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Self-Efficacy, Motivation Constructs, and Mathematics Performance of Entering Middle School Students

Frank Pajares and Laura Graham

Emory University

The objectives of this study were to determine the influence of various motivation variables on task-specific mathematics performance and to explore whether these variables change during the first year of middle school ($N = 273$). Students' task-specific self-efficacy was the only motivation variable to predict performance and did so both at start and end of year. There were no differences in anxiety, self-concept, or self-efficacy for self-regulation between start and end of year, but, by end of year, students described mathematics as less valuable and reported lower effort and persistence. Gifted students had stronger mathematics self-concept beliefs, and they had more accurate and less overconfident self-efficacy beliefs than did regular education students. There were no gender differences in any of the motivation constructs.

According to Bandura's (1986) social cognitive theory, students' *self-efficacy* beliefs—their judgments of confidence to perform academic tasks or succeed in academic activities—predict their subsequent capability to accomplish such tasks or succeed in the activities. Self-efficacy beliefs are also hypothesized to mediate the influence of other determinants of academic outcomes—such as skill or past performance—on subsequent actions. Efficacy beliefs also act in concert with other *common mechanisms* of personal agency—such as self-concept beliefs, anxiety, and self-regulatory practices—in influencing and predicting academic outcomes. The area of mathematics has received special attention in self-efficacy research for a number of reasons. Mathematics holds a valued place in the academic curriculum; it is prominent on high-stakes measures of achievement generally used for level placement, for entrance into special programs, and for college admis-

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Address reprint requests to Frank Pajares, Division of Educational Studies, Emory University, Atlanta, GA 30322. Fax: 404-727-2799.

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sions; and it has been called a ‘‘critical filter’’ for students in pursuit of scientific and technical careers at the college level (Sells, 1980).

Researchers have demonstrated that self-efficacy beliefs predict students’ mathematics performances, whether these performances are assessed as criterion-referenced test scores or achievement indexes (see Bandura, 1986; Pajares, 1996b; Schunk, 1991, for reviews). Typically, self-efficacy predicts mathematics performances to a greater degree than does math anxiety (Pajares & Miller, 1994), previous math experience (Hackett, 1985; Pajares & Miller, 1995), or self-efficacy for self-regulatory practices (Zimmerman, Bandura, & Martinez-Pons, 1992). Pajares and Kranzler (1995) found that the influence of self-efficacy on math performance was as strong as was the influence of general mental ability. Across ability levels, students whose self-efficacy is higher are more accurate in their mathematics computation and show greater persistence on difficult items than do students whose self-efficacy is low (Collins, 1982).

Recent findings suggest that gender differences in math achievement up to the high school level have diminished (Eisenberg, Martin, & Fabes, 1996), but various researchers report that gender differences in the mathematics attitudes of American and European students may still be prevalent (e.g., Catsambis, 1994; and see Wigfield, Eccles, & Pintrich, 1996). For example, it seems that boys and girls report equal confidence in their math ability during elementary school, but, by high school, boys are more confident. Even by middle school, boys tend to rate themselves more efficacious than do girls (Pintrich & De Groot, 1990; Seegers & Boekaerts, 1996; Wigfield, Eccles, MacIver, Reuman, & Midgley, 1991). Gifted girls are especially likely to be biased toward underconfidence in mathematics (Pajares, 1996a). By middle school, girls are also thought to show less interest in math and report higher levels of anxiety (Catsambis, 1994). Some researchers have suggested that gender differences in confidence may in part be due to the tendency of boys to be more self-congratulatory in their responses to efficacy instruments and of girls to be more modest (Wigfield *et al.*, 1996). This gender difference in mathematics confidence has sometimes been called the ‘‘confidence gap’’ (see Sadker & Sadker, 1994), and the middle school years have been identified as the time during which this gap between girls’ and boys’ self-perceptions of ability emerges (Fennema & Hart, 1994; Wigfield *et al.*, 1991).

Other motivation variables that act as common mechanisms of personal agency also predict math-related outcomes. These include math anxiety, self-concept, self-efficacy for self-regulation, perceived value, and academic engagement. Social cognitive theorists acknowledge the role these constructs play in the prediction of achievement behaviors. They also contend that self-efficacy beliefs influence broader self-beliefs (such as self-concept, anxiety, value) and that they mediate between self-regulatory beliefs and academic engagement (effort and persistence) and subsequent performances (Bandura, 1986, 1997; Hackett, 1985; Pajares, 1996b, 1997; Schunk, 1991; Zimmerman, 1990).

