoid negative) judgments of their competence; or learning goals, in which individuals seek to increase competence or mastery of something new. In the former, as little thinking as possible is paramount, and in the latter, intrinsic motivation for success and understanding are critical (Paris & Newman, 1990). According to Dweck (1986, 1990), children who believe in intelligence as fixed trait or entity orient towards performance goals, while those who believe intelligence is incremental and malleable tend to orient towards learning goals. Her research indicated that when seeking performance type goals, children based their task choice and pursuit process around ability, but with learning goals the choice and pursuit process were focused on progress and mastery through effort. Dweck and Leggett (1988) found that students who adopted a learning or mastery orientation increased perceptions of self-confidence [self-efficacy] and success in their courses. A number of studies have clearly shown that students demonstrated high levels of self-regulated learning when they are oriented toward learning goals (e.g., Meece, 1994; Schunk, 1994). Weiner (1986) found that children with low perceived ability were still mastery-oriented when their goal was to learn rather than to perform. Bandura (1993) emphasized that learning environments that accept ability as a skill that may be acquired, and de-emphasize competition and social comparison, are well suited for building self-efficacy and promoting academic achievement. Furthermore, Dweck's (1986) research indicated that students whose focus is based on ability judgments tend to withdraw from challenges, "whereas a focus on progress through effort creates a tendency to seek and be energized by challenge" (p.1041). The adaptive motivational pattern studied by Dweck (1986), "...is characterized by challenge seeking and high, effective persistence in the face of obstacles" (p.1040). Dweck contended that children with learning goals use these obstacles as a cue to increase their effort or to analyze and vary their strategies. For this study, we hypothesized our results would agree with those of Dweck (1986) and Schunk (1994), i.e., that learning goal orientation would be positively related self-regulated learning and self-efficacy.

Self-Efficacy

Collins (1985) and Pintrich and Schrauben (1992) noted that more efficacious students monitored their performance and applied more effort than students who were low in self-efficacy and Hembree (1988) posited that students with lower self-efficacy had lower achievement. Bandura (1993) said that people with high self-efficacy, "...heighten and sustain their efforts in the face of failure. They attribute failure to insufficient effort or deficient knowledge and skills that are acquirable" (p. 144). Bandura (1993) also argued that self-efficacy necessarily precedes achievement and that achievement is influenced by causal attributions as mediated by perceived self-efficacy. Bandura (1986), defined self-efficacy as, "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performance" (p.391).[2] Implicitly, self-efficacy refers to people's specific beliefs about their capability to perform certain actions or to bring about intended outcomes in a domain or to otherwise exert control over their lives (Bandura, 1986, 1993; Boekaerts, 1992; Schunk, 1990). Self-efficacy, a significant determinant of self-confidence (Locke & Latham, 1990, 1994) and performance [achievement], operates, in part, independent of underlying skills (Schunk, 1984).

In their path model, Zimmerman, Bandura, and Martinez-Pons (1992) showed that self-efficacy for self-regulated learning influenced self-efficacy for academic achievement, which in turn influenced final grades directly and indirectly, through student grade goals. The combined direct and indirect effect of self-efficacy for academic achievement on final grades was ($\beta = .37$, $p < .05$). Zimmerman and Bandura (1994) found essentially the same results in their study. Their combined effect was ($\beta = .38$, $p < .05$). In their path model, Garcia and Pintrich (1991) found that intrinsic motivation [comparable to learning goal orientation in this study] had a substantial effect on self-efficacy ($\beta = .36$), and that both intrinsic motivation and self-efficacy had moderate effects on self-regulated learning ($\beta = .24$ and $\beta = .26$). This particular study did not, however, investigate the role of these motivational effects on academic achievement. In our study, we posited that self-efficacy would be strongly and positively related to self-regulated learning and mathematics achievement and negatively related to worry.

Worry

Last, with respect to worry, research has repeatedly shown that high test anxiety is associated with low cognitive performance (Hembree, 1988, 1990). Anxiety may be differentiated into two components: worry (cognitive), and emotionality (physiological/ affective, Hembree, 1988; O'Neil & Fukumura, 1992). In several studies, worry has had a stronger negative correlation with achievement than emotionality, driving Seipp (1991) to

[2] For this study, "self-efficacy" was measured immediately after the Advanced Placement exam in calculus; therefore, strictly speaking, self-efficacy should be called "expectancy for success" or "self-evaluation" (Meece, Wigfield, & Eccles, 1990; F. Pajares, personal communication, February, 1996; Schunk, 1995a, in press). Schunk (1995a) found that self-evaluation related positively to self-efficacy; and, as he has previously stated (1984), in achievement situations, there may less of a distinction between expectancy and efficacy judgments. Nevertheless, the authors are not attempting to redefine the construct. In the next draft of this paper, self-efficacy will be properly renamed.

recommend that studies predicting academic achievement would be better served by using only the worry component. Hence, this study focused on worry, not emotionality, and specifically on state worry, as opposed to trait worry. We hypothesized that worry would be negatively related to self-regulation, self-efficacy, learning goal orientation, and high-stakes mathematics achievement.

<u>Purpose</u>

Self-regulated learners may be described as students who (a) exert effort on their work, (b)plan and check it, (c) are aware of their thought processes, and (d) use cognitive strategies to achieve their goals (O'Neil et al., 1992). This study investigated self-regulated learning and the effects of self-efficacy, learning goal orientation, and worry on achievement in a mathematically gifted sample of high school students in an Advanced Placement Program in mathematics. The study's objectives were to extend the theoretical and empirical research on goal orientation, self-efficacy, and self-regulated learning by (a) determining if learning goal orientation and self-efficacy are integral to self-regulated learning, (b) documenting their relationships to worry and high-stakes mathematics achievement, and (c) controlling for the effects of sex and prior high-stakes math achievement. Our hypothesized structural path model is shown in Figure 1.

Insert Figure 1 about here

The differences between the model used in this study and many of those found in the lite ature are: (a) the factors of metacognition and effort have been combined to form a single construct of self-regulated learning (as previously discussed), (b) high-stakes tests--the Math Scholastic Aptitude Test and the Advanced Placement exam in calculus are used instead of low-stakes tests or grade point averages.

Method

Participants

Participants consisted of 144 mathematically gifted students (78 boys and 66 girls) in grades 10-12, from six public high schools, in Southern California. The median age was 18.0. More than half of the students were Asian-Americans (59.7%); the remaining were White (35.4%), African-American (.5%), Hispanic (2.8%), and Native American (1.4%).

Our sample of students differs from most samples used in social cognitive theory research in several important respects. First, our students were mathematically gifted and in a high-stakes, highly competitive environment: Advanced Placement calculus. Secondly, our sample incorporated 60 percent Asian-Americans and only 35 percent Whites. Therefore, the reader is cautioned that comparisons of this study to similar research using a representative classroom environment, a majority of White participants, and grade point average as the criterion variable may not be clear-cut (e.g., see Stevenson & Lee [1990] and Whang & Hancock [1994]).

Measures and Instruments

Self-Regulation Questionnaire. State measures of each of the four latent variables (self-regulated learning [consisting of awareness, self-checking, planning, cognitive strategy use, and effort], self-efficacy, learning goal orientation, and worry) were obtained from the students, subsequent to their Advanced Placement calculus exam. The measurement instrument was a modified version of O'Neil et al.'s (1992) self-regulation questionnaire; with added scales for self-efficacy and learning goal orientation, that were developed specifically for the study (see Malpass [1994] for details on scale development and modification). Students indicated how they thought or felt during the "high-stakes" calculus exam. O'Neil et al. (1992) used Spielberger's (1975) trait-state anxiety theory to formulate a set of domain-independent trait and state measures for key constructs in this questionnaire. According to O'Neil and Abedi (in press), because "states" vary in intensity and fluctuate depending on the situation, the state responses used for this study were rated on an intensity dimension with responses such as: not at all, somewhat, moderately so, and very much so.

