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Sources of self-efficacy in mathematics: A validation study

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ABSTRACT

The purpose of this study was to develop and validate items with which to assess A. Bandura's (1997) theorized sources of self-efficacy among middle school mathematics students. Results from Phase 1 (*N* = 1111) were used to develop and refine items for subsequent use. In Phase 2 of the study (*N* = 824), a 39-item, four-factor exploratory model fit best. Items were revised to strengthen psychometric properties. In Phase 3 (*N* = 803), a 24-item, four-factor confirmatory factor model fit best. This final model was invariant across gender and ethnicity. Subscales correlated with self-efficacy, self-concept, mastery goals, and optimism. Results suggest that the sources scale is psychometrically sound and could be adapted for use in other domains.

1. Introduction

As a fundamental part of his social cognitive theory, Bandura (1986) posited that unless people believe they can produce desired outcomes they have little incentive to act. Although ample research attests to the predictive power of *self-efficacy*—the beliefs students hold about their academic capabilities—on academic achievement, there have been fewer efforts to investigate the sources underlying these self-beliefs (Pajares & Urdan, 2006).

Beliefs about one's own ability are not identical to beliefs about the likely outcome that one's actions will produce. Bandura (1986) has drawn a distinction between the role of self-efficacy beliefs versus that of *outcome expectations* in influencing and predicting motivation and behavior. Efficacy beliefs and outcome expectations are often positively related. The outcomes people expect are largely dependent on their judgments of what they can accomplish. For example, students confident in their academic skills typically expect high marks on exams. The relationship between self-efficacy and outcome expectations is not always consistent, however. A student reasonably confident in her mathematics capabilities, for example, may choose not to take an advanced statistics course because the teacher's grading curve convinces her that earning a top grade is unlikely. In the present study, we are concerned with the sources of self-efficacy beliefs and not of outcome expectations.

Bandura (1997) hypothesized that self-efficacy beliefs are developed as individuals interpret information from four sources, the most powerful of which is the interpreted result of one's own previous attainments, or *mastery experience*. In school, for example, once students complete an academic task, they interpret and evaluate the results obtained, and judgments of competence are created or revised according to those interpretations. Mastery experiences prove particularly powerful when individuals overcome obstacles or succeed on challenging tasks, especially those that are difficult for others (Bandura, 1997). Most individuals do not quickly dismiss their experiences of mastery (or of failure). Indeed, successful performance in a domain can have lasting effects on one's self-efficacy.

In addition to interpreting the results of their actions, students build their efficacy beliefs through the *vicarious experience* of observing others. In many academic endeavors, there are no absolute measures of proficiency. Hence, students can gauge their capabilities in relation to the performance of others. Students compare themselves to particular individuals such as classmates, peers, and adults as they make judgments about their own academic capabilities. They are most likely to alter their beliefs following a model's success or failure to the degree that they feel similar to the model in the area in question (Schunk, 1987). Watching a similar classmate succeed at a challenging mathematics problem, for instance, may convince fellow students that they too can conquer the challenge. Individuals are also able to compare their current and past performances either cognitively or by recording and reviewing their performances. In this sense, self-comparative information is another type of vicarious experience capable of altering people's self-efficacy.

The *social persuasions* that students receive from others serve as a third source of self-efficacy. Encouragement from parents, teachers, and peers whom students trust can boost students' confidence in their academic capabilities. Supportive messages can serve to bolster a student's effort and self-confidence, particularly when accompanied by conditions and instruction that help bring about

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success (Bandura, 1997; and see Hattie & Timperley, 2007). Social persuasions may be limited in their ability to create enduring increases in self-efficacy, however. It may actually be easier to undermine an individual's self-efficacy through social persuasions than to enhance it, particularly in the formative years during which youngsters eagerly attend to the messages they receive from those close to them (Bandura, 1997).

Finally, Bandura (1997) hypothesized that self-efficacy beliefs are informed by *emotional and physiological states* such as anxiety, stress, fatigue, and mood. Students learn to interpret their physiological arousal as an indicator of personal competence by evaluating their own performances under differing conditions. Strong emotional reactions to school-related tasks can provide cues to expected success or failure. High anxiety can undermine self-efficacy. Students who experience a feeling of dread when going to a particular class each day likely interpret their apprehension as evidence of lack of skill in that area. In general, increasing students' physical and emotional well-being and reducing negative emotional states strengthens self-efficacy.

Perhaps the greatest limitation of research that has been conducted on the sources of self-efficacy is the manner in which the sources have been operationalized and assessed. For this reason, findings to date regarding the sources of self-efficacy should be interpreted with caution. Below we provide a description of the measures used to assess the sources, and we discuss their limitations.

1.1. Measuring the sources of self-efficacy

Researchers have not reached consensus on how best to measure the sources of self-efficacy in academic settings. Most have used adapted versions of the Sources of Mathematics Self-Efficacy Scale (SMES) developed by Lent, Lopez, & Bieschke, 1991. Originally designed to assess the sources of mathematics self-efficacy of college students, the items have been adapted for use in both academic and social settings (Anderson & Betz, 2001; Britner & Pajares, 2006; Lopez & Lent, 1992; Smith, 2001; Usher & Pajares, 2006b). Matsui, Matsui, and Ohnishi (1990) also designed a scale to measure the sources of college students' mathematics self-efficacy, which has been adapted for use with younger students (i.e., Klassen, 2004). Hampton (1998) developed the Sources of Academic Self-Efficacy scale, which was validated and subsequently used with high school and college students with learning disabilities (Hampton & Mason, 2003). Other researchers have relied on unpublished sources items (Bates & Khasawneh, 2007; Stevens, Olivárez, Jr., & Hamman, 2006) or have used alternate measures as proxies for one or more of the sources (Chin & Kameoka, 2002; Johnson, 2005). Below we analyze the measures used to assess each source.

Mastery experience has been assessed in various ways. Researchers who follow models such as those put forth by Lent and his colleagues have assessed mastery experience by asking students to rate their past and current performance in the academic subject of interest, and items have shown strong internal consistency (Britner & Pajares, 2006; Lent et al., 1991). One problematic practice, however, has been the use of students' objective performance as an indicator of mastery experience. For example, some researchers have asked participants to self-report previous grades obtained (Klassen, 2004; Matsui et al., 1990) or have used actual test scores as a measure of mastery experience (Chin & Kameoka, 2002). Such assessments do not reflect the mastery experiences described by Bandura (1997) as students' *interpretations* of experienced events rather than as their objective performance. This source of self-efficacy can be better obtained through self-report items that invite students to rate the degree to which they have experienced success rather than through concrete indicators of past performance such as grades. One need only imagine how two students with opposite academic histories might respond to a grade of "B" in mathematics to understand how such interpretations might differently alter their self-efficacy (see Pajares, 2006). In fact, when subjecting this contention to empirical scrutiny, researchers have found that perceptions of one's mastery experiences are better predictors of self-efficacy than are objective results (Lane, 2002; Lopez, Lent, Brown, & Gore, 1997).