Researchers have also reported that high ability students have stronger self-efficacy and are more accurately *calibrated*, that is, that they have more accurate self-perceptions (e.g., Zimmerman *et al.*, 1992). Pajares and Kranzler (1995) reported that accuracy of self-perception correlated with academic performance and with general mental ability, and they urged researchers to explore the relationship between self-efficacy and other math-related variables in high ability students, as this stronger sense of academic efficacy and greater accuracy of self-perception may alter the predictive and mediational role that efficacy judgments play in their academic performances. This accuracy of self-perception is often referred to as ''feeling-of-knowing accuracy'' or ''prediction calibration'' (see Glenberg, Sanocki, Epstein, & Morris, 1987; Schraw, 1995).

The first objective of the present study was to determine whether mathematics self-efficacy makes an independent contribution to the prediction of mathematics performance when other motivation and previous achievement variables that have been shown to predict math-related outcomes are controlled. Researchers have reported on this point, but several design features make our first objective additive to the existent literature. These include the number of variables used as controls, the high-stakes nature of the performance task, the inclusion of gifted and regular education students, and the assessment of beliefs and performance both at start and at end of year.

Data for the study are drawn from the first year of a 3-year investigation and were collected at the start of the students' 6th-grade year and again at the end of the year. Consequently, our second objective was to discover the extent to which mathematics self-beliefs begin to change during the first year of middle school. Researchers who have investigated the changing self-beliefs of middle school students have focused on domain-specific self-beliefs such as goals, math anxiety, or math expectancies (see Anderman & Maehr, 1994; Wigfield *et al.*, 1991). We include task-specific self-efficacy beliefs, relate these beliefs to domain-specific motivation constructs, and interpret findings from the perspective of social cognitive theory.

Our third objective was to discover whether differences in the motivation constructs would vary by gender or by regular education/gifted placement. Seegers and Boekaerts (1996) observed that researchers studying the influence of gender on math-related self-beliefs have used measures that tap only domain-specific attitudes and that few studies have included motivation variables assessed at the task-specific level. We analyzed gender differences in motivation constructs assessed both at the domain level (perceived value, self-concept, anxiety) and at the task level (self-efficacy, calibration). In addition, we included a measure of perceptions of self-regulatory strategies and another of engagement.

METHOD

Participants and Procedures

Participants were 273 students in grade 6 from one suburban, public middle school in the South (150 boys, 123 girls; 188 regular education, 85 gifted; 190 White, 47 African American, 12 Hispanic American, 24 Asian American). At this school, 6th grade was the first year of middle school. Information on students' race/ethnicity was collected, but we did not have access to socioeconomic status information. Hence, we do not report race/ethnicity differences that would likely be confounded by socioeconomic factors (see Graham, 1994). With permission of the principal, parental consent was obtained. None of the students were receiving special services in mathematics. The school followed a mathematics curriculum that integrated arithmetic, algebra, geometry, and measurement and was consistent with the standards of the National Council of Teachers of Mathematics (NCTM). The attitude measures were group administered by the second author to 18 mathematics classes one day during the first 9-week period of the academic year (October) and again during the last 9-week period (April). Surveys were read aloud. Classroom teachers were not present during this administration, and confidentiality of their answers was assured to students. On the following day, the math teachers administered, scored, and recorded the grades for the performance measures before providing them to the researchers.

Variables in the Study

The *mathematics self-efficacy* instrument asked students to express their confidence to solve 20 mathematics problems similar to those that they would subsequently be presented in an end-of-unit, high-stakes test prepared by the mathematics grade-level chair and the teaching team. This way of measuring self-efficacy beliefs represents a task-specific assessment of students' mathematics self-perceptions that is consistent with the criterial task with which such beliefs are compared. It differs from domain-specific assessments of students' mathematics self-beliefs (such as math anxiety and self-concept). Social cognitive theorists posit that task-specificity and correspondence with the outcome of interest serve to increase prediction of academic outcomes (Bandura, 1997) and that such assessments can provide prediction indexes and insights not available from broader assessments of self-beliefs (Seegers & Boekaerts, 1996).