Mathematics-Scholastic Aptitude Test (M-SAT). For this study, prior math achievement was measured by a single test score, the M-SAT. Scores were obtained from student records for the previous year. According to the Educational Testing Service, the internal consistency of the M-SAT was $\alpha = .91$ (R. Morgan, personal communication, December, 1995). The M-SAT is considered to be a high-stakes test because of the impact of scores on college choice as well as on math placement within a college.

Advanced Placement exam in calculus (APX). Math achievement also was measured by a single test score: the Advanced Placement exam in calculus. The Educational Testing Service confirmed the internal consistency of the APX to be $\alpha = .90$ (L.Jones, personal communication, October, 1994). Advanced Placement exams are administered annually to registered sophomore, junior, and senior students in the Advanced Placement Program. Test scores range from 1 to 5, where 5 is the highest score (for more information, refer to the Advanced Placement Course Description, 1984). This exam is also considered to be a high-stakes event because a satisfactory score (3, 4, or 5) may be important to the students for obtaining admission to the college of their choice and for validation of college credit. A satisfactory score also may mean one less college course to take.

Results

Data Analysis

We used EQS™ structural equation modeling software (Bentler, 1995b) to conduct all our structural equation model (SEM) analyses. First, we verified the internal consistencies of our scales; then we conducted a confirmatory factor analysis (CFA) on the measurement model shown in Figure 2. This first-order CFA model was used as the framework for all subsequent analyses to investigate the theoretical relationships of the components of self-regulated learning. As shown in Table 1, all scales had Cronbach coefficient alpha reliabilities above .65.

Insert Figure 2 about here

Insert Table 1 about here

Conf..matory factor analysis is the statistical technique used to analyze the validity of a measurement model. The confirmatory approach is normally concerned with implementing the theorist's hypotheses about how a particular domain of variables is structured, and then testing the adequacy of these hypotheses using a path analytic approach (Bentler, 1995a). However, in this study we were not only concerned with predicting the effect of one latent variable on another; we also used the latent variables to validate our constructs. That is, we wanted to determine how well a given set of indicators actually measured the underlying construct by assessing the quality of the fundamental indicators in terms of the consistency and validity (von Eye & Clogg, 1994). Confirmatory factor analysis, viewed as a subset of the more general structural equation modeling approach (Pedhazer & Schmelkin, 1991), allows the researcher to test the hypotheses that a particular linkage between the observed variables and their underlying latent factors actually exists (Byrne, 1994); i.e., does the hypothesized model measure what it is supposed to measure? (Sodowski, Taffe, Gutkin, & Wise, 1994).

Confirmatory Model

We performed a CFA on the measured variable intercorrelations and used post hoc model modifications, consisting of Wald Test recommendations, to eliminate nonsignificant paths. As shown in Figure 3, all factor loadings (single-headed arrows) were significant; all intercorrelations (double-headed arrows) shown were significant, $p < .05$, two-tailed. Even though Mardia's Normalized Coefficient was 2.448, indicating multivariately normal data, we used the Satorra-Bentler (*S-B*) robust scaled statistic to err on the safe side: $S\text{-}B\chi 2(140, N = 143) = 222.973$, $p<.001$. Fit indices, showing an acceptable model fit, are as follows: Comparative Fit Index (CFI) = .921; Adjusted CFI* = .928, Bentler-Bonett Nonnormed Fit Index (NNFI) = .898, Bentler-Bonett Normed Fit Index (NFI) = .829. These fit indices collectively indicated that most of the correlations among measures were explained by the model, and that its formulation was psychometrically quite acceptable (Huba, Wingard, & Bentler, 1981).

Results of the CFA showed that, at $p < .05$: (a) self-efficacy was highly related to prior and post mathematics achievement ($r = .519$ and $.564$), highly (negatively) related to worry ($r=-.708$), but only moderately related to self-regulated learning ($r = .222$), and not related at all to learning goal orientation; (b)worry had a greater, but moderate negative effect on post mathematics achievement than prior achievement ($r = -.487$ and $-.327$), and a smaller negative effect on self-regulated learning ($r=-.243$); (d) learning goal orientation was moderately related to self-regulation ($r = .465$), and last, (e) self-regulated learning (similar to Pintrich and De Groot [1990] and Yap [1993]) positively, but marginally affected post mathematics achievement ($r=.240$), and surprisingly was not affected by prior math achievement. Sex (coded: girls = 2, boys = 1) had three significant effects: (a) boys did marginally better in the M-SAT ($r = -.259$), but there were no differences in APX scores, (b) girls worried slightly more than boys ($r = .240$), and boys had moderately more self-efficacy than girls ($r = -.340$).

Insert Figure 3 about here

Path Analytic Model

Once we had substantive confidence in our confirmatory factor analytic model, we evaluated our causal hypotheses. Using path analysis, we measured the direct and indirect effects of sex and prior math achievement in our model. The path analysis hypothesized model is shown in Figures 4 and the total effects are shown in Figure 5.

Insert Figure 4 about here

Insert Figure 5 about here

Nonsignificant paths were deleted ($\underline{\beta} \geq .16$, $p > .05$) and once again, the fit of our model was acceptable: $S\text{-}B\chi2(134, \underline{N} = 143) = 217.699$, $\underline{p} < .001$. CFI = .921; Adjusted CFI* = .929, NNFI = .899, NFI = .829. As shown in Figure 5, at $\underline{p} < .05$, our path analysis revealed that self-regulation was significantly and negatively related to worry ($\underline{\beta} = -.214$). Self-efficacy was significantly and: (a) positively related to self-regulation ($\underline{\beta} = .282$) and post math achievement ($\underline{\beta} = .551$), and (b) highly and negatively related to worry ($\underline{\beta} = -.737$). Learning goal orientation was significantly and positively related to self-regulation ($\underline{\beta} = .457$) and worry ($\underline{\beta} = .200$)--but not related to self-efficacy or mathematics achievement. These latter three relationship were somewhat surprising. With respect to sex, boys had higher self-efficacy and lower worry than girls. As expected, prior math achievement was significantly and directly related to post math achievement ($\underline{\beta} = .408$); and, self-efficacy mediated the indirect relationship between prior and post achievement ($\underline{\beta} = .174$).

Discussion

Our findings agree with much of the goal orientation and self-efficacy literature, (e.g., Dweck, 1986; Bandura, 1993) as well as the recent self-efficacy findings of Brackney and Karabenick (1995), Pajares and Kranzler (1995), Pajares and Miller (1994, 1995), and Schunk (1995a). Our path model not only statistically fit the data, but also explained virtually all the covariances among measures. We expected a greater total effect between self-efficacy and self-regulation (ours was marginally significant [$\underline{\beta} = .282$]), but as Schunk (1995b) argued, "Although low self-efficacy is detrimental, effective self-regulation does not require that self-efficacy be extremely high" (p. 9). We also expected a negative relationship between learning goal orientation and worry, as well as a concomitant positive relationship with self-efficacy and self-regulation; however, as Dweck maintained (C. Dweck, personal communication, March, 1996), sometimes learning goal options appeal to students who are high in social desirability. These [gifted] students may be especially prone to choosing learning goals if they do not then have to face a learning challenge or sacrifice potential performance goals.