Vicarious experience is typically measured with items that ask students to rate the degree to which they are exposed to peer or adult models who demonstrate competence in the subject of interest. Items typically refer to how students perceive the academic skills of career role models, close friends in class, parents, teachers, or older students. Lent and his colleagues have typically used items tapping both peer and adult modeling experiences to assess vicarious experience (Lent et al., 1991; Lent, Lopez, Brown, & Gore, 1996; Lopez & Lent, 1992). Other researchers have limited their measurement of this source either to peer- (Klassen, 2004) or to adult-related modeling experiences (Hampton, 1998; Usher & Pajares, 2006a,b) despite the suggestion that peers and adults exercise markedly different influences on students at different developmental stages (Harris, 1995). This is likely why, with few exceptions, researchers have reported low to modest reliability coefficients among items created to assess vicarious experience (Gainor & Lent, 1998; Lent et al., 1991; Lopez & Lent, 1992; Matsui et al., 1990; Smith, 2001; Stevens et al., 2006; Usher & Pajares, 2006a, b). Findings obtained with measures in which only peer or adult modeling experiences are assessed may provide incomplete insights about the nature of this source (see Usher & Pajares, in press, for a review).

To assess social persuasions, researchers typically ask students to rate whether they receive encouraging messages about their academic capabilities from significant others such as peers, parents, teachers, and other adults (e.g., Lent et al., 1991; Matsui et al., 1990). When they have assessed social persuasions in this way, most investigators have reported moderate to strong reliabilities for social persuasion items. Some researchers have used measures inconsistent with Bandura's (1997) theorizing about this source. For example, some have assessed social persuasions with items tapping others' expectations, such as "My teacher expects me to go to college" (Chin & Kameoka, 2002) or the directives students receive from others, "My teachers told me to read questions carefully before writing answers down while taking exams" (Hampton, 1998). Others have assessed this source by asking students to rate the extent to which their instructors provide them with "prompt and regular feedback" (Bates & Khasawneh, 2007, p. 181). Such items do not reflect social persuasions as defined and theorized by Bandura (1997), nor do they assess the extent to which students receive evaluative feedback and criticism.

Bandura (1997) contended that a number of factors can influence physiological and affective states, including mood, physical strength, and distress levels. But physiological arousal has typically been assessed as students' anxiety toward a particular academic subject. Lent and his colleagues used the Fennema-Sherman Math Anxiety Scale revised by Betz (1978) to measure the physiological arousal of high school and college students (Gainor & Lent, 1998; Lent et al., 1991, 1996; Lopez & Lent, 1992). Anxiety items have also been used by other researchers (Bates & Khasawneh, 2007; Britner, 2008; Britner & Pajares, 2006; Pajares, Johnson, & Usher, 2007; Smith, 2001; Stevens et al., 2006; Usher & Pajares, 2006b). Others have used additional items used to measure this source such as asking students to rate how much they like a particular subject (Matsui et al., 1990), how thinking of a subject makes them feel (Klassen, 2004), or how school affects their physiological functioning (Hampton, 1998). Researchers using anxiety as a measure of physiological arousal have reported strong reliability estimates. Although one's feelings of anxiety may be the most salient form of psychological arousal in the classroom, particularly in the domain of mathematics, a measure that includes other forms such as physical arousal and mood would be more faithful to Bandura's (1997) description of this source.

1.2. Construct validity

A number of approaches have been used to assess the construct validity of the sources items. Matsui et al. (1990) used factor analysis to examine their 15 sources items. They imposed a three-factor solution representing vicarious experience, social persuasions, and physiological arousal that fit the model relatively well. The authors provided little information on the factor analytic methods employed, however. Furthermore, because mastery experience was equated with past performance, construct validity was established for only three sources. Klassen (2004) later attempted to enhance the construct validity of Matsui et al.'s items by asking students to assess the degree to which each item enhanced their self-efficacy (i.e., "Rate how each statement affects your confidence for doing math," p. 735). Again, construct validity was not established for perceived mastery experience.

Lent et al. (1996) used confirmatory factor analysis to identify the latent constructs underlying their sources items. Four latent structure models were proposed. The two-factor model consisted of a direct experience factor (including mastery experience, social persuasions, and physiological arousal items) and a vicarious experience factor. In the three-factor model, mastery experience and social persuasions items constituted the personal experience factor and vicarious experience and physiological arousal represented separate factors. The four-factor model represented the structure of the sources as hypothesized by Bandura (1986). In the five-factor model, the vicarious experience items were permitted to load on two factors, one representing modeling from peers and one from adults. The researchers determined that, for their college student sample, the four-factor model best fit the data. In a high school sample, the five-factor model provided the best fit, leading the authors to conclude that high school students may differentiate more between peer and adult influences than do college students. Interfactor correlations between mastery experience, social persuasions, and physiological arousal ranged from .66 to .92. It bears noting that the researchers used composite scores (i.e., item "parcels," which represent a sum or average of a set of individual items) rather than individual items to predict the latent source variables. Combining items in this way masks the contribution made by individual items to the measurement of each source of self-efficacy, a problematic practice in the creation of a measurement model (Byrne, 2006).

Exploratory factor analysis has been used to assess the latent structure of sources items adapted from Lent et al. (1991) for use with younger students. Some researchers found that a five-factor model in which vicarious experience was separated into a peer and an adult factor best fit the data, but items representing the peers factor demonstrated poor internal consistency (Usher & Pajares, 2006b). Britner and Pajares (2006) found that a four-factor exploratory model best fit the data in a sample of middle school science students.

Stevens et al. (2006) used a confirmatory factor analytic measurement model to determine whether the parceled scores from sources subscale items supported a single latent factor representing the sources of mathematics self-efficacy. Due to poor fit, the measurement model was revised such that only the combination of mastery experience, vicarious experience, and social persuasions formed the sources factor. Items assessing anxiety factor analyzed separately with negative valence mathematics interest items to form a latent factor labeled "emotional feedback" (p. 175). When the factor structure of variables is unknown, particularly when the factor structure may be multidimensional, parceling items may result in a misspecified factor solution or in estimation bias (Bandalos, 2002). It is also possible that the negative wording in these items may likely have led to what Marsh (1996) referred to as "artifactors" blurring conceptual and theoretical distinctions in the variables.

The limitations noted above point to the need for researchers to develop more thorough measures that assess the multidimensionality of the hypothesized sources of self-efficacy. Factor analytic results and the low reliability of the vicarious experience subscales reported across studies suggest that measures used to assess this source have been inadequate. Furthermore, in many cases little information about the construct validity of the sources items has been provided, and there has been little correspondence between the actual variables used and Bandura's (1997) theorized sources. Findings from such studies can offer little insight about how academic self-efficacy develops.