Directions on the self-efficacy instrument asked students, ''Suppose that you were asked to answer the following mathematics questions in a multiple choice test tomorrow. Please indicate how confident you are that you will give the correct answer to each question correctly.'' (Sample item: ''A train is traveling an average speed of 75 miles per hour. Use the four-step plan to find out how far it will travel in four hours.''). Students used an 8-point Likert scale ranging from 1 (not confident at all) to 8 (completely confident) to rate the strength of their confidence to successfully solve each problem. They provided confidence judgments for each problem. Scores were added across items to form a score that ranged from 20 to 160, and this score was then divided by 20 to provide an average self-efficacy score congruent with the 1–8 Likert scale. We obtained Cronbach's α coefficients of .94 for the fall administration and .93 for the spring. These indexes are consistent with coefficients obtained from similar instruments in previous investigations (Pajares & Kranzler, 1995; Pajares & Miller, 1997).

We adapted Betz's (1978) Mathematics Anxiety Scale (MAS) in line with guidelines provided by Pajares and Urdan's (1996) factor analysis. Our adapted MAS consisted of 8 of the original 10 items and one suggested by Pajares and Urdan (sample item: ''I dread having to do math.''). As with the self-efficacy measure, students responded on an 8-point Likert scale. Alpha coefficients ranging from .86 to .92 have typically been reported on the original MAS (e.g., Hackett & Betz, 1989; Pajares & Kranzler, 1995; Pajares & Urdan, 1996). We scored the adapted MAS such that a high score is indicative of high anxiety. We obtained reliability coefficients of .87 for the fall administration and .91 for the spring administration.

Mathematics self-concept was measured using the mathematics scale of the Academic Self-Description Questionnaire II (ASDQII), specifically developed to assess the self-concept beliefs of early adolescents (see Marsh, 1990, 1992). The mathematics scale consists of 6 items (sample item: ''I have always done well in mathematics.''). The ASDQII has 13 scales reflecting various academic subjects. Marsh (1992) obtained coefficient αs ranging from .89 to .95 for the various academic areas with students in grades 7-10. We obtained Cronbach's α coefficients of .89 for the fall and .91 for the spring.

The *Self-Efficacy for Self-Regulated Learning Scale* is a subscale from Bandura's Children's Multidimensional Self-Efficacy Scales (see Zimmerman *et al.*, 1992) and consists of 11 items, 7 of which were used in the present study. This scale assesses students' judgments of their capability to use various self-regulated learning strategies such as finishing homework assignments by deadlines, planning and organizing schoolwork, and studying in the face of distractions. The 8-point Likert scale ranged from 1 (not too well) to 8 (very well). A validation study of the original scale by Zimmerman and Martinez-Pons (1988) revealed that a single factor underlay the scale. Zimmerman *et al.* (1992) reported a Cronbach's α coefficient of .87. We obtained coefficient αs of .81 and .82 for the fall and spring administrations, respectively.

The variable that expectancy-value researchers call *value of mathematics* is typically composed of self-beliefs assessing perceived importance, interest, and enjoyment of math. Our scale consisted of 7 items. The two importance items are from the Student Attitude Questionaire (SAQ) (Eccles, 1983) and were used by Meece, Wigfield, and Eccles (1990). Students rate how important it is to them to be good at and get good grades in mathematics. For interest, students were asked whether or not they found mathematics as a subject, as well as solving mathematics problems, interesting (see Seegers & Boekaerts, 1996). Enjoyment of mathematics was assessed using three items (sample item: ''I enjoy doing mathematics homework.''). We used an 8-point Likert scale. For the complete value scale, we obtained α coefficients of .80 and .82 for fall and spring, respectively.

Engagement is considered an important consequent of efficacy beliefs and a determinant of academic performances (Miller, Greene, Montalvo, Ravindran, & Nochols, 1996; Pintrich & DeGroot, 1990; Pintrich & Schrauben, 1992; Schunk, 1984). It was assessed using three items measuring effort and persistence in math (sample items: ''When a mathematics problem is difficult for me to solve, I just put more effort into it.'' ''I will work as long as necessary to solve a difficult mathematics problem''). We obtained coefficient α scores of .71 and .75 for fall and spring.

