

MEASURING THE RELATIONSHIP BETWEEN SELF-EFFICACY AND MATH PERFORMANCE AMONG FIRST-GENERATION COLLEGE-BOUND MIDDLE SCHOOL STUDENTS

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Using confirmatory factor analysis, this study examines the validity of the Usher and Pajares Sources of Self Efficacy in Mathematics (SSEM) for prospective or eventual first-generation college students while still in middle school, a population not studied with the SSEM heretofore. Studying this population is especially noteworthy as educators seek to increase college going rates for this group, especially in science, technology, engineering, and math. After minor modifications, we achieved an acceptable model fit for both first-generation and non-first-generation students, although the model was not invariant across groups. The most notable difference was the significantly higher level of stress and negative physiological response reported by first-generation students. Knowing this important difference can be important for middle grades educators in helping these students successfully access foundational math curricula. Additionally, we successfully utilized the SSEM as a predictor of math course grades for first-generation and non-first generation students showing a significant positive relationship between math self-efficacy and math course grades. The positive relationship indicated an increase in self-efficacy related to an increase in math performance and was not significantly different between groups.

INTRODUCTION

In recent years, particular attention has been paid to the postsecondary success of first-generation students—those whose parents did not attend college. The population of college students who fit this description is nontrivial: Approximately a third of those attending 4-

year institutions are first-generation students (Chen & Carroll, 2005; Choy, 2001). Frequently, they face challenges matriculating to college and then succeeding once there, as measured by metrics such as persistence and grades. The sources of these challenges likely begin years before first-generation students attempt to matriculate or attend their first

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college class. While in K–12 schools, these students tend to have less knowledge about postsecondary education (Bloom, 2007; Terenzini, Springer, Yaeger, Pascarella, & Nora, 1996) and complete less rigorous academic preparation (Horn & Nuñez, 2000; Warburton & Nuñez, 2001), particularly in science, technology, engineering, and math (STEM).

As educators seek to increase the number of K–12 students—particularly eventual first-generation college students—prepared for university-level coursework in STEM subjects and ultimately STEM careers, mathematics performance holds a key position (Cooper, Cooper, Azmitia, & Chavira, 2002; Nichols, Wolfe, Besterfield-Sacre, Shuman, & Larpkittaworn, 2007). In addition to providing the necessary knowledge and skill base for future success, advanced math taking has been shown to lead to higher postsecondary enrollment rates for first-generation students (Choy, 2001). One of the most frequently documented early courses for later math success is algebra, often taken during the eighth grade (Gamoran & Hannigan, 2000; Miner, 1995; Oakes, 1990).

In order to successfully engage advanced mathematics curricula, students need a reasonable belief they can do so successfully. As a result, researchers increasingly have come to recognize that successful academic performance, most certainly including math, depends significantly on high self-efficacy (Hackett & Betz, 1989; Pietsch, Walker, & Chapman, 2003). The concept of self-efficacy comes from Bandura's (1986) social cognitive theory, which hypothesized that individuals need to believe they can succeed at a task in order to have the motivation necessary to maintain a trajectory within that given subject or behavior. Applying Bandura's model to student learning, self-efficacy is the belief students hold about their academic capabilities.

Yet, scant attention has been paid to the role of self-efficacy in STEM subjects specifically for eventual first-generation students. For example, does self-efficacy play an important

role in math achievement specifically among eventual first-generation students? If so, how might that shape the STEM opportunities afforded to them?

Although this has not been studied specifically among first-generation students, what has been studied are the sources of self-efficacy for middle school students generally (Britner & Pajares, 2006; Pajares & Graham, 1999) and mathematics self-efficacy among broader populations of students (Pajares, 1996; Usher, 2009). More recently Usher and Pajares (2009) developed and validated the Sources of Math Self-Efficacy instrument for use with middle school students, which utilizes Bandura's (1986) theory. These works, then, provide a foundation for the current study, which investigates self-efficacy specifically for eventual first-generation students as compared to other student groups and measures the relationship between self-efficacy and mathematics course outcomes.

LITERATURE REVIEW

Self-efficacy beliefs are one's perceptions s/he can successfully complete specific tasks under specific conditions (Bandura, 1977, 1986, 1997). Self-efficacy beliefs are not, however, synonymous with outcome expectation, although they are often positively related (Bandura, 1986). A variety of choices including activity, effort, and resilience are influenced by self-efficacy beliefs, and all of these can impact learning.

Bandura's (1986) theory divided self-efficacy into four sources: mastery experiences, vicarious experiences, social persuasions, and physiological states. The most powerful source of self-efficacy was students' mastery experiences where students' past success informs their confidence to perform similar tasks, and perceived failures function to erode mastery experiences. Vicarious experiences help to build self-efficacy through students' observations of others, usually other students. This process allows students to calibrate their

performance relative to their peers. Social persuasions are formed through the encouraging interaction with peers and influential adults, such as parents or teachers. This influence is especially strong when students are in new academic settings making self-calibrated mastery experiences difficult. Similar to mastery experiences, social persuasions can be eroded through negative interaction. Negative physiological states, such as stress, anxiety, or depression reduce self-efficacy and are often used as filter for students when approaching new tasks.

A number of studies have measured self-efficacy in differing educational contexts, including secondary education (Britner & Pajares, 2006; Lopez & Lent, 1992; Usher & Pajares, 2009) and the success of first-generation college students in postsecondary education mathematics (Majer, 2009; McMurray & Sorrells, 2010; Ramos-Sanchez & Nichols, 2007; Turley, Gore, & Leuwerke, 2006).