1.3. Convergent validity

Mastery experience has been shown to be the most consistent predictor of students' self-efficacy across academic domains and levels, but reports for the other three sources have been less consistent. These inconsistent results are likely due to methodological problems such as poor reliability, aggregated scores that mask information from any one source, or multicollinearity between the sources. It bears noting, however, that the contextual factors present may have partly determined how the sources have functioned in diverse academic settings. Differences in the predictive value of the sources on self-efficacy vary according to the domain in which the constructs are assessed, and the magnitude and strength of the relationship between the sources and self-efficacy appear to be influenced by students' gender, ethnicity, or academic ability level (e.g., Lent et al., 1996; Usher & Pajares, 2006b). Though it is too early to make general observations about the part played by these contextual factors, additional research should examine whether students from different groups interpret information about their efficacy differently.

We view four primary reasons why establishing a valid and reliable measure of the hypothesized sources of self-efficacy is warranted. First, there has been little consistency across studies as regards the items used to assess the sources, which has resulted in inconsistent findings. Second, low reliabilities have plagued vicarious experience items. Third, researchers have not yet determined whether the measurement models representing the sources scores are invariant across student groups. Finally, and perhaps most important, many of the items in the measures used to date have not been consistent with Bandura's (1997) original description of the sources and thus offer little evidence for or against the theorized influence of the sources.

1.4. Purpose of the study

Consistent with much of the research on self-efficacy in school settings, most investigations of the sources have been conducted in the domain of mathematics. And most studies of the sources have been undertaken with high school and college students. This seems surprising given the tendency for students' judgments about their mathematics capabilities to decline when students encounter the more rigorous coursework of middle school (Anderman & Maehr, 1994). For this reason we elected to create a measure of sources of self-efficacy for use in the domain of mathematics and with middle school students.

Because conclusions drawn from empirical investigations of the sources are only as reliable as are the items from instruments on which data are gathered and results obtained, items developed directly from the tenets of social cognitive theory are likely to produce results that are able to expand and refine these tenets. Hence, the aim of this study was to develop and validate items with which to assess Bandura's (1997) theorized four sources of self-efficacy in the area of mathematics at the middle school level.

There are two important reasons why a valid and reliable measure of the sources of self-efficacy is needed. First, self-efficacy beliefs play a critical role in the academic and career choices of students (Hackett, 1995). Naturally, then, it is important for teachers and counselors to be cognizant of the factors that help create and nurture the self-efficacy beliefs of their students. This information is invaluable in helping teachers tailor their instructional strategies and counseling practices in ways most supportive both of their students' self-efficacy and, subsequently, of their achievement. Teachers and counselors can also make use of such assessments as they evaluate the manner in which academic programs and intervention strategies may influence the self-efficacy beliefs of the young people in their care. All professional educators would readily agree that identifying the ways in which students' unrealistically low self-efficacy beliefs can be challenged and altered is an essential and critical enterprise.

Another important reason why a psychometrically sound assessment of the sources of self-efficacy is required is that the tenets of Bandura's (1986) social cognitive theory regarding the workings of self-efficacy cannot effectively be tested without such an assessment. Researchers who wish to understand the formation of academic self-efficacy must obtain that understanding using valid and reliable measures that faithfully reflect the sources hypothesized and their role within the broader structure of social cognitive theory. This is especially important in the field of academic motivation where the sources of self-efficacy have often been operationalized and measured in a manner that bears little resemblance to how they were hypothesized by Bandura (1986, 1997).

The overall validation process took place in three phases, during which we followed the scale validation protocol described by Spector (1992). We first aimed to craft items to assess each source by matching them carefully to each source as it has been described by Bandura (1997, chap. 3). We next sought to establish a psychometrically sound model to measure the sources of self-efficacy and to test whether the model is invariant across gender, ethnicity, and mathematics ability level. We examined evidence for convergent and divergent validity by assessing the relationship between the sources, self-efficacy, and other constructs typically included in studies of academic motivation. We henceforth refer to these respective phases as Phase 1, Phase 2, and Phase 3 to render our procedures and findings straightforward.

2. Phase 1

2.1. Methods

2.1.1. Participants

In the fall of 2005, we invited a focus group of Grade 6 students ($n = 23$), a sixth-grade mathematics teacher, a parent of three middle school students, an eighth-grade teacher and mathematics department chair, and a middle school principal to complete a survey and to provide us with feedback on item wording and clarity. We selected sixth-grade students for this focus group because they represented the youngest participants in the study and thus would be most likely to point out unfamiliar or unclear wording.

Several weeks later, we conducted a large-scale investigation of the revised survey instrument with 1111 students (559 girls, 552 boys) in Grades 6 ($n = 373$), Grade 7 ($n = 375$), and Grade 8 ($n = 363$) enrolled in a public suburban middle school in the Southeastern United States. Most students in this sample were of upper-middle socioeconomic status. Participants identified themselves as 62% White ($n = 677$), 17% Asian or Asian American ($n = 189$), 13% Black or African American ($n = 137$), 5% Hispanic ($n = 58$), and 2% of mixed ethnic origin ($n = 27$). Twenty-three students did not report their ethnicity.

2.1.2. Data sources and collection procedures

We followed a number of steps when creating the *Sources of Middle School Mathematics Self-Efficacy Scale*. We relied on the seminal theoretical work in which the sources of self-efficacy are described (Bandura, 1997) to create items to assess each of the four sources. Items were written as first-person statements, and students were asked to rate how true or false each statement was for them on a scale from 1 (*definitely false*) to 6 (*definitely true*). Student focus group participants were drawn from a sixth-grade language arts class. The first author was present to debrief the focus group participants and to discuss item wording. Adults provided feedback on the telephone or via e-mail correspondence. After having first subjected the initial 84-item sources instrument to focus group participants for feedback, we made slight revisions to item wording. We did not at this point drop any items. The revised items were then used with the larger sample described above. The sources scale used in Phase 1 comprised 84 items: 21 mastery experience items, 23 vicarious experience items, 20 social persuasions items, and 20 physiological and affective state items.

We also assessed mathematics self-efficacy using four measures: *mathematics grade self-efficacy* and *mathematics courses self-efficacy* (Bandura, 2006; Hackett & Betz, 1989); *mathematics skills self-efficacy* (see NCTM, 2000); and *self-efficacy for self-regulated learning* (Bandura, 2006; Usher & Pajares, 2008). Students responded to the self-efficacy measures on a six-point Likert-type scale ranging from 1 (*not at all confident*), to 6 (*completely confident*). Alpha reliabilities for the self-efficacy measures were .94, .94, .95, and .85, respectively.