According to social cognitive theory, *previous academic achievement* provides the type of mastery experience information theorized to foster the creation of self-efficacy beliefs. As such, it provides an important statistical control in studies of academic self-beliefs. The school provided us with two measures of previous achievement: (a) students' percentile scores on the math section of the Iowa Test of Basic Skills (ITBS), a national, standardized achievement test that students took at end of 5th grade and (b) students' grade point average (GPA) in mathematics for all terms during grades 5 and 6. The ITBS assessment represented the most recent, standardized indicator of mathematics attainment for the students in the study (M = 69th percentile; 67th percentile; girls; 71th percentile boys).

As recommended by Schraw (1995), we used two measures of calibration. The first was the *mean bias* score described by Keren (1991) and Yates (1990). Bias reveals the direction of the errors in judgment and is computed by subtracting actual performance from predicted confidence. To compute bias, a correct answer on the performance measure was scored 8 and an incorrect answer was scored 1. Recall that the Likert scale for the self-efficacy instrument also ranged 1 to 8. So, for example, expressing no confidence (1) and answering incorrectly (1) reflects zero bias (1 minus 1), whereas the same lack of confidence with a correct answer would receive a bias score of −7 (1 minus 8), indicating underconfidence. Bias scores ranged from −7 to +7. Scores greater than zero correspond to overconfidence; scores less than zero correspond to underconfidence. The second measure of calibration was *mean accuracy*, which was computed by subtracting the absolute value of each bias score from 7. The resultant score reveals the magnitude of the judgment error, which can range from 0 (complete inaccuracy) to 7 (complete accuracy) (see Schraw, Dunkle, Bendixen, & DeBacker Roedel, 1995, for similar procedures).

Classification of students as gifted or regular education was made on the basis of their placement in mathematics classes. Students were classified as gifted under state guidelines, which specified that they obtained a score of 130+ on a district-administered IQ assessment. These students were instructed separately in mathematics and received enriched instruction from a gifted-certified teacher using the same curriculum and book as the regular education students. Regular education students were students not receiving special services in mathematics.

The *mathematics performance* outcomes with which efficacy judgments have been compared have often been low-stakes in nature. Predictive and explanatory power of efficacy assessments is maximized when performance is measured on actual, high-stakes rather than simulated situations (Bandura, 1986, 1997). Consequently, the performance task consisted of two end-of-unit exams created by the mathematics department chair and teaching team. Students were aware that results would be used to compute their term grade in mathematics class. To help ensure that correlated specifics would not artificially inflate the correlation between self-efficacy and performance, the problems on which performance was assessed at each administration were similar, but not identical, to those on which confidence was measured (see Marsh, Roche, Pajares, & Miller, 1997). We obtained KR 20 reliability coefficients of .78 for fall and .86 for spring.

Analyses

We conducted two multiple regression analyses to determine whether self-efficacy made an independent contribution to performance when other variables are controlled. The first analysis predicted performance at start of year (fall) and the second at end of year (spring). Independent variables in each analysis were self-efficacy, anxiety, self-concept, self-efficacy for self-regulation, perceived value, engagement, two previous achievement indexes (ITBS math score and previous term's GPA in mathematics), gender, and gifted/regular education placement. In addition, we included the performance score from the fall as a predictor of performance in the spring. Dependent sample *t* tests, with significance adjusted to reflect multiple comparisons, were used to determine change in math-related variables between fall and spring, and multivariate analyses of variance (MANOVA) were conducted to determine whether these differences varied as a function of gender, regular education/gifted placement, and their interaction. MANOVA was conducted to examine mean difference for gender, gifted/regular education placement, and their interaction on the performance, self-beliefs, and calibration variables at start and end of year.

RESULTS

Predicting Mathematics Performance

Means, standard deviations, and correlations for the variables in the study at each administration are provided in Table 1. The correlations between self-

TABLE 1
Means and Zero-Order Correlations for Variables in the Study for Fall and Spring Administrations ($N = 273$)