We found a nonsignificant relationship between self-regulation and prior and post mathematics achievement. We had expected self-regulation would act as a mediator, much in the same manner as self-efficacy; however, considering the sample of gifted students, correlations tend to be compressed. This may also account for the relatively low correlation and beta between prior and post math achievement in our CFA (r = .603) and path analysis (β = .408), as compared to Reynolds and Walberg (1991), who found β =.729 between prior and post science achievement in their path analysis. Worry had a higher correlation with achievement in our study than in Yap's (1993), but this should be expected in a high-stakes environment. There are other theoretical similarities and differences with analogous studies that require additional elaboration.

Theoretical Similarities and Differences

Garcia and Pintrich. In their LISREL model of mainstream college student motivation and self-regulated learning, Garcia and Pintrich (1991) found that both intrinsic motivation [learning goal orientation] and self-efficacy had strong, positive impacts on self-regulated learning (β = .36 and .38, for Time 1), but moderate impacts for Time 2 (β = .24 and .26), respectively. In our study, the relationship between learning goal orientation and self-regulation was higher (β=.46), but for self-efficacy, the relationship was only marginally significant (β = .28). This latter relationship may be due to the fact that gifted-students scores [e.g., on the Motivated Strategies for Learning Questionnaire] tend to be deflated because they have higher standards (T.Garcia, personal communication, April, 1995).

Pintrich and De Groot. Pintrich and De Groot (1990) found that although self-efficacy facilitated cognitive engagement, the cognitive engagement variables were more directly tied to performance. They also found a negative relationship between worry and self-efficacy but no significant relationship of test anxiety [worry] with self-regulation. We found that self-efficacy was more tied to performance than self-regulation and its concomitant variables and that worry had a significant negative relationship with both self-efficacy and self-regulation. Using the

MSLQ, Pintrich and De Groot found that students with higher self-efficacy, intrinsic value [learning goal orientation], cognitive strategy use, and use of self-regulating strategies [metacognition/effort] had significantly higher grades, better seatwork, and better scores in exams/quizzes and essays/reports. Even though our methodologies and criterion variables were different, many of our results were comparable; in particular, we both found empirical evidence "for the importance of considering both motivational and self-regulated learning components in our models of classroom academic performance" (p. 38).

Schunk. Schunk (1984) determined that self-efficacy had both a direct and indirect (as mediated by persistence) path of influence to cognitive skill development. Schunk (1995a) conducted an experiment on 4th grade children and found that emphasizing that the goal was to learn to solve problems (rather than simply completing them) can raise self-efficacy for learning and increase self-regulation and persistence. In 1994, Schunk posited that, "Students who adopt a learning goal are apt to experience a sense of self-efficacy for skill improvement and engage in activities they believe enhance learning (e.g., expend effort, persist, use effective strategies)" (p.89). We found a nonsignificant relationship between learning goal orientation and self-efficacy. With this one exception, our findings are comparable to Schunk's (1995a).

Pajares and Colleagues. With a group of high school students, Pajares and Kranzler (1995) found significant direct paths from self-efficacy to mathematics performance and anxiety (r = .349, -.394, p< .05). In a similar study, Pajares and Miller (1994) found a significant direct path from self-efficacy to academic achievement (r =.349, p < .05). In their 1995 study, Pajares and Miller found a significant correlation between mathematics self-efficacy, and problem-solving performance (r=.69, p < .0001). Brackney and Karabenick (1995) obtained results very similar to Pajares and his colleagues. For the current study, we also found a significant direct path from self-efficacy to mathematics performance (β = .551, p<.05) and from self-efficacy to worry (β=-.737, p<.05).

Implications

Given the propensity for "dropping out" of high school in a number of today's youths, implications of this study may provide insight on (a) the effectiveness of training adolescents in self-regulated learning strategies (Zimmerman & Martinez-Pons, 1992), and (b) the training of academic counselors to use cognitive restructuring with the appropriate intervention, targeting these students' poor regulation of effort (Brackney & Karabenick, 1995) and low self-efficacy (Pajares & Kranzler, 1995).

Because the sample size was small to moderate (N = 144), according to some authors (e.g., Bollen, 1989; Ding, Velicer, & Harlow, 1995), the majority of participants were Asian-American (60%), and the mathematical achievement was in a high-stakes environment, this study should be replicated with larger, more diverse samples before the results can be generalized to other populations and achievement criteria. In fact, any statistical "model that has been extensively respecified on the same data, cross-validation on new data is both desirable and necessary (Gerbing & Hamilton, 1996, p. 63).

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Appendix A (Data)

Table A1

CFA Model Correlation Matrix for Measured and Latent Variables, N = 143

		V5 V 5	V7 V 7	V8 V 8	V15 V 15	V21 V 21
V5	V 5	1.000				
V7	V 7	0.070	1.000			
V8	V 8	-0.380	0.000	1.000		
V15	V 15	-0.309	0.000	0.410	1.000	
V21	V 21	0.568	0.070	-0.378	-0.308	1.000
V22	V 22	-0.501	0.000	0.665	0.541	-0.499
V27	V 27	0.621	0.077	-0.414	-0.337	0.619
V29	V 29	0.114	0.472	0.000	0.000	0.113
V36	V 36	0.099	0.410	0.000	0.000	0.098
V41	V 41	0.092	0.381	0.000	0.000	0.091
V46	V 46	0.562	0.069	-0.375	-0.304	0.560
AWARENES	V 49	-0.142	0.195	0.122	0.099	-0.142
COGNITIV	V 50	-0.145	0.199	0.125	0.101	-0.145
EFFORT	V 51	-0.103	0.141	0.088	0.072	-0.103
PLANNING	V 54	-0.166	0.228	0.143	0.116	-0.166
SELF-CHE	V 55	-0.087	0.120	0.075	0.061	-0.087
APX	V 63	-0.357	0.000	0.389	0.316	-0.356
SEX	V 68	0.154	0.000	-0.241	-0.196	0.153
M-SAT	V 79	-0.163	-0.066	0.244	0.198	-0.163
SELFREGU	F 1	-0.183	0.252	0.157	0.128	-0.183
PRIORHSM	F 2	-0.247	-0.100	0.368	0.299	-0.246
WORRY	F 3	0.755	0.093	-0.503	-0.409	0.752
LEARNING	F 4	0.130	0.541	0.000	0.000	0.130
SELF-EFF	F 5	-0.535	0.000	0.710	0.577	-0.533
POSTHSMA	F 6	-0.368	0.000	0.401	0.326	-0.366
SEX	F 7	0.154	0.000	-0.241	-0.196	0.153

		V22 V 22	V27 V 27	V29 V 29	V36 V 36	V41 V 41
V22	V 22	1.000				
V27	V 27	-0.547	1.000			
V29	V 29	0.000	0.124	1.000		
V36	V 36	0.000	0.108	0.662	1.000	
V41	V 41	0.000	0.100	0.615	0.534	1.000
V46	V 46	-0.494	0.613	0.112	0.097	0.090
AWARENES	V 49	0.161	-0.155	0.315	0.274	0.254
COGNITIV	V 50	0.164	-0.158	0.322	0.280	0.260
EFFORT	V 51	0.117	-0.112	0.228	0.198	0.184
PLANNING	V 54	0.188	-0.181	0.368	0.320	0.297
SELF-CHE	V 55	0.099	-0.095	0.194	0.168	0.156
APX	V 63	0.514	-0.389	0.000	0.000	0.000
SEX	V 68	-0.319	0.168	0.000	0.000	0.000
M-SAT	V 79	0.322	-0.178	-0.107	-0.093	-0.086
SELFREGU	F 1	0.208	-0.200	0.406	0.353	0.328
PRIORHSM	F 2	0.486	-0.269	-0.161	-0.140	-0.130