Instruments were administered to middle school students during an extended homeroom class monitored by the first author and trained graduate students. Directions were read aloud to all students via a closed-circuit video broadcast prerecorded by the first author. Students submitted their surveys in a sealed envelope to ensure anonymity.

2.1.3. Analyses

Singer and Willett (2003) observed that "wise researchers conduct descriptive exploratory analyses of their data before fitting statistical models" (p. 16). It was in this spirit that we undertook data analyses at this and each subsequent phase of the validation study. We first closely examined item means, standard deviations, frequency distributions, skewness, and kurtosis. We assessed evidence for construct validity by examining each item's bivariate correlation with the subscale total and with each of the four measures of self-efficacy. We also used Cronbach's alpha coefficients to examine internal consistency among items in each subscale. Variables with poor item-to-scale-total correlations ($r < .40$) were flagged for potential removal. Likewise, each item was expected to demonstrate at least a moderate ($|r| > .30$) correlation with the self-efficacy outcomes used. Items with weaker correlations were flagged for removal. The last step in data screening was to determine whether items performed consistently across measures. Any item flagged on the basis of two or more criteria (i.e., high skewness or kurtosis, low item-total or item-outcome correlations) was deleted or revised.

2.1.4. Results and discussion

Of the 84 sources items used in Phase 1, 23 items (13 of which were vicarious experience items) were identified as having low item-total correlations. Because previous findings have suggested that items tapping vicarious experiences from peers or from adults may represent two distinct factors (e.g., Lent et al., 1996; Usher & Pajares, 2006b), we recalculated item-total correlations for the vicarious experience items after separating them into three categories representing vicarious experience from peers, from adults, and from self. Results still revealed ten problematic item-total correlations among the vicarious experience items. These findings mirrored the difficulties other researchers have had in creating internally consistent items to assess this source, particularly as it pertains to vicarious influences in mathematics.

We next examined correlations between each item and the four self-efficacy measures. Coefficients below |.30| were observed for 7 of the 84 mastery experience correlations, 55 of the 92 vicarious experience correlations, 19 of the 80 social persuasions correlations, and 16 of the 80 physiological state correlations. Finally, we looked across all criteria and flagged items that were subpar on multiple indicators. Poorly-performing items were removed and used to generate new items for use in Phase 2.

3. Phase 2

3.1. Methods

3.1.1. Participants

Participants in Phase 2 were 824 students (435 girls, 389 boys) in Grade 6 (n = 248), Grade 7 (n = 259), and Grade 8 (n = 317) enrolled at a public suburban middle school in the Southeastern United States. School records identified these participants as 66% White (n = 546), 21% Black or African American (n = 171), 6% Hispanic (n = 50), 4% Asian or Asian American (n = 30), and 3% of mixed ethnic origin (n = 27). Although most students in this sample were of upper-middle socioeconomic status, 21% (n = 172) were registered to receive free or reduced-price lunch. Students were grouped by ability in mathematics and received instruction that was either below grade level, on grade level, or above grade level. The school had identified 178 students as "talented and gifted" in mathematics.

3.1.2. Data sources and collection procedures

Based on findings of Phase 1, we made modifications and additions to the Sources of Middle School Mathematics Self-Efficacy Scale items, particularly those tapping vicarious experience and social persuasions, which demonstrated some psychometric weaknesses in Phase 1. Once again, we took care to craft and retain items that represented as many facets of each source as possible as described by Bandura (1997). We began Phase 2 with 86 sources items: 12 assessing mastery experience, 30 assessing vicarious experience, 28 assessing social persuasions, and 16 assessing physiological state. We used the same self-efficacy measures in Phase 2 as were used in Phase 1. Internal consistency for the self-efficacy measures ranged from .89 to .94. Instruments in Phase 2 were administered in individual mathematics classes by the first author in February of 2006.

3.1.3. Analyses

We used the same cutoff criteria described in Phase 1 for determining the psychometric fitness of the items. These criteria incorporated skew and kurtosis cutoffs recommended by Kline (2005) for analyses using maximum likelihood (ML) estimation. We then conducted *exploratory factor analysis* (EFA) with ML estimation to determine whether four distinct sources underlay students' responses to the remaining items. Squared multiple correlations were used to estimate each variable's communality, and eigenvalues associated with each factor were examined. An oblique, promax rotation was used because the sources are theorized to be correlated. Variables that loaded on more than one factor were excluded, as were variables with factor pattern loadings less than |.35|.

3.1.4. Results and discussion

We analyzed descriptive statistics of the Phase 2 items using the cutoff criteria described in Phase 1, and we initially removed 35 subpar items. These analyses rendered 51 sources items that were then subjected to EFA. In the initial EFA, Factor 1 accounted for 70% of the variance, Factor 2 for 11%, Factor 3 for 7%, Factor 4 for 4%, Factor 5 for 3%, and Factors 6 and 7 for 2%. Although the Kaiser criterion would have suggested retaining these seven factors, the scree plot suggested that a four-factor model best explained the variance. Factor 7 had only two acceptably high loadings, and neither Factor 5 nor 6 represented a clear construct. Therefore, we ran the analysis again specifying only four factors and retaining only those items with a factor pattern loading greater than |.35|. This rendered a 39-item final model for Phase 2. Thirteen items loaded on Factor 1 (loadings ranged from .36 to .84), which was labeled social persuasions. Ten items loaded on Factor 2 (loadings ranged from .53 to .90) and 10 items on Factor 3 (loadings from .40 to .75). These factors were respectively labeled physiological state and vicarious experience. Six items loaded on Factor 4, labeled mastery experience (loadings from .44 to .66). The four factors accounted for a combined 98% of the variance, and the interfactor correlations ranged from .29 between mastery experience and vicarious experience to .60 between mastery experience and social persuasions. The items composing each of the four factors also demonstrated good internal consistency (α range from .85 to .92).

4. Phase 3

4.1. Methods

4.1.1. Participants

Participants in Phase 3 were 803 students (408 girls, 395 boys) in Grade 6 (n = 282), Grade 7 (n = 255), and Grade 8 (n = 266) enrolled at a public suburban middle school in the Southeastern United States. School records identified these participants as 67% White (n = 541), 19% Black or African American (n = 150), 6% Hispanic (n = 51), 4% Asian or Asian American (n = 28), and 4% of mixed ethnic origin (n = 33). Once again, most students were of upper-middle socioeconomic status, but 19% (n = 153) were registered to receive free or reduced-price lunch. Students receiving self-contained special education mathematics instruction were not included in the study; however, special education students receiving inclusion instruction (n = 41) were invited to participate. Students were grouped by ability in mathematics and received instruction that was either below grade level (n = 71, 9%), on grade level (n = 479, 60%), or above grade level (n = 253, 31%).