Variable	Fall *M*	Fall *SD*	1	2	3	4	5	6	7	8	9	10	11	12	Spring *M*	Spring *SD*
1. Performance	15.4	3.4		.59***	.32***	.49***	.27***	.29***	.19**	−.68***	.81***	.64***	.08	.52***	12.1	5.0
2. Self-efficacy	7.1	0.9	.57***		−.60***	.70***	.52***	.50***	.40***	.18*	.48***	.59***	.06	.39***	6.4	1.3
3. Anxiety	3.5	1.5	−.40***	−.61***		−.68***	−.59***	−.61***	−.45***	−.15*	−.28***	−.41***	−.13	−.13	3.5	1.7
4. Self-concept	6.2	1.4	.48***	.66***	−.68***		.63***	.66***	.56***	.02	.38***	.61***	.07	.24***	6.1	1.6
5. Self-regulation	5.9	1.3	.30***	.53***	−.57***	.60***		.62***	.61***	.14	.23***	.27***	.04	.15*	5.7	1.4
6. Value	5.8	1.3	.30***	.34***	−.54***	.56***	.51***		.69***	.10	.27***	.32***	.06	.12	5.5	1.5
7. Engagement	6.0	1.5	.23**	.37***	−.48***	.47***	.52***	.66***		.13	.22**	.24***	.10	.12	5.6	1.6
8. Bias	0.8	1.0	−.63***	.28***	−.11	.06	.15*	−.04	.08		−.56***	−.25***	−.05	−.28***	1.1	1.4
9. Accuracy	5.2	1.0	.88***	.67***	−.48***	.57***	.39***	.39***	.31***	−.39***		.45***	.06	.50***	4.3	1.2
10. ITBS	68.8	24.5	.66***	.51***	−.35***	.50***	.21**	.21**	.14	−.29***	.65***		.08	.56***	68.8	24.5
11. Gender			.00	.10	−.13	.17*	.02	.03	.09	.10	.03	.08		.13		
12. Gifted/Regular Ed			.49***	.25	−.17*	.30***	.03	.14	.02	−.34***	.49***	.56***	.13			

Note. Correlations below the matrix are for the fall administration; correlations above the matrix are for the spring administration.
* $p < .01$.
** $p < .001$.
*** $p < .0001$.

TABLE 2
Multiple Regression Results for the Prediction of Task-Specific and Domain-Specific Mathematics Outcomes

	Task-specific math outcome (exam score)					
	Fall			Spring		
Variable	β	*t*	*p*	β́	*t*	*p*
Self-efficacy	.267*	4.25	.0001	.272*	4.12	.0001
Anxiety	−.039	−0.63	.5299	.082	1.29	.1990
Self-concept	−.074	−0.99	.3236	−.002	−0.02	.9808
Self-regulation	.021	0.37	.7128	−.016	−0.26	.7936
Value	.098	1.58	.1162	.064	0.94	.3499
Engagement	−.000	−0.01	.9938	−.082	−1.32	.1873
ITBS score	.300*	4.83	.0001	.251*	3.68	.0003
Gender	−.087*	−2.07	.0394	.051	1.17	.2414
Giftedness	.174*	3.44	.0007	.164*	3.01	.0029
Term GPA Grade 5	.210*	3.58	.0004		–	
Term GPA Grade 6		–		.127*	2.02	.0449
Fall exam score		–		.162*	2.38	.0179
R^2		.56			.53	

Note. Self-efficacy was assessed at the task-specific level of solving problems on a mathematics exam; mathematics self-concept was assessed at the domain-specific level of mathematics. For Fall models, Term GPA Grade 5 consisted of mathematics grade obtained during last term of Grade 5; for Spring models, Term GPA Grade 6 consisted of mathematics grade obtained during previous term of Grade 6.

efficacy and performance (.57 fall, .59 spring) are similar to those obtained in previous studies (see Pajares, 1996b), although correlations between self-efficacy and self-concept (.66 fall, .70 spring) are higher than those typically found. Correlations between math self-concept and math anxiety were strong (see Pajares, 1996a; Pajares & Kranzler, 1995, for similar results), but we did not judge them strong enough to merit exclusion of either variable in subsequent analyses. The exam administered in the spring (M = 12.1) was more difficult than the exam administered in the fall (M = 15.4), a phenomenon that, no doubt, contributed to the drop in self-efficacy scores (7.1 fall, 6.4 spring) and in calibration scores. Recall that the exam was a high-stakes measure created by the teaching team at the school and reflected the more challenging material covered at that time of the academic year.