WORRY	F 3	-0.664	0.823	0.150	0.131	0.121
LEARNING	F 4	0.000	0.142	0.873	0.759	0.704
SELF-EFF	F 5	0.937	-0.583	0.000	0.000	0.000
POSTHSMA	F 6	0.529	-0.401	0.000	0.000	0.000
SEX	F 7	-0.319	0.168	0.000	0.000	0.000

		V46 V 46	AWARENES V 49	COGNITIV V 50	EFFORT V 51	PLANNING V 54
V46	V 46	1.000				
AWARENES	V 49	-0.140	1.000			
COGNITIV	V 50	-0.143	0.615	1.000		
EFFORT	V 51	-0.102	0.437	0.445	1.000	
PLANNING	V 54	-0.164	0.704	0.718	0.510	1.000
SELF-CHE	V 55	-0.086	0.371	0.378	0.268	0.433
APX	V 63	-0.352	0.181	0.184	0.131	0.211
SEX	V 68	0.152	0.000	0.000	0.000	0.000
M-SAT	V 79	-0.161	0.000	0.000	0.000	0.000
SELFREGU	F 1	-0.181	0.777	0.792	0.562	0.907
PRIORHSM	F 2	-0.243	0.000	0.000	0.000	0.000
WORRY	F 3	0.745	-0.189	-0.192	-0.136	-0.220
LEARNING	F 4	0.128	0.361	0.368	0.261	0.422
SELF-EFF	F 5	-0.527	0.172	0.175	0.125	0.201
POSTHSMA	F 6	-0.363	0.186	0.190	0.135	0.217
SEX	F 7	0.152	0.000	0.000	0.000	0.000

		SELF-CHE V 55	APX V 63	SEX V 68	M-SAT V 79	SELFREGU F 1
SELF-CHE	V 55	1.000				
APX	V 63	0.111	1.000			
SEX	V 68	0.000	0.000	1.000		
M-SAT	V 79	0.000	0.388	-0.171	1.000	
SELFREGU	F 1	0.477	0.233	0.000	0.000	1.000
PRIORHSM	F 2	0.000	0.586	-0.259	0.662	0.000
WORRY	F 3	-0.116	-0.473	0.204	-0.216	-0.243
LEARNING	F 4	0.222	0.000	0.000	-0.122	0.465
SELF-EFF	F 5	0.106	0.548	-0.340	0.344	0.222
POSTHSMA	F 6	0.114	0.971	0.000	0.400	0.240
SEX	F 7	0.000	0.000	1.000	-0.171	0.000

		PRIORHSM F 2	WORRY F 3	LEARNING F 4	SELF-EFF F 5	POSTHSMA F 6
PRIORHSM	F 2	1.000				
WORRY	F 3	-0.327	1.000			
LEARNING	F 4	-0.184	0.172	1.000		
SELF-EFF	F 5	0.519	-0.708	0.000	1.000	
POSTHSMA	F 6	0.603	-0.487	0.000	0.564	1.000
SEX	F 7	-0.259	0.204	0.000	-0.340	0.000

		SEX F 7
SEX	F 7	1.000

Table A2

Path Model Correlation Matrix for Measured and Latent Variables, N = 143

		V5 V 5	V7 V 7	V8 V 8	V15 V 15	V21 V 21
V5	V 5	1.000				
V7	V 7	0.098	1.000			
V8	V 8	-0.394	-0.049	1.000		
V15	V 15	-0.320	-0.040	0.411	1.000	
V21	V 21	0.578	0.098	-0.393	-0.319	1.000
V22	V 22	-0.525	-0.066	0.674	0.547	-0.523
V27	V 27	0.632	0.107	-0.429	-0.348	0.630
V29	V 29	0.158	0.471	-0.079	-0.064	0.157
V36	V 36	0.137	0.410	-0.069	-0.056	0.137
V41	V 41	0.128	0.383	-0.064	-0.052	0.128
V46	V 46	0.573	0.097	-0.390	-0.316	0.571
AWARENES	V 49	-0.135	0.187	0.105	0.085	-0.134
COGNITIV	V 50	-0.137	0.191	0.107	0.087	-0.137
EFFORT	V 51	-0.097	0.135	0.076	0.061	-0.097
PLANNING	V 54	-0.157	0.219	0.122	0.099	-0.157
SELF-CHE	V 55	-0.083	0.115	0.064	0.052	-0.082
APX	V 63	-0.371	0.004	0.408	0.331	-0.370
SEX	V 68	0.195	0.046	-0.271	-0.219	0.194
M-SAT	V 79	-0.186	-0.064	0.273	0.221	-0.186
SELF-REG	F 1	-0.174	0.242	0.135	0.110	-0.173
LEARNING	F 2	0.181	0.542	-0.091	-0.074	0.181
SELF-EFF	F 3	-0.554	-0.069	0.712	0.577	-0.553
WORRY	F 4	0.762	0.129	-0.518	-0.420	0.760

		V22 V 22	V27 V 27	V29 V 29	V36 V 36	V41 V 41
V22	V 22	1.000				
V27	V 27	-0.571	1.000			
V29	V 29	-0.106	0.172	1.000		
V36	V 36	-0.092	0.149	0.658	1.000	
V41	V 41	-0.086	0.139	0.615	0.534	1.000
V46	V 46	-0.518	0.624	0.156	0.135	0.126
AWARENES	V 49	0.140	-0.147	0.301	0.262	0.244
COGNITIV	V 50	0.142	-0.149	0.307	0.267	0.249
EFFORT	V 51	0.101	-0.106	0.217	0.189	0.176
PLANNING	V 54	0.163	-0.171	0.351	0.305	0.285
SELF-CHE	V 55	0.086	-0.090	0.185	0.161	0.150
APX	V 63	0.542	-0.404	0.007	0.006	0.005
SEX	V 68	-0.360	0.212	0.074	0.064	0.060
M-SAT	V 79	0.363	-0.203	-0.103	-0.090	-0.084
SELF-REG	F 1	0.180	-0.189	0.388	0.337	0.315
LEARNING	F 2	-0.121	0.197	0.870	0.757	0.706
SELF-EFF	F 3	0.947	-0.603	-0.112	-0.097	-0.091
WORRY	F 4	-0.689	0.829	0.207	0.180	0.168

		V46 V 46	AWARENES V 49	COGNITIV V 50	EFFORT V 51	PLANNING V 54
V46	V 46	1.000				
AWARENES	V 49	-0.133	1.000			
COGNITIV	V 50	-0.135	0.613	1.000		
EFFORT	V 51	-0.096	0.434	0.443	1.000	
PLANNING	V 54	-0.155	0.702	0.715	0.507	1.000
SELF-CHE	V 55	-0.082	0.369	0.376	0.267	0.431
APX	V 63	-0.366	0.195	0.199	0.141	0.228
SEX	V 68	0.192	0.012	0.012	0.009	0.014
M-SAT	V 79	-0.184	0.026	0.027	0.019	0.031
SELF-REG	F 1	-0.171	0.775	0.790	0.560	0.905
LEARNING	F 2	0.179	0.346	0.352	0.250	0.404
SELF-EFF	F 3	-0.547	0.147	0.150	0.106	0.172
WORRY	F 4	0.752	-0.177	-0.180	-0.128	-0.206