For example, Lopez and Lent (1992), using a small sample of high school students, examined the relationship between mathematical self-efficacy and semester grades. They developed a 5-factor model for self-efficacy. The additional factor was a division of vicarious experiences into separate factors for adults and peers. Similar to other studies noting a difference in achievement, the authors found women had significantly higher course grades. Women also had higher self-efficacy and self-concept. The authors hypothesized the difference in self-efficacy may be due to the unique characteristics of the sample, which utilized students taking an advanced elective course.

Pajares (1996) examined self-efficacy for gifted students in middle school algebra classes. After controlling for a number of variables, including anxiety, ability level, and math grades, self-efficacy still made a significant contribution in predicting problem solving. Gifted girls outperformed boys but did not report higher self-efficacy. Path analysis showed key differences in the roles played by gender, prior achievement, and cognitive abil-

ity between the gifted and regular education students in predicting performance.

Lent, Lopez, Brown, and Gore (1996) used high school students in geometry and algebra classes to measure a relationship between self-efficacy, course outcome expectations, grades, and objective measures of mathematics ability. They found significant relationships between self-efficacy and outcome expectancies, as well as a relationship between direct and vicarious experiences in the formation of self-efficacy.

Pajares and Graham (1999) investigated self-efficacy for first year middle school students and mathematics performance. They measured a number of motivation variables, including mathematics self-efficacy, mathematics self-concept, self-efficacy for self-regulated learning, and engagement at both the start and end of the school year. Results indicated self-efficacy to be the only significant motivation variable for predicting performance at both the start and end of the year. Of note for those trying to increase STEM participation, while there were no changes in anxiety, self-concept, or self-efficacy by the end of the year students did report a decline in effort and persistence in mathematics courses.

A qualitative investigation by Usher (2009) examined how middle school students formed self-efficacy beliefs for mathematics. She interviewed groups of students with both high and low self-efficacy in addition to their teachers and parents. The results continued to support the importance of the role of mastery—or nonmastery—experiences to the formation of self-efficacy in both groups. The addition of teachers and parents helped to frame the importance of praise and innate beliefs about mathematics ability in formation of self-efficacy beliefs during this critical developmental phase.

A recent important contribution to the study of self-efficacy in the middle school population has been the development and validation by Usher and Pajares (2009) of the Sources of Self-efficacy in Mathematics instrument. This

24-item tool measures Bandura's four self-efficacy factors: mastery experiences, vicarious experiences, social persuasions, and physiological state. Moreover, Usher and Pajares established the construct validity of the instrument and demonstrated its reliability across genders, ethnicity (African American and White only), and mathematical ability level (on level/above level).

Missing from these prior works has been a focus specifically on first-generation college students—while still in K-12 education—and the relationship between their self-efficacy and math performance. This is a notable research gap, since, as discussed above, early learning experiences play an important role in the success of first-generation college students. What makes this particularly important are prior findings indicating the academic challenges potentially influencing the self-efficacy of first-generation students are numerous, including low levels of parental involvement in planning coursework, lack of encouragement by teachers and counselors to take advanced mathematics, and a need to study more than their peers (Bui, 2002; Horn & Nuñez, 2000). Low-income, first-generation students also tend to report doubts regarding their academic ability (Bloom, 2007). This may result in a different “picture” of self-efficacy for first-generation students, lower levels of self-efficacy among eventual first-generation students compared to their non-first-generation peers, and perhaps differential effects in the relationship between self-efficacy and academic outcomes like math. The lack of evidence to date, however, leaves this as supposition. Therefore, using Usher and Pajares's tool for measuring self-efficacy, this study asks:

1. Is the Bandura/Usher and Pajares model a valid measurement of self-efficacy for eventual first-generation students?
2. To what degree is math self-efficacy related to math course grades for eventual first-generation college students?

METHODS

Sample

All participants—first-generation and non-first-generation (total $n = 897$)—were middle school students in Grades 6 through 8 enrolled in a federally funded, university-based STEM education program, a subsample of which included prospective (i.e., eventual) first-generation college students ($n = 339$). The latter were self-identified as potentially college-bound given their participation in a precollegiate program. All study participants selected the STEM program from a number of possible opportunities available in the precollegiate program. Additionally, these students' parents indicated no education beyond the high school level on parental background surveys. This definition of first-generation students aligns with Horn and Nunez's (2000) National Center for Education Statistics report in which this population is defined and described. Our further identification of middle school students enrolled in a precollegiate program as eventual first-generation comports with Garriott's (2012) research in which students were defined as prospective first-generation based on their enrollment in a precollegiate program. Garriott sought to determine if a particular hypothesized model of social cognitive career theory proved a good fit to a sample of prospective first-generation students, an approach we pursue below in general rather than specific terms, as our particular models, variables, and analyses differ from his.