4.1.2. Data sources and collection procedures

Although we were pleased with the 39 items retained in Phase 2, there were several reasons why we felt it important to include more rather than fewer items in the final phase of the validation study. First, many items that survived Phase 2 were redundant and could be improved by slight modification. We also made changes to some of the items that did not survive empirical scrutiny in Phase 2 in hopes of retaining them in Phase 3. Second, adding or modifying items once again helped us in our quest to develop items reflective of the multidimensionality of the sources described by Bandura (1997). Third, we began the final phase of the study by submitting items to experts in social cognitive theory for their feedback on content validity of the final items (A. Bandura, personal communication, November 20, 2006; B. J. Zimmerman, personal communication, October 24, 2006; D. H. Schunk, personal communication, November 1, 2006). These experts were asked whether items were theoretically sound, and they were given space to comment on each of the items. Based on the observations and recommendations of these scholars, we rejected four items (e.g., "I'm happy with the grades I make in math"), reworded five items (e.g., Phase 2 item "Other students have told me that I am good at math" became Phase 3 item, "Other students have told me that I am good at learning math"), and added six items (e.g., "I feel energized when I'm learning math").

The Sources of Middle School Mathematics Self-Efficacy Scale crafted for use in Phase 3 comprised 73 items: 15 assessing mastery experience, 22 assessing vicarious experience (included items tapping peer, adult, and self-modeling experiences), 18 assessing social persuasions, and 18 assessing physiological state. These items included the 39 items that survived empirical scrutiny in Phase 2 and 34 items that were refined or added as noted above.

For the purpose of gathering evidence of convergent and discriminant validity, several motivation variables were measured in the third phase of the study. The four self-efficacy measures used previously were included, although students in Phase 3 were asked to evaluate their Middle School Mathematics Skills Self-Efficacy on a scale from 1 (*not at all confident*) to 100 (*completely confident*). We obtained a Cronbach's alpha of .95 for this revised self-efficacy measure and ranging from .91 to .93 on the other three self-efficacy measures.

Additional variables were assessed with scales frequently used in studies of academic motivation. We selected these variables because they have been shown to be correlates of self-efficacy and hence should also correlate with self-efficacy's hypothesized sources. *Engagement*, considered an important corollary of efficacy beliefs (Miller, Greene, Montalvo, Ravindran, & Nichols, 1996), was assessed using four items designed to measure students' effort and persistence ($\alpha = .81$). *Mathematics self-concept* was assessed using six items from Marsh's (1992) Self-Description Questionnaire II (SDQII) ($\alpha = .88$). The invitational messages students send themselves and others have been shown to be related to both the sources and to self-efficacy (Usher & Pajares, 2006a). These *invitations* were assessed with the Inviting/Disinviting Index-Revised (Valiante & Pajares, 1999), which consists of 10 items representing the degree to which individuals are inviting to themselves (e.g., "I congratulate myself on my successes.") or to others (e.g., "I am quick to recognize the value of other people."). Cronbach's alpha coefficients were .82 for invitations of self and .79 for invitations of others. Students' *achievement goal orientations* were assessed using frequently-used scales from the Patterns of Adaptive Learning Survey (PALS; Midgley et al., 2000), as was reported use of *self-handicapping* strategies (e.g., "Some students fool around the night before a math test. Then if they don't do well they can say that is the reason. How true is this of you?"). Cronbach's alphas for these scales ranged from .80 to .85. A number of social cognitive theorists have also reported that self-efficacy beliefs engender a sense of *optimism* or a positive view of one's self in relation to the world (Pajares, 2001; Scheier & Carver, 1985). Students' optimism was assessed with 10 items (e.g., "In uncertain times, I usually expect the best.") drawn from the Life Orientation Test-Revised (LOT-R; Scheier & Carver, 1985) ($\alpha = .85$).

The instrument used in Phase 3 was administered to students in their mathematics classes by the first author during November and December of the 2006–2007 school year. Students' responses to all motivation statements were assessed using a Likert-type scale ranging from 1 (*definitely false*) to 6 (*definitely true*).

To further test the convergent validity of the sources of mathematics self-efficacy, we obtained two measures of students' achievement in mathematics: students' semester grades in mathematics as well as their mathematics teacher's rating of their mathematics competence on a scale of 1 to 10. Teacher ratings of students' mathematics competence have been frequently used as a valid proxy for academic achievement (see Hoge & Coladarci, 1989). We expected that students with higher ratings in their mathematics competence would tend to report more mastery experience and social persuasions and lower negative arousal than those with lower mathematics competence.

4.1.3. Analyses

The primary aim of Phase 3 was to ascertain the model that best represented the simple structure of the sources of self-efficacy. We made our initial decisions for item elimination by invoking cutoff criteria for the descriptive and correlational statistics described in Phase 1. We then imposed a more stringent psychometric cutoff to eliminate items with skewness or kurtosis exceeding one standard deviation from the mean (Kline, 2005). We next examined the item-total correlations, flagging items whose correlations with subscale totals were less than or equal to .55. This higher threshold provided a more stringent criterion for item selection, but, bearing in mind that item-total correlations are inherently dependent on items that may themselves be problematic, we used this criterion as only one indication of an item's psychometric viability. We also flagged any item with a correlation below |.30| with any of the four self-efficacy outcomes of interest. In cases where similarly-worded items passed all criteria, only one item was retained so as to move toward a model that best reflected the multidimensional sources as theorized by Bandura (1997). This enabled us to arrive at a final sources scale that was parsimonious, practical, and conceptually and psychometrically strong.

We used confirmatory factor analysis (CFA) to test a measurement model of scores on the remaining sources items. Unlike EFA in which the number of factors is unknown, CFA requires that researchers have a strong hypothesis regarding the number of latent variables in a model (Thompson, 2004). In keeping with findings from Phase 2, our measurement model included four latent variables: mastery experience, vicarious experience, social persuasions, and physiological states. The factors were permitted to covary (see Lent et al., 1996). Error terms were hypothesized to be uncorrelated. In each model the first item loading was constrained to 1.0 to set the scale of measurement, and no items were allowed to double load.

We relied on four commonly-used indexes to determine the fit of each CFA model: the Satorra–Bentler (S-B) χ^2 test statistic, used when data are non-normally distributed, which was the case with our data (Bentler, 2005); the comparative fit index (CFI); the root mean square error of approximation (RMSEA); and the standardized root mean square residual (SRMR). Statisticians such as Byrne (2006) frequently remind researchers that fit indexes can only describe a model's "*lack of fit*" (p. 102) and that the judgment of a model's adequacy "*rests squarely on the shoulders of the researcher*" (p. 102). With this in mind, we also examined significance tests for factor loadings, R^2 values, the residual and normalized residual matrices, and modification indices such as the Lagrange Multiplier (LM) test when assessing each model. In keeping with suggestions made by Bentler (2005) and Byrne (2006) changes to the model were made only if and when in the service of creating a stronger model both conceptually and theoretically and always with an eye toward model parsimony.