Table 2 provides results of the multiple regression analyses. As expected, ITBS scores were predictive both in fall (β = .300) and spring (β = .251), and the performance test taken in the fall predicted performance in spring (β = .162). Also as expected, gifted students outperformed regular education students (β = .174 fall; β = .164 spring). Despite these controls, self-efficacy predicted performance at both administrations and was the only motivation

TABLE 3
Mean Differences between Start and End of Year for Variables in the Study by Gender, Placement, and for the Full Sample, Test–Retest Correlations for Full Sample

	Mean difference					
Variable	Girls	Boys	Reg Ed	Gifted	Full Sample	Fall/Spring *r*
Performance	−3.76*	−2.90*	−3.90*a	−1.92*b	−3.29*	.61***
Self-efficacy	−0.78*	−0.80*	−0.97*a	−0.39*b	−0.79*	.65***
Anxiety	−0.06	0.01	−0.01	0.12	0.03	.64***
Self-concept	−0.03	−0.24	−0.09	−0.18	−0.12	.72***
Self-regulation	−0.23	−0.18	−0.32a*	0.04b	−0.21	.54***
Value	−0.30*	−0.21	−0.25	−0.25	−0.25*	.65***
Engagement	−0.39*	−0.35*	−0.45*	−0.20	−0.37*	.55***
Mean bias	0.54*	0.21	0.40*	0.28	0.36*	.35***
Mean accuracy	−0.96*	−0.88*	−0.98*	−0.78*	−0.92*	.54***
GPA	−0.24*	−0.59*	−0.43*	−0.44*	−0.43*	.57***

Note. Group means for gender and placement for a dependent variable (row) that are subscripted by different letters are statistically different (experimentwise $\alpha \leq .05$) computed on an effect identified by MANOVA. For regular education/gifted placement, Wilks $\lambda = .84$, $F(10, 254) = 4.84$, $p < .0001$. Multivariate effects for gender and for the interactive effect of gender and placement were nonsignificant.

* Mean differences denotes significance at $p < .002$.

*** Test–retest correlations denotes significance at $p < .0001$.

variable to do so ($\beta = .267$ fall; $\beta = .272$ spring). The independent variables accounted for 56% of the variance in performance for the fall model, $F(10, 255) = 34.23$, $p < .0001$, and 53% for the spring model, $F(11, 261) = 28.48$, $p < .0001$. To ensure that self-efficacy made an independent contribution, we tested for differences between full models with self-efficacy as a predictor and reduced models without self-efficacy. The significant difference in R^2 revealed that self-efficacy made a modest but independent contribution, R^2 diff $= .03$, $F(1, 254) = 17.01$, $p < .05$, for fall and R^2 diff $= .03$, $F(1, 263) = 15.96$, $p < .05$, for spring. These results resolved the first objective of the study.

Differences between Start and End of year

Our second objective was to discover the extent of change in math-related constructs from start to end of year. Results of dependent-sample *t* tests with significance adjusted to account for multiple comparisons ($p < .001$) are provided on Table 3. There were significant differences for performance (−.3.3) and for self-efficacy (−.79), but recall that the self-efficacy decrease was likely a result of the more challenging spring exam. There were no differences in anxiety, self-concept, or self-efficacy for self-regulation between fall and spring. However, at the end of the academic year, students rated mathematics as less valuable (−.25) and reported lower effort and persistence (−.37) than at start of year. Students grew more biased toward overconfidence (.36), and their self-efficacy beliefs were less congruent with their performance scores (−.92). The nearly one full point decrease in mean accuracy is especially pronounced. Students' mathematics GPA also decreased from grade 5 to grade 6 (−.43).

We had no reason to expect that scores between fall and spring would differ by gender or by giftedness—we expected that motivation constructs, calibration, and achievement indexes would differ proportionately both for boys and girls and for regular education and gifted students. In other words, if self-beliefs or performance decreased, we expected that they would decrease equally for each group. Table 3 shows mean difference in scores between start and end of year by gender and by placement. Note that mean scores of the gifted students on performance, self-efficacy, and self-efficacy for self-regulation decreased in lower proportion than did scores of the regular education students.

Differences in Mathematics-Related Variables by Gender and Giftedness

Our third objective was to explore differences in the math-related measures by gender and by regular education/gifted placement, and their interaction. The multivariate effect for gender and for the interaction of gender and placement were nonsignificant at each administration. There was a multivariate effect for placement at each administration, Wilks' $\lambda = .68$, $F(9, 254) = 13.07$; $p < .0001$ for fall; Wilks' $\lambda = .68$, $F(10, 260) = 12.24$; $p < .0001$ for spring. Gifted students had higher mean scores on performance, were less biased toward overconfidence, and more accurate in their self-efficacy beliefs at each administration, which is to say that they were better calibrated than were regular education students. Gifted students also reported higher math self-efficacy and self-concept at each administration. Table 4 shows results of this analysis.