Table 1 indicates the demographic characteristics of the sample disaggregated by first generation and nonfirst generation. In total, the sample included more females than males. Most students were not on an Individual Education Program or enrolled in a gifted program. The majority lived with their two biological parents, was non-Hispanic, and was not eligible for the free or reduced lunch program. Differences based on first-generation status were trivial and not statistically significant on most characteristics, save one—the

TABLE 1
Descriptive Statistics for the Sample

	<i>Not First Generation</i>	<i>First Generation</i>	<i>Total</i>
Individual Education Program			
Yes	6.3%	4.5%	5.6%
No	66.2%	67.3%	66.7%
Don't know	27.5%	28.2%	27.8%
In School Gifted Program			
Yes	40.6%	33.7%	37.8%
No	53.8%	57.7%	55.4%
Don't Know	5.5%	8.6%	6.8%
Gender			
male	50.1%	36.8%	44.8%
Female	49.9%	63.2%	55.2%
Hispanic			
Yes	24.6%	29.5%	26.6%
No	75.4%	70.5%	73.4%
Free or Reduced Lunch Qualifier			
Yes	44.0%	40.7%	43.0%
No	45.4%	52.5%	47.5%
Don't know	10.6%	6.8%	4.5%
Family Status			
No answer	.2%	.6%	.3%
Two original parents	59.0%	55.5%	57.7%
Not two original parents	40.8%	44.0%	42.0%

percentage of females in the first-generation subsample was significantly greater compared to the non-first-generation group ($\chi^2 = 14.55$, $p = .000$).

By grade, 20.5% were sixth graders, 55.9% were seventh graders, and 23.6% were eighth graders. The students hailed from 19 Colorado school districts with four districts contributing approximately 60% of the participants. These districts ranged from an urban setting of 23,000 total enrollment to a small suburban district of 9,000. Predominantly the districts were near 50% minority enrollment with the highest at 67% and the lowest at 35%. Hispanic enrollment for the districts ranged from 17% to 41% with an average of 28%.

Measures

Student self-efficacy was measured using the Sources of Self-Efficacy in Mathematics (SSEM), which consists of 24 items in four subscales corresponding to the four primary sources of self-efficacy hypothesized by Bandura (1986). The items—all written in the first person—were measured on a 6-point Likert scale, where 1 = *definitely false* and 6 = *definitely true*. Table 1 lists the 24 questions on the SSEM, and Figure 1 indicates the relationships between the items and the subscales.

Usher and Pajares (2009) reported multiple analyses to establish the validity and reliability of the SSEM. These included expert review of items, item-total correlations, exploratory

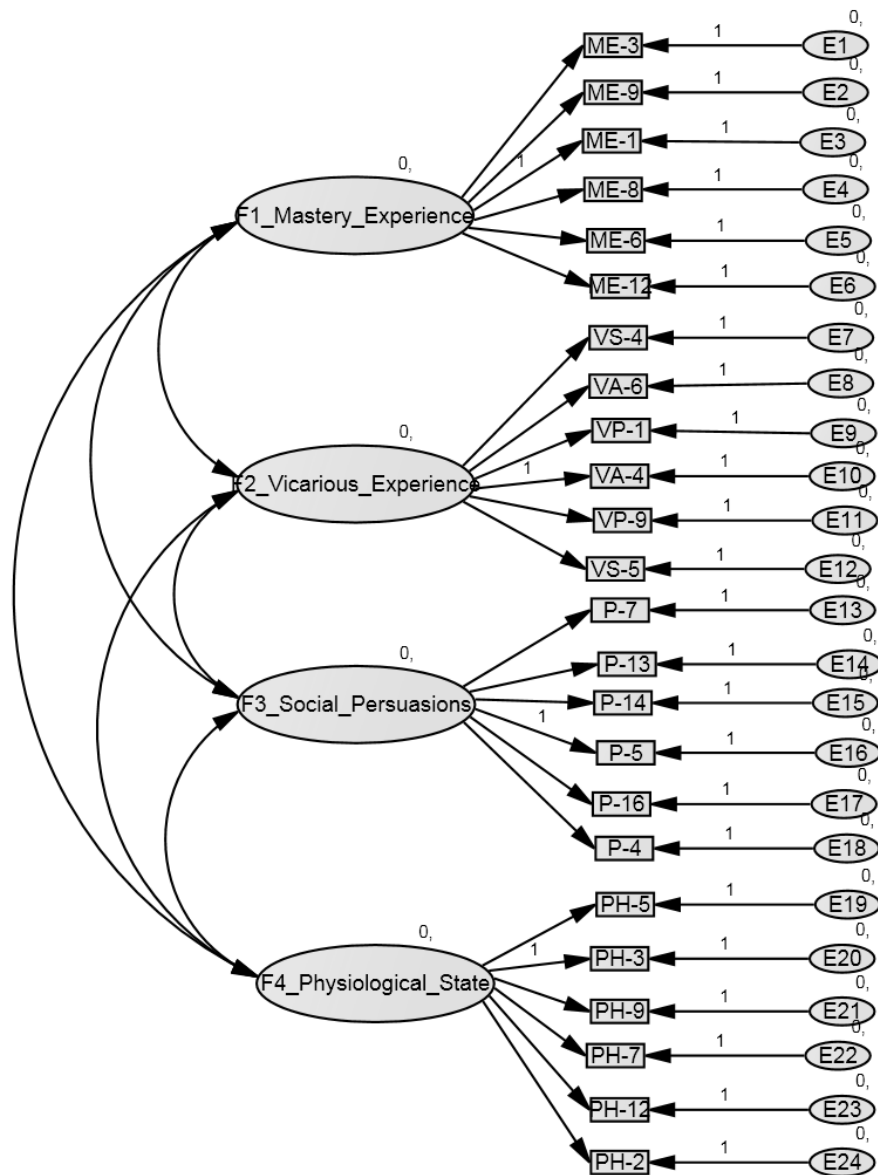


Figure 1. Usher and Pajares model of student self-efficacy in math.

factor analysis, confirmatory factor analysis, and examinations of the relationship between self-efficacy and multiple math achievement outcomes. Although it is outside the scope of this treatment to restate their findings in total, several are worth noting. First, results from final interitem correlations among the items designed to measure each construct ranged

from .40 to .68. Moreover, the six items in each of the four subscales showed adequate internal consistency, with Cronbach's alpha coefficients at .88 for mastery experience, .84 for vicarious experience, .88 for social persuasions, and .87 for physiological state. In the confirmatory factor analysis, the final measurement model showed acceptable fit, CFI =

.96, RMSEA = .04, SRMR = .04, and all standardized factor loadings in the model were significant at the $p = .05$ level and ranged in magnitude from .61 to .83.