We conducted tests for multigroup measurement invariance by examining two increasingly-restrictive hierarchical CFA measurement models. These models were based on analysis of covariance structures and were run separately by gender, ethnicity, and ability level for all subgroups with more than 100 participants. The baseline model tested for equivalent factor structure, not taking into account the factor pattern loadings. In the second model, factor loadings were constrained to be invariant across groups. We compared the fit of the two models to determine whether the factor loadings in each model were invariant. A nonsignificant change in chi-square (see French & Finch, 2006) and a change in CFI of less than .01 (Cheung & Rensvold, 2002) were indicative of model invariance.

We examined evidence for the external validity of the sources items by calculating descriptive statistics and Pearson correlations between the final sources subscales, self-efficacy outcomes, and the motivation variables of interest. To establish construct validity, we conducted four multiple regression analyses in which we examined, simultaneously, the independent contribution of the four sources of self-efficacy to the prediction of each self-efficacy measure. Because previous results (Usher & Pajares, 2006b) and theoretical guidance (Bandura, 1997) suggest that the relationship between physiological state and self-efficacy is potentially curvilinear, we included the quadratic term of physiological state in each initial model. If the term was nonsignificant, it was removed from the final model. We supplemented these analyses with commonality analysis and regression structure coefficients (Courville & Thompson, 2001).

4.1.4. Results and discussion

The final sources of self-efficacy items were administered to this new sample of students and the more stringent psychometric cutoff criteria described above were imposed. Through this process we identified 34 problematic items that were removed from further analysis. Five similarly-worded items were also removed, leaving us with 34 items. We used psychometric and conceptual (theoretically driven) considerations when selecting the 24 best items to retain for the confirmatory factor analysis. Of the items retained in the final model, seven were used in Phase 1, six were modified from Phase 1 for use in Phase 2, seven were used in Phase 2, one was modified from Phase 2 for use in Phase 3, and three were new items designed for Phase 3. Table 1 presents the correlation matrix and item-total correlations for the dependent (observed) variables in the model. Inter-item correlations among the six items designed to measure each source ranged from .40 to .68. The six items in each of the four subscales showed adequate internal consistency, with Cronbach's alpha coefficients above the cutoff of .80 recommended by Henson (2001) .88 for mastery experience, .84 for vicarious experience, .88 for social persuasions, and .87 for physiological state.

The final measurement model, illustrated in Fig. 1, showed acceptable fit, S-B $\chi^2(246) = 601.21$, $p < .0001$, CFI = .96, RMSEA = .04, SRMR = .04. All standardized factor loadings in the model were significant at the $\alpha = .05$ level and ranged in magnitude from .61 to .83. As described above, rarely do individuals rely on only one informational source when making judgments of their efficacy to perform academic tasks (Bandura, 1997). Hence, the sources of self-efficacy are theoretically interrelated, which the findings of this study maintain. The four sources factors showed intercorrelations ranging in magnitude from −.45 (between vicarious experience and physiological state) to .83 (between social persuasions and mastery experience). The strong correlation between mastery experience items and social persuasions is not surprising, given that these two sources tend to operate in tandem in this context. Students who perceive their past performances in mathematics as successful are likely to receive frequent praise on those very performances. Conversely, students who interpret their efforts in mathematics as futile are likely to receive (or to *perceive*) messages from others that they are not capable. In the absence of an experiential base, social persuasions often become hollow platitudes that do little to influence efficacy judgments (Bandura, 1997).

Table 1
Means, standard deviations, and correlations for final sources of self-efficacy items

Item	*M*	*SD*	ME-1	ME-3	ME-6	ME-8	ME-9	ME-12	VA-4	VA-6	VP-1	VP-9	VS-4	VS-5	P-4	P-5	P-7	P-13	P-14	P-16	PH-2	PH-3	PH-5	PH-7	PH-9	PH-12
ME-1	4.2	1.4	**.76**																							
ME-3	4.2	1.5	.61	**.67**																						
ME-6	4.6	1.6	.53	.47	**.62**																					
ME-8	4.9	1.5	.61	.42	.48	**.63**																				
ME-9	4.6	1.2	.65	.60	.57	.60	**.77**																			
ME-12	3.7	1.5	.62	.60	.50	.48	.63	**.70**																		
VA-4	3.7	1.6	.24	.28	.19	.20	.33	.37	**.65**																	
VA-6	3.9	1.5	.31	.33	.33	.29	.43	.43	.49	**.66**																
VP-1	4.3	1.5	.27	.31	.23	.23	.32	.36	.51	.40	**.58**															
VP-9	4.0	1.5	.28	.29	.30	.26	.39	.43	.45	.59	.41	**.60**														
VS-4	3.6	1.7	.32	.32	.28	.27	.39	.41	.52	.53	.45	.46	**.63**													
VS-5	3.8	1.8	.24	.28	.23	.22	.35	.35	.45	.45	.45	.41	.43	**.58**												
P-4	3.8	1.6	.40	.43	.38	.36	.47	.52	.34	.42	.33	.33	.36	.31	**.66**											
P-5	3.4	1.7	.44	.54	.40	.34	.46	.55	.29	.34	.27	.33	.37	.34	.54	**.70**										
P-7	4.2	1.6	.45	.48	.42	.40	.53	.51	.39	.40	.34	.37	.41	.36	.50	.62	**.68**									
P-13	3.6	1.6	.51	.50	.40	.40	.53	.56	.41	.43	.33	.37	.41	.36	.59	.61	.61	**.76**								
P-14	3.6	1.6	.44	.47	.40	.42	.53	.58	.36	.42	.34	.37	.45	.38	.55	.58	.56	.64	**.74**							
P-16	3.7	1.6	.48	.44	.45	.45	.54	.56	.34	.38	.33	.34	.37	.34	.48	.47	.47	.57	.63	**.64**						
PH-2	2.6	1.7	−.35	−.43	−.44	−.29	−.43	−.41	−.20	−.27	−.18	−.23	−.23	−.15	−.31	−.33	−.31	−.32	−.35	−.36	**.71**					
PH-3	2.7	1.6	−.36	−.35	−.39	−.32	−.37	−.37	−.11	−.26	−.20	−.17	−.26	−.15	−.28	−.26	−.30	-.28	-.31	−.31	.45	**.57**				
PH-5	2.6	1.6	−.38	−.43	−.46	−.33	−.51	−.42	−.22	−.33	−.23	−.28	−.32	−.22	−.33	−.33	−.32	−.34	−.36	−.40	.68	.49	**.75**			
PH-7	2.8	1.7	−.41	−.43	−.47	−.33	−.47	−.44	−.21	−.31	−.19	−.23	−.27	−.21	−.28	−.29	−.31	−.30	−.33	−.39	.51	.43	.55	**.63**		
PH-9	2.5	1.7	−.31	−.36	−.37	−.26	−.39	−.38	−.27	−.35	−.21	−.22	−.30	−.23	−.33	−.30	-.30	−.30	−.31	-.32	.51	.45	.57	.49	**.65**	
PH-12	2.4	1.6	−.37	−.42	−.43	−.33	−.42	−.42	−.11	−.29	−.16	−.20	−.22	−.12	−.29	−.32	−.31	−.30	−.30	−.30	.63	.47	.62	.54	.56	**.72**

N = 803.
Note. Item-total correlations between each item and its subscale counterparts appear on diagonal. Items within each given subscale appear in grayscale.