		SELF-CHE V 55	APX V 63	SEX V 68	M-SAT V 79	SELF-REG F 1
SELF-CHE	V 55	1.000				
APX	V 63	0.120	1.000			
SEX	V 68	0.008	-0.096	1.000		
M-SAT	V 79	0.016	0.410	-0.216	1.000	
SELF-REG	F 1	0.476	0.252	.016	0.034	1.000
LEARNING	F 2	0.212	0.008	0.085	-0.119	0.446
SELF-EFF	F 3	0.090	0.573	-0.380	0.383	0.190
WORRY	F 4	-0.108	-0.487	0.256	-0.245	-0.228

		LEARNING F 2	SELF-EFF F 3	WORRY F 4
LEARNING	F 2	1.000		
SELF-EFF	F 3	-0.128	1.000	
WORRY	F 4	0.238	-0.728	1.000

Table A3

Descriptive Statistics

Variable ID	MEAN	SD
V5	2.229	1.069
V7	2.715	0.994
V8	2.417	0.972
V15	2.285	0.890
V21	2.500	0.989
V22	2.201	0.972
V27	2.229	1.036
V29	2.382	1.017
V36	2.264	0.908
V41	2.493	1.051
Awareness	14.514	2.794
Cognitive Strategy Use	17.889	3.640
Effort	20.931	2.813
Planning	17.292	3.104
Self-Checking	13.958	2.786
APX	3.514	1.333
M-SAT	3.326	0.418

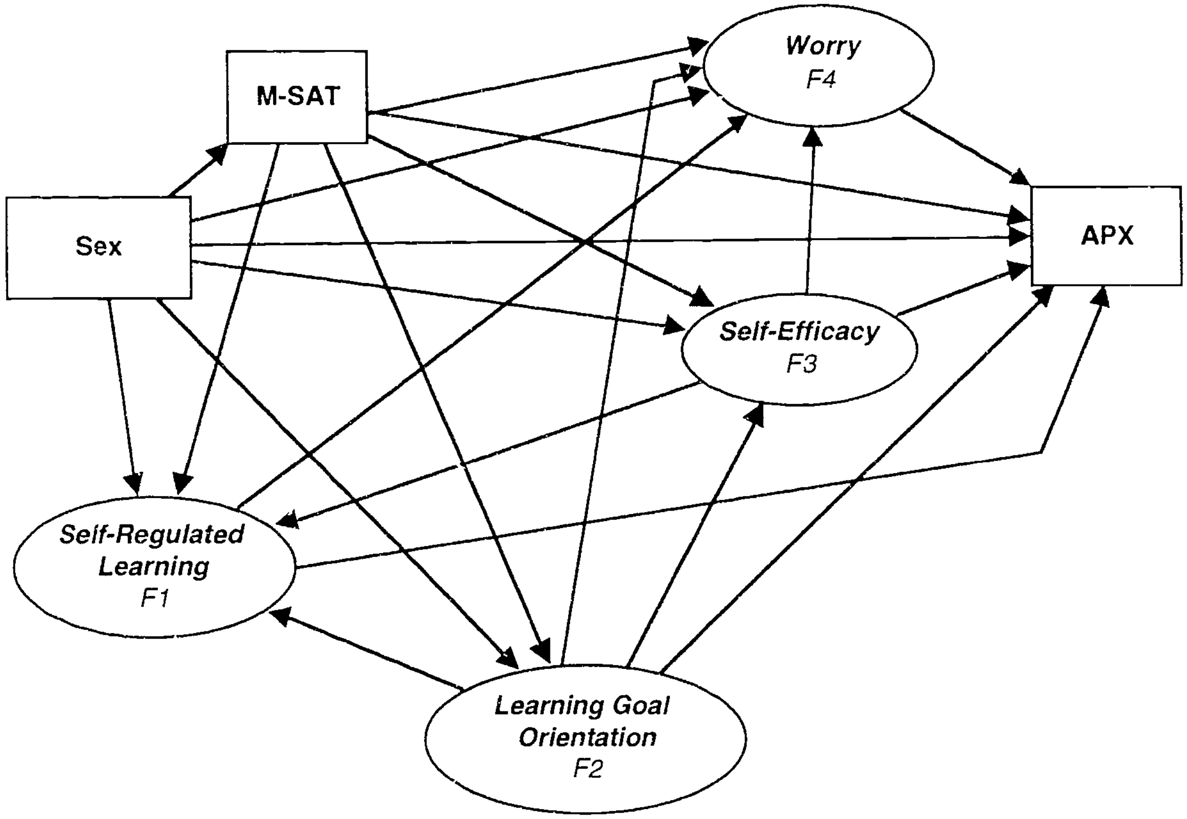

Figure 1. Hypothesized path model of sex, self-regulation, self-efficacy, learning goal orientation, worry, and prior and post high-stakes mathematics achievement.

Note. M-SAT = Math Scholastic Aptitude Test, APX = Advanced Placement Exam in calculus.