Consequently, Usher and Pajares concluded,

Analyses of items in each of the four sources subscales provided evidence for strong content validity, internal consistency, and criterion validity. Indeed, results of the factor and reliability analyses reveal that the sources scale is psychometrically sound and can be reliably used to assess the antecedents of mathematics self-efficacy with students in Grades 6–8. (p. 99)

The authors also tested the invariance of the model based on gender, ethnicity (African American and White), and mathematics ability level and found it to be invariant. Although their findings of invariance for these groups certainly contribute to the instrument's validity and reliability, it remains to be seen if it also proves to be invariant based on first-generation status. Since Hispanic students made up the largest segment of racial/ethnic minorities in our sample, it is also important to note that the instrument has yet to be validated for Hispanic students.

For this study, SSEM data were gathered from students at the start of program participation for STEM center activities. Instructions were read aloud by staff members followed by questions from students. Participants completed the SSEM under the supervision of program staff at their own pace and returned surveys upon completion. Other study data included parent-provided demographic information, specifically parental level of education (which was used to determine first-generation status) and mathematics semester course grades, which were coded on a traditional 4.0 scale (all students' mean grade = 3.06, $SD = .89$; first-generation mean = 3.21, $SD = .80$; non-first-generation mean = 2.85, $SD = .96$). The unconditional difference in grades between first-generation and non-first-generation is statistically significant ($t = -3.30$, $p =$

.01), but we do not anticipate, nor has prior literature indicated a reason to believe this will affect our analyses meaningfully.

Although the use of grades as a dependent measure generally comes with some limitations (Hoffman & Lowitzki, 2005), its use is, nonetheless, ubiquitous in both research and practice. In research, grades are used as both a dependent variable (Jaret & Reitzes, 2009) and as a predictor (Cohn, Cohn, Balch, & Bradley Jr., 2004; Zheng, Saunders, Shelley, & Whalen, 2002). Studies on factors that predict success in college, for example, identify high school grades as strong and significant predictors (Kirby, White, & Arguete, 2007; Sawyer, 2013), particularly for at-risk students (Mattson, 2007). In practice, grades are widely used for numerous and diverse reasons. K–12 schools use them for determining retention, honor rolls, and sports eligibility (Vidal-Fernandez, 2011). Grades feature prominently in admissions decisions in colleges and universities (Hattie & Anderman, 2013) and even in the determination of other variables that feature prominently in college admissions, such as class rank (Lang, 2007). Thus, given such ubiquity and use in prior research related to our analyses, grades represent a useful and important measure in their relationship to self-efficacy for the purposes of this study.

These data were gathered in two phases. Parent and family demographic information was obtained when students registered for program participation. At the time, parents agreed to a release of student records for semester grades, which were mailed to the STEM program offices at the completion of the semester and entered by program staff.

Analysis

Following guidance by Byrne (2010), the analysis proceeded in seven steps, using confirmatory factor analysis as the primary analytical procedure. First, we examined the construct validity of Usher and Pajares's four factor model using the entire sample (i.e., first-generation and non-first-generation). Second,

we adjusted the original model slightly in that we added a second-order factor of self-efficacy (Byrne, 2010). Third, we made slight modifications to the model using modification indices. Fourth, the modified model was reexamined on the entire sample. Fifth, the modified model's validity was examined for each group separately (i.e., first generation and nonfirst generation). Sixth, the modified model was tested for invariance between groups. Seventh, when the model proved to be not invariant between groups we used critical ratios tests to determine the source of the variance between groups. Finally, we examined whether math self-efficacy was a significant predictor of classroom math grades, both in general and for each group, using a structural equation model. All analyses were completed using maximum likelihood in AMOS 20.

Throughout, several model fit indices were used to judge the goodness of fit of the models, including (a) Minimum Discrepancy (CMIN) or χ^2 , (b) Adjusted Goodness of Fit Index (AGFI), (c) Comparative Fit Index (CFI), and (d) Root Mean Square Error of Approximation (RMSEA). This analysis followed the recommendations of Hu and Bentler (1999) using a cutoff value close to 0.06 for RMSEA, cutoff values close to 0.95 for CFI, and cutoff values close to 1.0 for AGFI to support claims of goodness of fit of the model in relation to the data. In addition to these indicators, the χ^2/df ratio was used in order to lessen the sensitivity of the χ^2 test to sample size. As a rule of thumb, χ^2/df values of 3.0 or less signify a good fit of the model (Kline, 2010). The use of several indicators follows Bollen's (1989) and Joreskog and Sorboms (2006) recommendation of examining the extent to which the pattern of indicators is supportive of the model rather than relying on a single indicator of fit.

RESULTS

We begin this section with a presentation of the descriptive statistics for each item in the SSEM. As indicated in Table 2, most of the

items (15) were rated between "a little bit true" and "mostly true." Two other items were rated as "mostly true." The remaining items, all of which were negative effects associated with math, were rated at approximately "mostly false." In general, then, the descriptive statistics for the items appear to indicate students reported a positive affect concerning math.