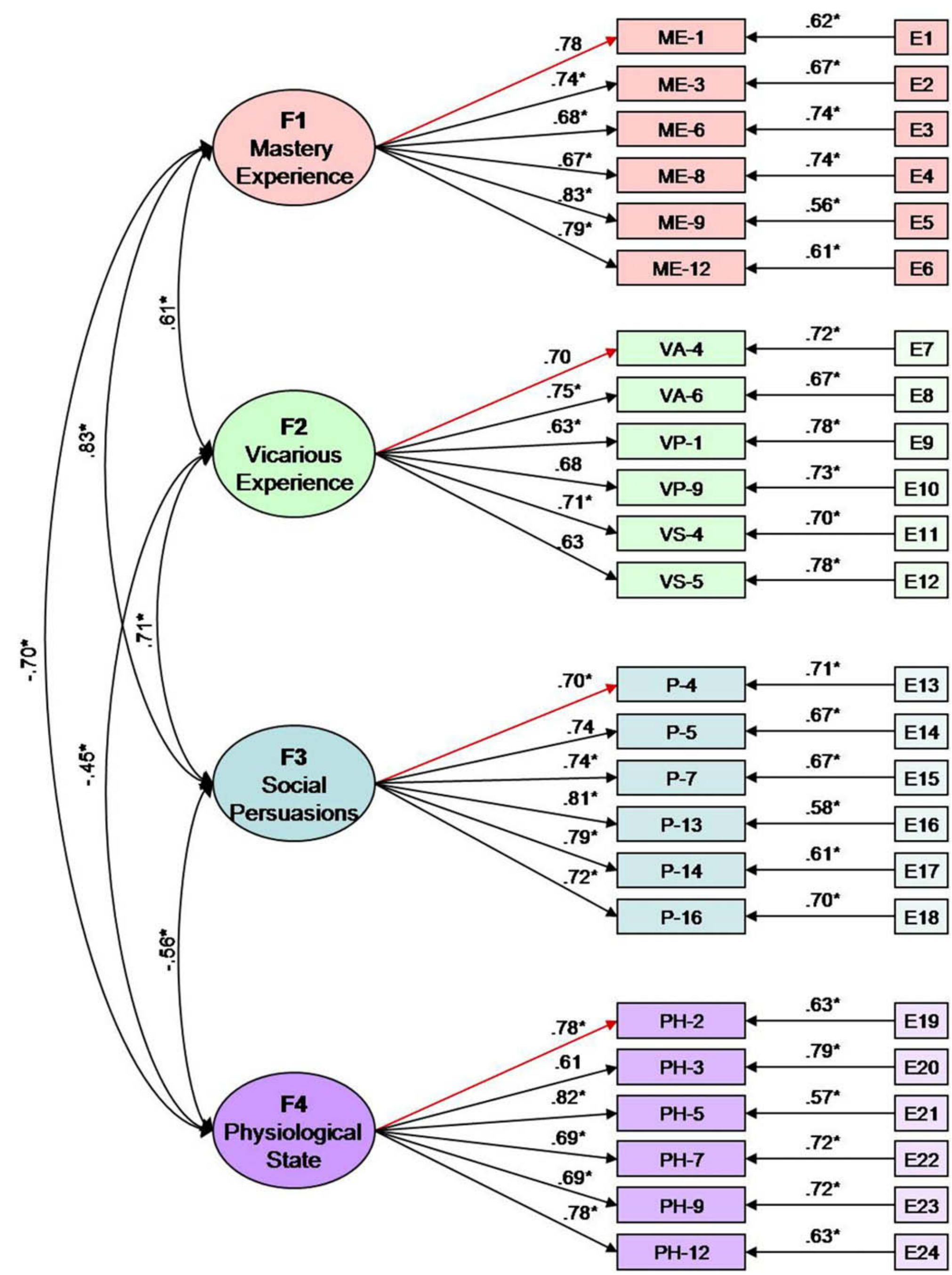

Fig. 1. Measurement Model for the 24-Item Sources of Middle School Mathematics Self-Efficacy Scale. *Note*. S-B χ^2 (246) = 601.21, CFI = .96, RMR = .04, RMSEA = .04, RMSEA 90% CI: (.038, .047) Parameters without asterisks were fixed to 1. All path coefficients were statistically significant, $p < .05$.

Table 2
Summary of Goodness-of-Fit Statistics for the Final Sources of Self-Efficacy Measurement Model by Subgroup

Subgroup Model	S-Bχ^2	*df*	CFI	SRMR	RMSEA
Girls	440.53	246	.96	.05	.04
Boys	443.41	246	.95	.05	.05
African American students	320.75	246	.95	.06	.05
White students	495.17	246	.95	.05	.05
On-Level students	437.97	246	.96	.04	.04
Above-level students	396.10	246	.94	.05	.06

Note. Robust statistics are reported. Models were specified for each subgroup as illustrated in Fig. 1. Girls (n = 408), Boys (n = 395); African American (n = 150), White (n = 541); On Level (n = 479), Above Level (n = 253).

4.1.5. Tests for measurement invariance

Recall that we conducted confirmatory factor analyses on two increasingly-restrictive hierarchical measurement models for each of the three subgroups of interest: gender, ethnicity, and mathematics ability level. Because the measurement model showed adequate model fit for girls, boys, African American students, White students, on-level students, and above-level students (see results in Table 2), we specified the same model for each subgroup when testing for factorial invariance.