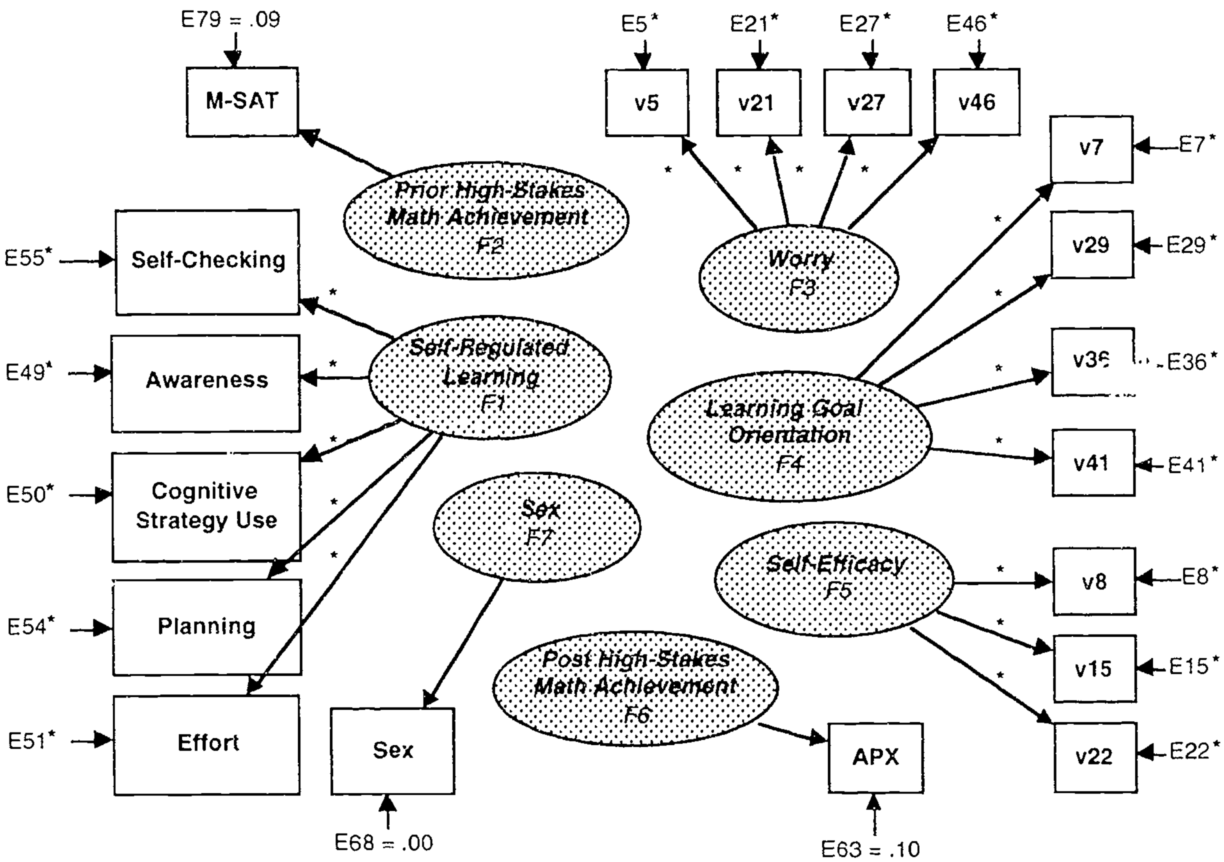

Figure 2. Measurement model of self-regulation, prior high-stakes math achievement, worry, learning goal orientation, self-efficacy, post high-stakes math achievement, and sex. Correlations among factors are not shown; asterisks indicate free parameters.

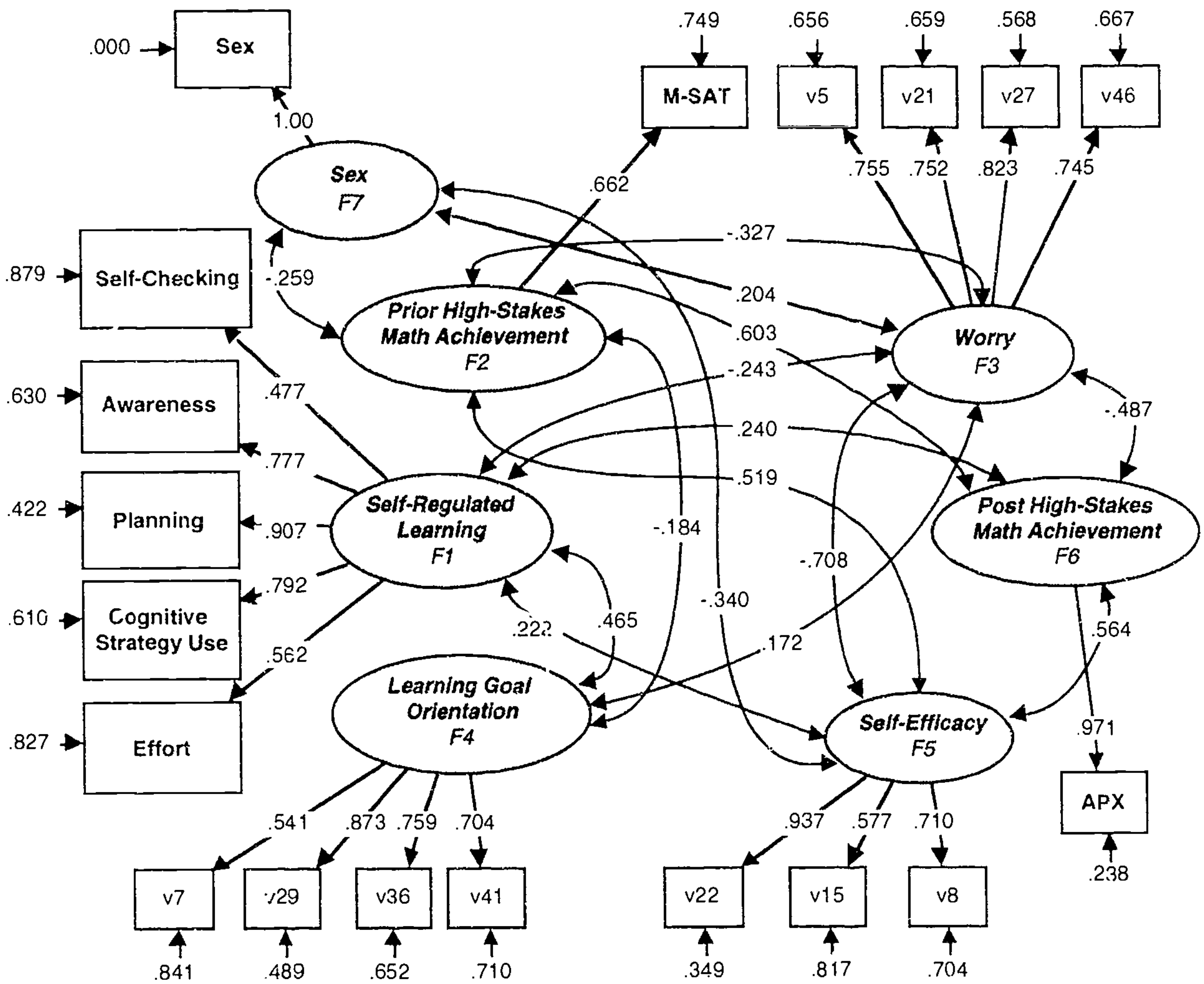

Figure 3. Results of the first-order CFA.

Note. For additional information, see the correlation matrix and descriptive statistics at Appendix A.