Turning to the analysis of construct validity, results from the first step in our analysis—a confirmatory factor analysis based on the proposed model using the entire sample—showed a relatively poor fitting model. Chi-square results showed $\chi^2 = 1243.57(246)$, $p \leq .000$. The other indices indicated $\chi^2/df = 5.055$, CFI = .906, and RMSEA = .086. Alternatively, we changed the model slightly by removing the covariances between the four factors and instead adding a second order factor to capture the latent construct of self-efficacy implied in the model. This produced a slightly better model fit compared to the original but still relatively poor. Chi-square results showed $\chi^2 = 1574.237(248)$, $p \leq .000$. The other indices indicated $\chi^2/df = 6.348$, CFI = .916, and RMSEA = .077. Based on this initial model fit, and using the modification indices, we modified the proposed model by removing one poorly performing question—Mastery Experience question six (ME-6) "Even when I study very hard, I do poorly in math"—and adding covariances between identified error terms. This yielded $\chi^2 = 632.509(210)$, $p \leq .000$; $\chi^2/df = 3.012$; CFI = .972; and RMSEA = .047. The resulting model (see Figures 2 and 3) was an improved and acceptable fit. Note that we retained the second order factor model for three reasons: (1) The latent construct of self-efficacy is implied in Usher and Pajares's work; (2) in its original iteration it was a slightly better fit with the data; and (3) we intended to fit an SEM with a math grade outcome, which the second order factor facilitated.

We next ran the modified model for both first-generation and non-first-generation students to determine if the factor structure held for each group. The results indicated the fac-

TABLE 2
Descriptive Statistics for SSEM Items

	<i>Mean</i>	<i>SD</i>
1 (VS-4): I imagine myself working through challenging math problems successfully.	4.75	1.36
2 (ME-3): I have always been successful with math.	4.75	1.33
3 (PH-5): I start to feel stressed-out as soon as I begin my math work.	2.37	1.44
4 (ME-9): I do well on math assignments.	5.04	1.07
5 (P-7): Adults in my family have told me what a good math student I am.	4.77	1.35
6 (VA-6): When I see how my math teacher solves a problem, I can picture myself solving the problem in the same way.	4.68	1.37
7 (VP-1): Seeing kids do better than me in math pushes me to do better.	4.82	1.38
8 (P-13): I have been praised for my ability in math.	4.58	1.44
9 (VA-4): Seeing adults do well in math pushes me to do better.	4.52	1.42
10 (ME-1): I make excellent grades on math tests.	4.85	1.19
11 (P-14): Other students have told me that I'm good at learning math.	4.46	1.43
12 (VP-9): When I see how another student solves a math problem, I can see myself solving the problem in the same way.	4.36	1.40
13 (PH-3): Doing math work takes all of my energy.	2.52	1.50
14 (VS-5): I compete with myself in math.	4.32	1.58
15 (ME-6): Even when I study hard, I do poorly in math.	2.09	1.35
16 (PH-9): I get depressed when I think about learning math.	1.98	1.34
17 (ME-8): I got good grades in math on my last report card.	5.23	1.11
18 (PH-7): My mind goes blank and I am unable to think clearly when doing math work.	2.16	1.40
19 (ME-12): I do well on even the most difficult math assignments.	4.54	1.33
20 (P-5): People have told me that I have a talent for math.	4.35	1.54
21 (P-16): My classmates like to work with me in math because they think I'm good at it.	4.41	1.52
22 (PH-12): My whole body becomes tense when I have to do math.	2.01	1.32
23 (PH-2): Just being in math class makes me feel stressed and nervous.	1.99	1.35
24 (P-4): My math teachers have told me that I am good at learning math.	4.59	1.43

tor structure held for both groups and a good model fit for each. For first-generation students: $\chi^2 = 408.534(210)$, $p \leq .000$; $\chi^2/df = 1.945$; CFI = .960; and RMSEA = .053. The non-first-generation results indicated: $\chi^2 = 507.804(210)$, $p \leq .000$; $\chi^2/df = 2.418$; CFI = .970; and RMSEA = .051. Figures 2 and 3 indicate the models for the respective groups and the relevant coefficients. After determining the factor structure held for both groups we ran tests of invariance. Results, as indicated in Table 3, indicated the model was not invariant between groups. Consequently, we

used critical ratios tests to identify the sources of the differences. The results, using standardized scores, are reported in Table 4. Beginning with regression weights, Table 4 indicates a significant difference on the path between Self-Efficacy and Physiological State. Here, it appears the negative relationship between self-efficacy and the physiological effects of having to do math is greater for first-generation students as compared to their non-first-generation peers. These physiological effects include stress and nervousness, tension, fatigue, and so forth.