DISCUSSION

The first objective of this study was to discover whether students' mathematics self-efficacy beliefs make an independent contribution to the prediction of mathematics performance when motivation variables shown to predict math-related outcomes are controlled. Mathematics self-efficacy was the only motivation variable to predict mathematics performance both at beginning and end of year, resolving this substantive issue. This finding is consistent with those obtained by other researchers but is notable because of the number of variables used as controls. We believe that this was, in part, due to the particularized assessment of self-efficacy, which was operationalized as the task-specific beliefs of capability to solve the problems on which performance was based. We expect that, as performance tasks increase in gener-

TABLE 4
Mean Scores and Standard Deviations for Variables in the Study by Gender and Gifted/Regular Education ($N = 273$)

	Fall				Spring				Fall				Spring			
	Girls		Boys		Girls		Boys		Reg Ed		Gifted		Reg Ed		Gifted	
Variables	M	*SE*	M	*SE*	M	*SE*	M	*SE*	M	*SE*	M	*SE*	M	*SE*	M	*SE*
Performance	15.4	3.4	15.4	3.3	11.7	4.9	12.5	5.0	14.3a	3.4	17.8b	1.5	10.4a	4.3	15.9b	4.2
Self-efficacy	7.0	0.9	7.2	0.9	6.3	1.2	6.4	1.4	7.0a	1.1	7.5b	0.5	6.0a	1.3	7.1b	0.9
Anxiety	3.7	1.5	3.3	1.5	3.8	1.7	3.3	1.6	3.7a	1.6	3.1b	1.3	3.7	1.7	3.2	1.6
Self-concept	5.9	1.5	6.4	1.4	6.0	1.7	6.2	1.5	5.9a	1.5	6.8b	0.9	5.8b	1.7	6.7b	1.2
Self-regulation	5.9	1.3	6.0	1.3	5.7	1.3	5.8	1.4	5.9	1.3	6.0	1.2	5.6	1.4	6.0	1.3
Value	5.8	1.3	5.8	1.2	5.4	1.3	5.6	1.4	5.7	1.3	6.0	1.1	5.4	1.4	5.8	1.2
Engagement	5.9	1.5	6.1	1.5	5.5	1.5	5.8	1.6	6.0	1.6	6.1	1.3	5.5	1.6	5.9	1.4
Mean bias	0.6	1.0	0.8	1.0	1.2	1.3	1.1	1.5	1.0a	1.1	0.2b	0.6	1.4a	1.3	0.5b	1.5
Mean accuracy	5.2	0.9	5.3	1.1	4.2	1.1	4.4	1.2	4.9a	1.0	6.0b	0.6	3.9a	0.9	5.2b	1.2
GPA	3.2	0.8	3.4	0.8	3.0	1.3	2.8	1.2	3.1a	0.8	3.8b	0.4	2.6a	1.3	3.4b	0.7

Note. Mean scores in math self-efficacy, math anxiety, math self-concept, self-efficacy for self-regulation, perceived value of mathematics, and engagement in mathematics range from 1 (low) to 8 (high). Mean scores for performance range from 1 (low) to 20 (high). Mean scores for bias range from −7 (complete underconfidence) to 7 (complete overconfidence). Mean scores for mean accuracy range from 0 (total inaccuracy) to 7 (total accuracy). ITBS percentile scores in mathematics were used as covariate. Group means for a dependent variable (row) that are subscripted by different letters are statistically different (experimentwise $\alpha \leq .05$) computed on an effect identified by MANOVA.

ality, broader self-beliefs such as self-concept would increase in prediction (see Bong & Clark, 1998; Marsh, 1993; Marsh *et al.*, 1997; Pajares, 1996b, 1997; Skaalvik & Rankin, 1996).