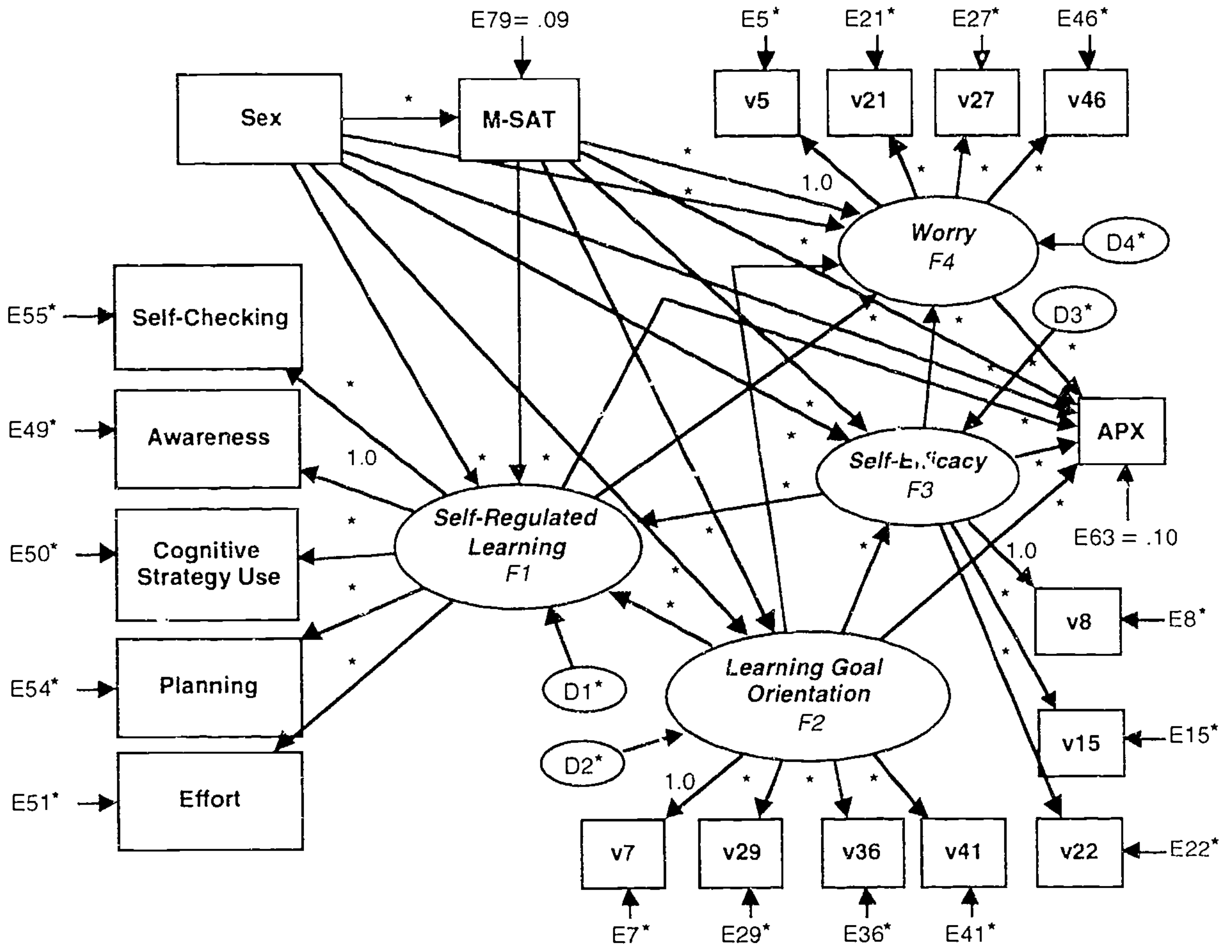

Figure 4. Hypothesized path analysis model. Asterisks indicate free parameters.

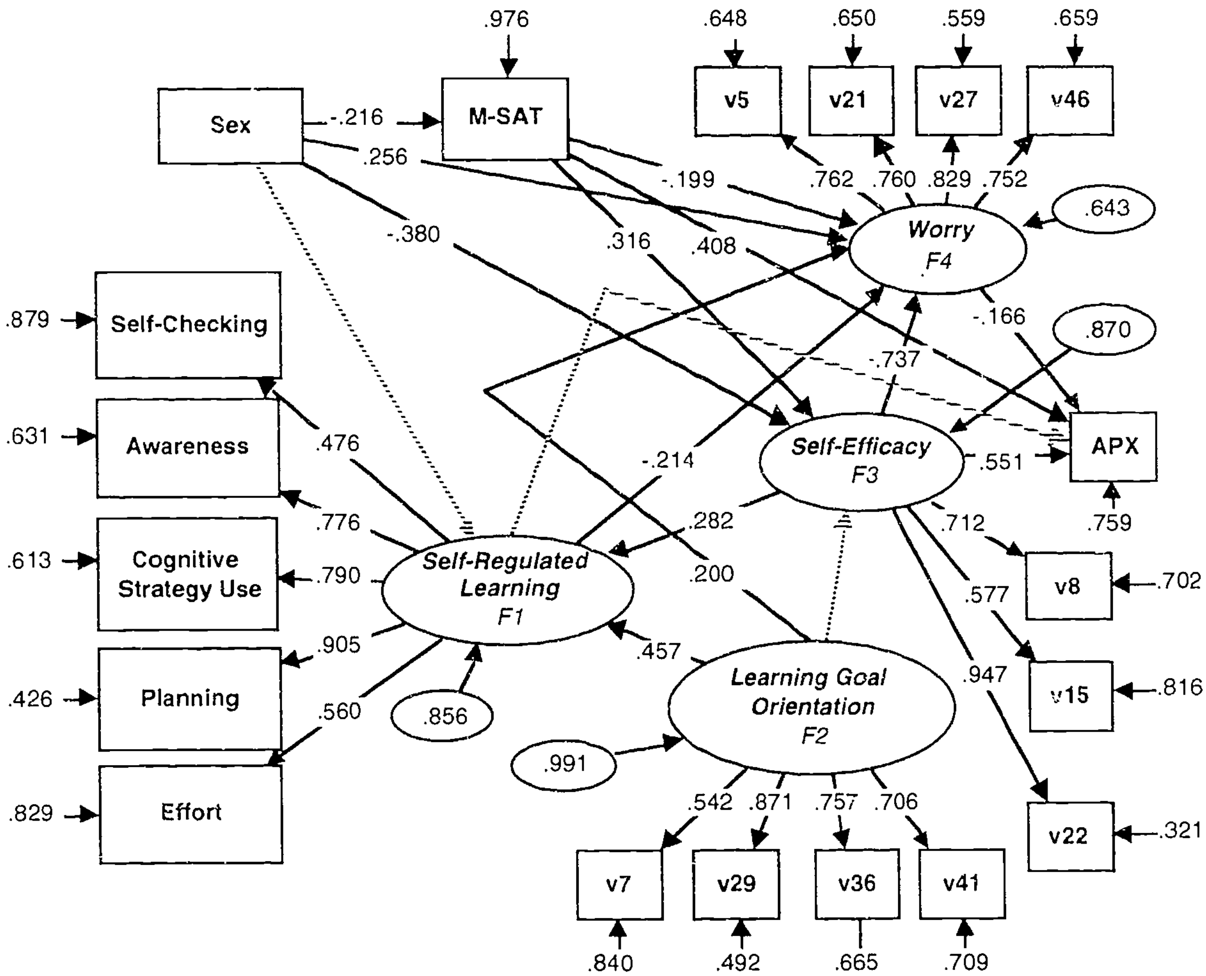

Figure 5. Path analysis structural model showing total effects (controlling for sex).

Note. Nonsignificant paths [β ≤ .16, p>.05] were deleted. For additional information, see the correlation matrix and descriptive statistics at Appendix A.