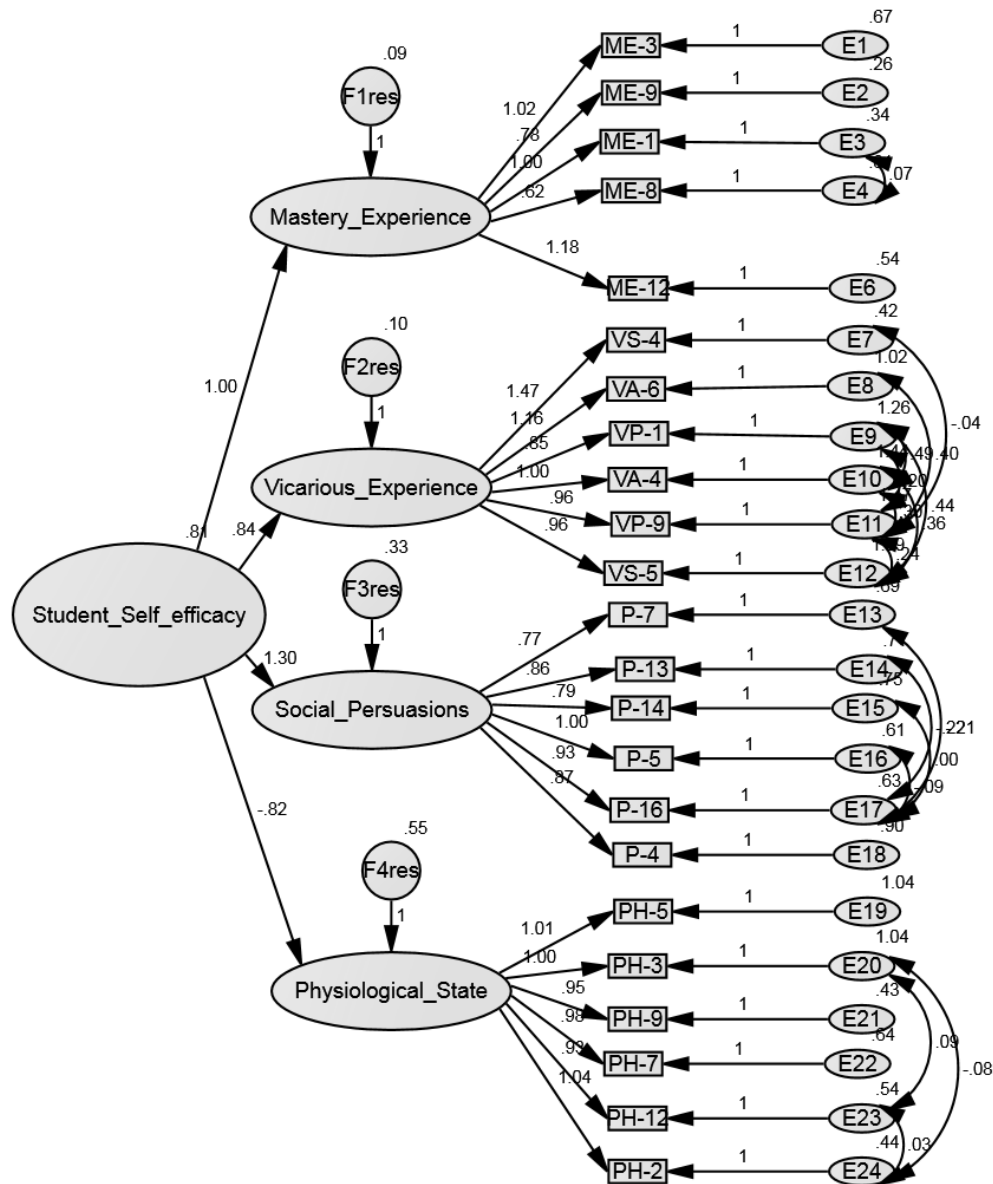


Figure 2. Modified model of student self-efficacy in math, first-generation students.

The loadings for each of the survey items indicated as significant in Table 4 indicate a weaker relationship for first-generation students as compared to non-first-generation. The questions Social Persuasion (P-14) "Other students have told me I'm good at learning math," Physiological State (PH-9) "I get depressed when I think about learning math," Physiological

State (PH-7) "My mind goes blank and I am unable to think clearly when doing math work," and Mastery Experiences (ME-9) "I do well on math assignments" all showed significant differences in performance between groups. A few of the loadings for variances and covariances were also significantly different between groups, with a weaker relationship