These are striking findings in light of the rigorous test of the influence of self-efficacy that inclusion of achievement assessments provide in investigations of academic performances. When researchers gauge the influence of affective factors on these performances and statistically control for previous performance attainments with measures such as standardized achievement tests or GPA, these controls are problematic, in that scores on such assessments are themselves confounded by affective factors. As Bandura (1997) has observed, ‘‘behavior is not a cause of behavior’’ (p. 69), and motivational and self-regulatory influences affect both prior and later performance attainments. As a consequence, controlling for previous achievements controls not only for those achievements but also for the prior impact of motivational determinants such as self-efficacy or self-concept on the achievements. Thus, the influence of affective factors on mathematics performance is potentially greater than the results obtained indicate. These confounding influences are not easily disentangled, hence, they should be kept in mind as results are interpreted (see Bandura, 1997, pp. 68–70, for a discussion of this issue). Note that we used two measures of previous achievement for the fall model and three measures for the spring model.

Our second objective was to discover the extent to which mathematics self-beliefs change during the first year of middle school. By the end of the academic year, students described mathematics as less valuable, and they reported decreased effort and persistence in mathematics. Our results regarding students’ decreasing value, engagement, and grades are consistent with those reported by researchers who have documented that student attitudes in mathematics diminish, often along with achievement indexes, during their transition to middle school (Anderman & Maehr, 1994; Midgley, Feldlaufer, & Eccles, 1989; Wigfield *et al.*, 1991, 1996). Performance, self-efficacy, and calibration scores were lower at end of year than they were at start, but we emphasize that these decreases may be explained by the more difficult spring examination. Additional study using performance measures of similar difficulty at start and end of year will be required to ascertain whether self-efficacy diminishes or whether there is an increasing tendency for 6th-grade students to make less accurate, and more overconfident, judgments of their math capability as the year progresses. Consistent with previous findings, students were biased toward overconfidence (Hackett, 1985; Pajares, 1996a).

Mathematics self-concept did not decrease during the year, suggesting that students’ *domain-specific* mathematics beliefs had not been altered. If these beliefs are to decrease by end of middle school, changes in beliefs related to value and engagement of mathematics may be precursors to subsequent changes in more general expectancy beliefs and judgments of self-worth about mathematics at later stages in the students' middle school careers (see Midgley *et al.*, 1989, on transition from elementary to middle school). If this is the case, intertheoretical crosstalk and continued research using expectancy-value, self-concept, and self-efficacy constructs should provide valuable insights.

Finally, we sought to discover whether differences in the math-related measures varied by gender or by regular education/gifted placement in mathematics. We found no gender differences in self-efficacy beliefs either at start or end of year. These results differ from those of some researchers. For example, Seegers and Boekaerts (1996) found that Dutch boys reported stronger mathematics self-efficacy than did girls. Boys in their sample also had higher math achievement. In our study, there were no gender differences in performance. For our sample, the ''confidence gap'' between boys and girls was not in evidence as students began middle school. Catsambis (1994) reported that 8th-grade girls reported higher math anxiety and lower interest and perceived value of mathematics than did boys. We did not find differences on these variables with our 6th-grade sample. Again, results from the forthcoming two years of data will reveal whether these differences accentuate as students progress through middle school.

As expected, there were differences between regular education and gifted students. At each administration, regular education students had lower performance scores, lower self-efficacy, and lower self-concept. They were also less accurate in their efficacy perceptions and more overconfident. Of special concern is the decrease in self-efficacy for self-regulation by regular education students. Subskills required to organize a course of action are themselves governed by broader self-regulatory skills, such as knowing how to diagnose task demands or constructing and evaluating alternative strategies. Possessing these self-regulatory skills helps students to improve their performance across varied academic activities (see Zimmerman, 1989; Zimmerman & Schunk, 1989), and self-regulatory efficacy is critical in that it contributes to academic efficacy and subsequent achievement (see Zimmerman *et al.*, 1992).

Findings from this study support Bandura's (1986, 1997) claim that self-efficacy beliefs predict academic outcomes. They also support the work of investigators who report significant relations between self-efficacy, other motivation constructs, and academic performances. The implication that arises is that researchers and school practitioners should be looking to students' beliefs about their mathematics capabilities, for they are important components of motivation and of academic achievement (see Bandura, 1997; Pajares, 1997; Schunk, 1991; Zeldin & Pajares, in press). It also seems warranted to suggest that researchers should continue to identify the contexts in which certain motivation constructs may be better predictors of math-related outcomes as well as the unique role that each construct plays in the general development of self-regulatory and performance skills. The result will be a clearer and deeper understanding of the nature of the interplay among the differing self-beliefs, other motivation constructs, self-regulatory processes, and mathematics performances.

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