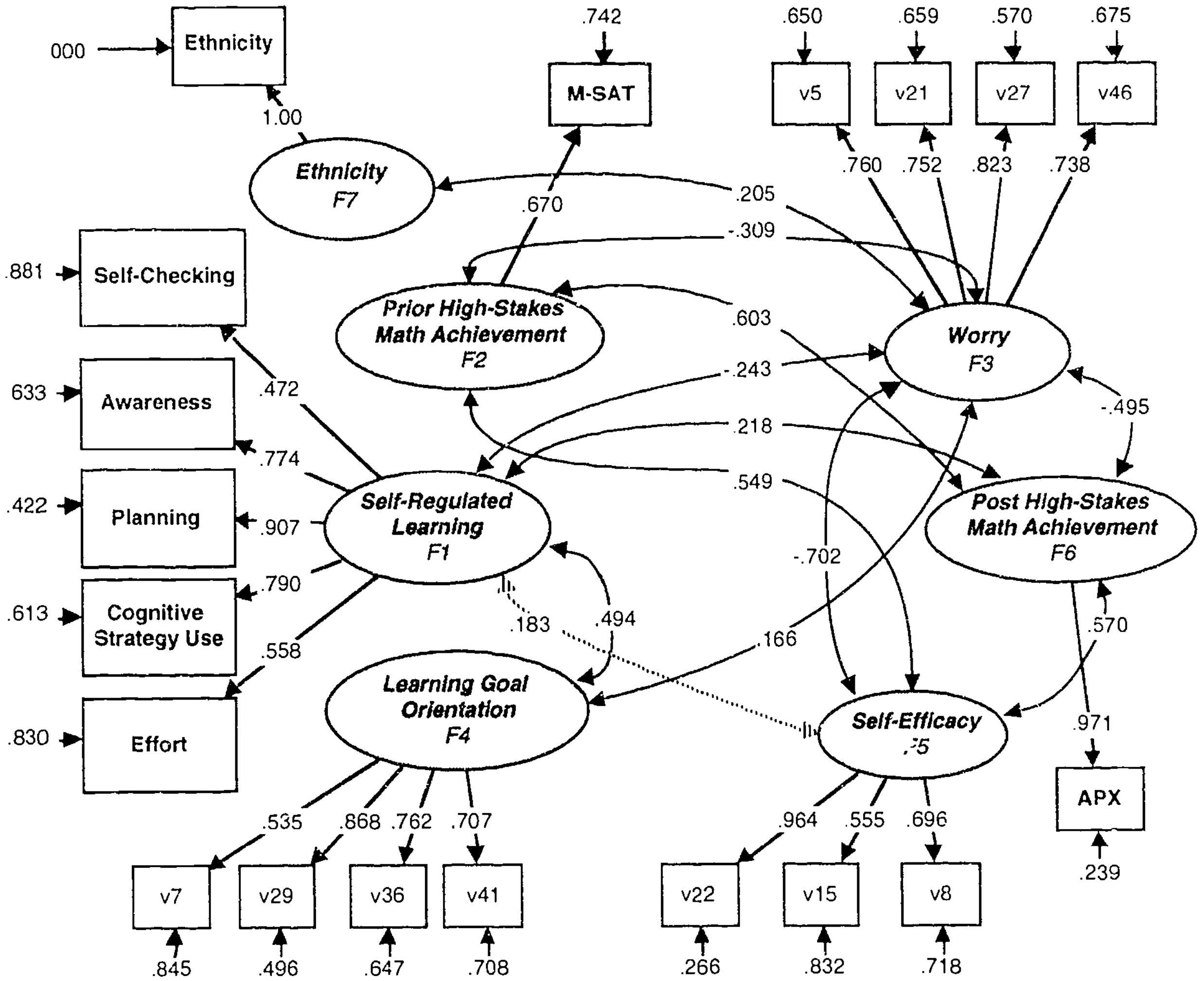

Figure 3b. Results of the first-order CFA (ethnicity).

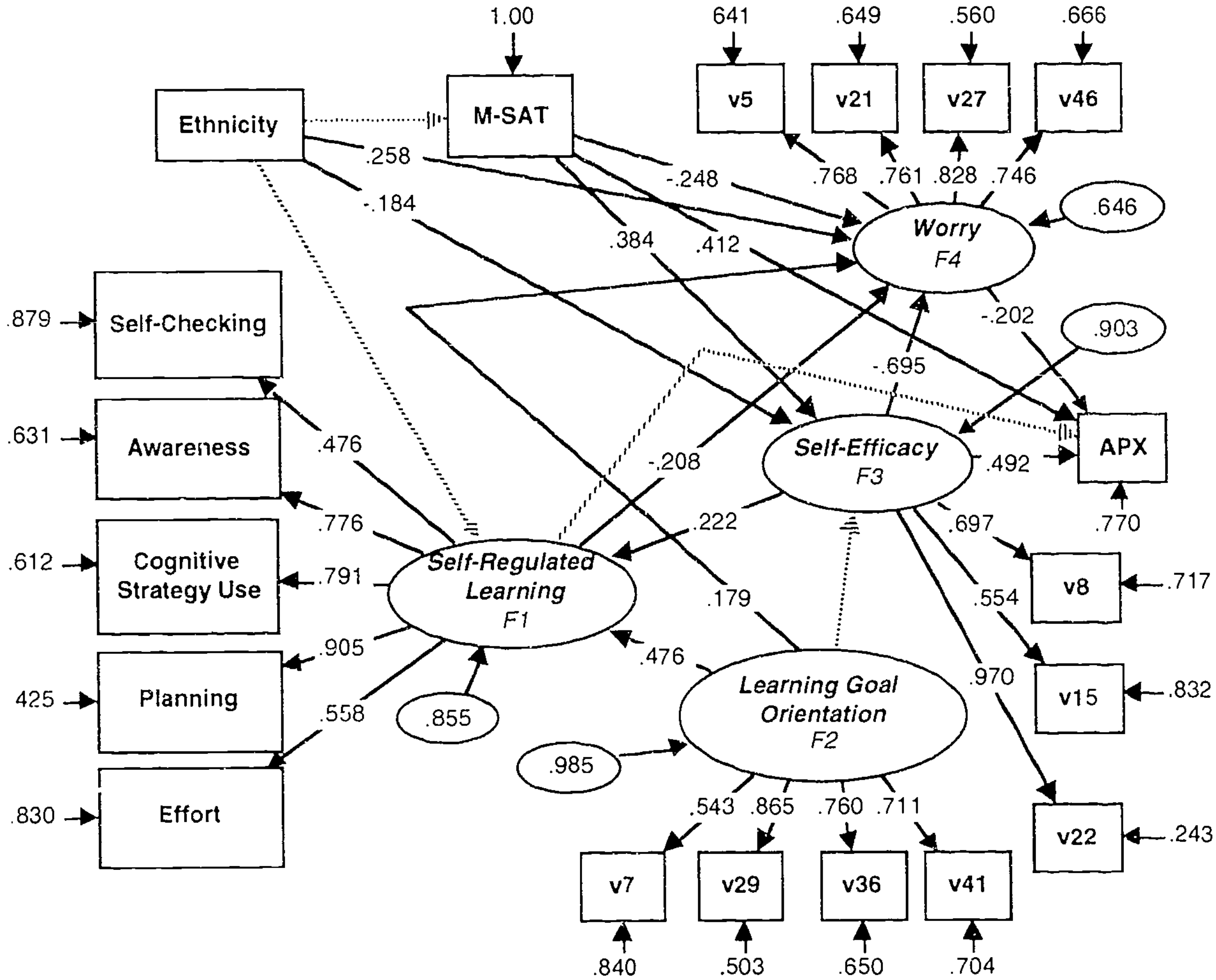

Figure 5b. Path analysis structural model showing total effects (controlling for ethnicity).

Note. Nonsignificant paths [$\beta \leq .16$, $p>.05$] were deleted).

Table 1

Items Means and Standard Deviations, and Scale Reliabilities.

Scale	No. of Items	Item Mean	Item *SD*	Alpha
Self-Regulated Learning	5	N/A	N/A	.82
Awareness	5	2.90	.58	.74
Cognitive Strategy Use	7	2.56	.37	.73
Effort	6	3.49	.58	.76
Planning	6	2.88	.48	.74
Self-Checking	5	2.79	.47	.66
Self-Efficacy	3	2.30	.11	.80
Learning Goal Orientation	4	2.46	.19	.81
Worry	4	2.39	.19	.86

Note. For this study, self-regulated learning was hypothesized to be comprised of five composite variables.

Table 2

Indices of Fit for the CFA and Path Models.

	Sex		Ethnicity	
Fit Index	CFA	Path	CFA	Path
Bentler-Bonett Normed Fit Index (NFI)	.826	.829	.821	.828
Bentler-Bonett Nonnormed Fit Index (NNFI)	.903	.898	.901	.897
Comparative Fit Index (CFI)	.921	.920	.918	.919
Adjusted CFI	.928	.927	.924	.927
Bollen Fit Index (IFI)	.923	.922	.920	.922
MacDonald's Fit Index (MFI)	.726	.723	.720	.725
LISREL Goodness of Fit Index (GFI)	.863	.865	.864	.871
LISREL Adjusted Goodness of Fit Index (AGFI)	.814	.808	.818	.817
Root Mean Squared Residual (RMSR)	.193	.191	.192	.190
Standardized Root Mean Squared Residual (SRMR)	.075	.066	.079	.063