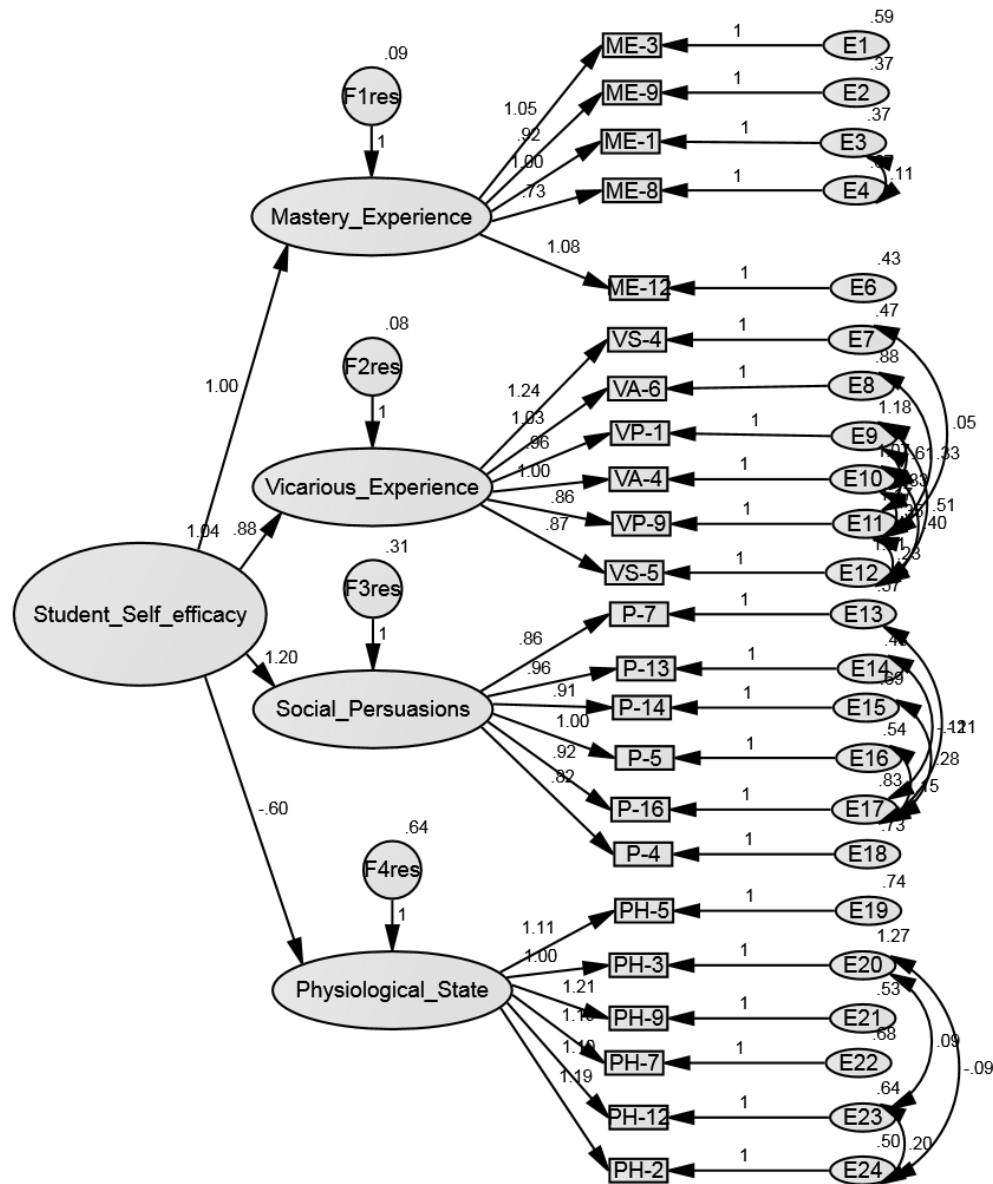


Figure 3. Modified model of student self-efficacy in math, non-first-generation students.

for non-first-generation students as compared to first generation. For the sake of parsimony, those results are not reported here but are available from the authors.

Finally, we tested if math self-efficacy was a significant predictor of classroom math grades. Results indicate it is a significant predictor for both groups, and the effects are very

similar. For first-generation students, $\beta = 0.374$, $p \leq .000$, and for non-first-generation students, $\beta = 0.394$, $p \leq .000$. The coefficients indicate a positive relationship, where an increase in self-efficacy is related to an increase in math performance. The slight differences between groups in the relationship between self-efficacy and math were not significant.

TABLE 3
Test of Invariance Between Groups

	<i>df</i>	χ^2	<i>p</i>
Measurement weights	19	44.655	0.001
Structural weights	22	51.229	0.000
Structural covariances	23	55.005	0.000
Structural residuals	27	70.836	0.000
Measurement residuals	66	246.049	0.000

TABLE 4
Critical Ratios Test Results for Regression Weights

<i>Parameter Name</i>	<i>First Generation</i>	<i>Nonfirst Generation</i>
Mastery Experience ~ Self-Efficacy	1.000	1.000
Vicarious Experience ~ Self-Efficacy	0.839	0.878
Social Persuasions ~ Self-Efficacy	1.304	1.202
Physiological State ~ Self-Efficacy*	-0.819	-0.599
VS-4 (1) ~ Vicarious Experience	1.468	1.238
VA-6 (6) ~ Vicarious Experience	1.156	1.030
VP-1 (7) ~ Vicarious Experience	0.845	0.957
VA-4 (9) ~ Vicarious Experience	1.000	1.000
VP-9 (12) ~ Vicarious Experience	0.958	0.864
VS-5 (14) ~ Vicarious Experience	0.963	0.875
P-7 (5) ~ Social Persuasions	0.774	0.857
P-13 (8) ~ Social Persuasions	0.856	0.960
P-14 (11) ~ Social Persuasions*	0.788	0.905
P-5 (20) ~ Social Persuasions	1.000	1.000
P-16 (21) ~ Social Persuasions	0.926	0.921
P-4 (24) ~ Social Persuasions	0.869	0.815
PH-5 (3) ~ Physiological State	1.011	1.114
PH-3 (13) ~ Physiological State	1.000	1.000
PH-9 (16) ~ Physiological State*	0.949	1.205
PH-7 (18) ~ Physiological State*	0.978	1.189
PH-12 (22) ~ Physiological State	0.934	1.104
PH-2 (23) ~ Physiological State	1.037	1.187
ME-9 (4) ~ Mastery Experience*	0.775	0.921
ME-1 (10) ~ Mastery Experience	1.000	1.000
ME-8 (17) ~ Mastery Experience	0.625	0.734
ME-12 (19) ~ Mastery Experience	1.183	1.077
ME-3 (2) ~ Mastery Experience	1.017	1.052

Note: * $p \leq .05$.

DISCUSSION

This study examined the validity of the Usher and Pajares (2009) SSEM for eventual first-generation students and the degree to which math self-efficacy was related to the outcome variable of math course grades. In their original study, Usher and Pajares validated the model based on gender, ethnicity (African American and White), and mathematics ability level, and we expanded it to a new population, eventual first-generation college students while still in middle school.

Our results supported the four factor model for self-efficacy hypothesized by Bandura (1986) and validated by previous of researchers (Lent et al., 1996) and specifically the model proposed by Usher and Pajares (2009). Our initial tests of the proposed model indicated a relatively poor fit. After performing minor modifications—removing a question and adding covariances—we achieved an improved and acceptable fit. The final factor structure held for both first-generation and non-first-generation students but was not invariant, indicating differences in how the groups constructed the latent variable of self-efficacy.

The most notable difference was the negative relationship between self-efficacy and the physiological effects of doing math. This appeared to be greater for first-generation students, indicating they generally experience more symptoms of math-related stress than their non-first-generation peers. In particular, two questions yielded significantly more negative physiological states for first-generation students. Those questions were PH-9: “I get depressed when I think about learning math,” and PH-7: “My mind goes blank and I am unable to think clearly when doing math work.”

Such results may reflect comparatively greater stress and other physiological states experienced by first-generation students generally, which are manifest in math here because it was the context under study. As Penrose (2002) notes, prospective first-genera-

tion students are often distinguished in middle and high school from their peers by socioeconomic and academic factors that can result in isolation and self-doubt. Ashley’s (2001) work reveals that this may be true even for high achieving students.

These dynamics are exacerbated by student race/ethnicity. Gillen-O’Neel, Ruble, and Fuligni (2011) discuss how ethnic-minority children report greater academic anxiety resulting from stigma awareness. “Stigmatization occurs when one’s social identity is devalued in a particular context, and members of stigmatized groups are at risk for a variety of negative outcomes” (p. 1470). Since ethnic-minority students are more likely than other students to be the first in their family to attend college (Dennis, Phinney, & Chuateco, 2005; Terenzini et al., 1996; Zalaquett, 1999), negative physiological states may be even more present and manifest in many subjects. This may be especially true in our sample, in which almost a third of first-generation students were Hispanic. According to Piedra, Schiffner, and Reynaga-Abiko (2011) many first-generation Hispanic students struggle with a lower sense of self-efficacy and self-esteem than those with at least one college-educated parent.

Our results also may be a manifestation of the quality of simply being “first.” Prior research has demonstrated how first-generation students (that is, children of immigrant parents) report greater levels of stress, anxiety, and inadequacy, both academically and generally (Lin, Endler, & Kocovski, 2001; Zhou, Peverly, Xin, Huang, & Wang, 2003). And ethnic-minority students who are the first to work toward or attend college are more likely to receive criticism from friends and family who have not attended college due to school responsibilities that take aspiring college students away from family or community activities (Pryor et al., 2005).

Related to this were weaker perceptions that first-generation students held about their math abilities, particularly on two questions—P-14: “Other students have told me I’m good at learning math,” and ME-9: “I do well on math

assignments.” Middle school students confront challenges every day as they navigate peer relationships, and first-generation students more frequently discuss their academic experiences with friends than they do even with their fathers, making the perceptions of peers particularly important (Horn & Nuñez, 2000). If a student perceives that others do not think s/he can do math, then this can affect his or her self-efficacy and depress attempts at performing well in math, even if it is within his or her capabilities.

A second notable finding was the relationship between self-efficacy and math grades, particularly that the relationship was consistent for both groups. Although a number of researchers have applied Bandura’s social cognitive theory to mathematics self-efficacy beliefs, the use of an outcome variable more often takes the form of proximal variables, such as problem solving (Pajares, 1996) or unit exams (Pajares & Graham, 1999). This study adds to the comparatively smaller literature that considers the more distal variable of course grades. This finding is important because grades play such an important part in getting into college; thus, self-efficacy has an immediate manifestation in grades but also an eventual impact on getting into college itself. This relationship between self-efficacy and grades is also reciprocal or circular (Jurecska, Lee, Chang, & Sequeira, 2011). Although we examined how self-efficacy influences academic performance, Bandura (1977) and others (Jurecska et al., 2011; Williams & Williams, 2010) discuss how performance increases self-efficacy; so as someone earns good grades, their self-efficacy increases, which, in turn, influences subsequent academic performance.

All of these things taken together have several important implications. First, while middle school teachers maintain focus on academics, they frequently must also address the socioemotional conditions of their students due to the challenges of being an early teenager. As children strive to exercise control over their surroundings, their transactions are

mediated by adults who can empower them with self-assurance or diminish their self-beliefs. Because children are not entirely proficient at making accurate self-appraisals, they rely on the judgments of others to create their own judgments of confidence and of self-worth. Teachers who provide children with challenging tasks and meaningful activities that can be mastered, and who chaperone these efforts with support and encouragement, help ensure the development of a robust sense of self-worth and self-confidence (Riding & Rayner, 2001).

Second, teachers’ awareness of the negative stress response to math and its impact on first-generation students in particular could influence their instructional methods, identification for tutoring, differentiation to try to mitigate the negative stress response, or other interventions. For example, working with colleges or universities to create successful precollegiate math and science programs built on inquiry learning and hands-on methods can help increase confidence in math and science (Lam, Mawasha, Doverspike, McClain, & Vesalo, 2000). Teachers and other school leaders can also look into ways to increase a sense of school belonging. Several authors have noted how school belonging—students’ emotional connection with their school and the people at their school—is consistently associated with positive academic outcomes for students of all ages and backgrounds. Students who report more school belonging tend to have lower academic anxiety and higher intrinsic motivation (Battistich, Solomon, Kim, Watson, & Schaps, 1995; Close & Solberg, 2008; Gillen-O’Neel et al., 2011).

Finally, parental involvement and encouragement, particularly that of mothers, in math course taking and other academic experiences is significant (Piedra et al., 2011). Yet, as noted above, first-generation students are more likely to face criticism from family members for academic pursuits. Thus, when schools provide information to parents of first-generation students on how to support their child’s studies and interests and encourage their

involvement, this could be particularly powerful (Horn & Nuñez, 2000).

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