The measurement model was invariant for girls and boys, with an adjusted Δ S-B $\chi^2(20) = 27.52$ (see Table 3). The nonsignificant chi square statistic provides evidence against rejecting the null hypothesis, which states that the model postulated does not differ

Table 3
Tests for Invariance of Final Sources of Self-Efficacy Measurement Model Across Gender, Ethnicity, and Ability Level

Group: Model	S-Bχ^2	*df*	CFI	SRMR	RMSEA	RMSEA 90% CI	Model Comparison	Δ S-Bχ^2	Δ *df*	Δ CFI
Gender: Model 1-Configural (no constraints)	883.94	492	.956	.047	.045	.040, .049	–	–	–	–
Gender: Model 2-Factor loadings invariant	9380.97	552	.955	.052	.044	.040, .049	2 versus 1	27.52	20	.001
Ethnicity: Model 1-Configural (no constraints)	875.57	492	.952	.054	.048	.042, .053	–	–	–	–
Ethnicity: Model 2-Factor loadings invariant	898.33	512	.952	.060	.047	.042, .052	2 versus 1	17.60	20	.000
Math Ability: Model 1-Configural (no constraints)	833.95	492	.956	.050	.044	.038, .049	–	–	–	–
Math Ability: Model 2-Factor loadings invariant	856.52	512	.956	.055	.043	.038, .048	2 versus 1	19.52	20	.000

Note. Robust statistics are reported. The Δ S-Bχ^2 represents a corrected value (see Satorra & Bentler, 2001). The Δ S-Bχ^2 statistics are not statistically significant, indicating equivalence in the two measurement models for each subgroup.
Girls (n = 408), Boys (n = 395); African American (n = 150), White (n = 541); On Level (n = 479), Above Level (n = 253).

from the population model (Byrne, 2006; Thompson, 2004). The analysis by ethnicity also revealed that the sources items were invariant for White and African American students. The two-group model with constrained loadings also showed an adequate fit to the data, **Δ** S-B $\chi^2(20) = 17.60$. Finally, the sources items were invariant for students on and above level in mathematics, showing an acceptable fit in the invariance model, adjusted Δ S-B $\chi^2(20) = 19.52$. Table 4 lists each item in the final Sources of Middle School Mathematics Self-Efficacy Scale along with its standardized loading estimate and error term for each of the seven measurement models. In all analyses, the standardized factor loadings were significant at the $\alpha = .05$ level and ranged in magnitude from .41 to .79.

4.1.6. Evidence of construct validity

The items, both individually and combined, were correlated with the four self-efficacy measures. The magnitude of the zero-order correlations between the sources subscales and the four self-efficacy outcomes offers compelling evidence for the criterion validity of the sources subscales. Correlations between the sources and self-efficacy were all statistically significant ($p < .001$) and ranged from an absolute value of .32 to .77. Consistent with past research, the highest correlation was that obtained between mastery experience and self-efficacy (see Usher & Pajares, in press). Comparing the correlation between the sources measures and self-efficacy outcomes to those obtained in previous research studies of the sources reveals that the measures created in this study are not only sound, but demonstrate greater predictive utility than have past measures.

Convergent validity was supported by the strong association between the sources, self-efficacy, related motivation constructs, and achievement (see Table 5). In fact, each source was related to mathematics self-concept, invitations of self and others, task goals, self-handicapping, optimism, and semester grades in mathematics. These associations were especially strong between the sources and mathematics self-concept beliefs and invitations. Given the well-established relationship between self-efficacy and self-concept, there is likely little distance between the pathways that nourish these two self-beliefs. Indeed, self-concept theorists have contended that students rely on factors such as mastery experiences, social comparative information, and praise when forming their self-perceptions (Bong & Skaalvik, 2003; Skaalvik, 1997). Moreover, there is evidence to show that these sources have a more pronounced effect on self-concept when self-concept is assessed at the domain-specific level, such as mathematics, than at a more global level (O'Mara, Marsh, Craven, & Debus, 2006).

The strong correlations between the sources and students' tendency to be inviting of self and others also confirms past research findings. Researchers have contended that the invitational (or *dis*invitational) messages that students send themselves and others act as a sieve through which their observations of themselves and the world necessarily pass (Usher & Pajares, 2006a; Valiante & Pajares, 1999). Indeed, the sources of self-efficacy and invitations share some features. For example, Purkey (2000) has suggested that "asking students to describe what significant others say about them reveals much about what students say to themselves" (p. 26). As have other researchers (Pajares & Zeldin, 1999; Usher & Pajares, 2006a), we found that all four sources were related to students' invitations of self and others.

The sources subscales were also able to discriminate between unrelated constructs. For example, self-efficacy researchers have noted that performance approach goals and self-efficacy are rarely correlated (e.g., Pajares, Britner, & Valiante, 2000). Our own results corroborate this finding by showing low or nonsignificant correlations between the sources of self-efficacy and students' performance approach goal orientation. Correlations between vicarious experience and achievement were also low, whereas those between the other three sources and achievement were not, which would also be expected.

We next sought to ascertain the independent contribution made by each of the four hypothesized sources to the prediction of middle school students' mathematics self-efficacy. We regressed the four self-efficacy outcome variables—grade self-efficacy, mathematics skills self-efficacy, courses self-efficacy, and self-efficacy for self-regulated learning—on the four sources of self-efficacy in four simultaneous multiple regression analyses (see Table 6). Regression results revealed that, consistent with past research, mastery experience was a strong and consistent predictor of self-efficacy. In fact, mastery experience explained over 20% of the variance in grade self-efficacy and in mathematics skills self-efficacy, minimizing the variance explained by each of the other sources to 2% or less. Vicarious experience was a strong predictor of self-efficacy for self-regulated learning, explaining 16% of the variance in that outcome. Social persuasions contributed modestly to the prediction of grade and courses self-efficacy. Physiological state was quadratically related to self-efficacy for self-regulated learning.

These findings offer support for Bandura's (1997) theorizing that mastery experience is the most powerful source of self-efficacy and that the three other sources also influence, if to a lesser degree, students' beliefs in their mathematics efficacy. As our results also indicate, the relative predictive power of the sources of self-efficacy depends on the outcome measure being used. It is easy to understand, for example, that students' perceptions of their mastery experience are strongly related to their self-efficacy for obtaining a high grade in mathematics. Moreover, our findings support Bandura's contention that the weights people assign to the various sources of self-efficacy are not identical across contexts. For example, it may be that in the context of sports the relative predictive power of each source is quite different than it is in mathematics.

Table 4
Standardized factor pattern loadings for final sources of self-efficacy items by subgroup

	Item	Full Sample	Girls	Boys	African American	White	On Level	Above Level
1.	I make excellent grades on math tests (ME-1)[2]	.783 (.622)	.791 (.611)	.772 (.635)	.648 (.762)	.804 (.594)	.786 (.618)	.781 (.625)
2.	I have always been successful with math (ME-3)[2]	.740 (.672)	.743 (.669)	.736 (.677)	.740 (.673)	.723 (.691)	.722 (.692)	.756 (.654)
3.	Even when I study very hard, I do poorly in math (ME-6)[*1]	.677 (.736)	.698 (.716)	.652 (.759)	.611 (.792)	.711 (.703)	.705 (.709)	.643 (.766)
4.	I got good grades in math on my last report card (ME-8)[1]	.668 (.744)	.664 (.748)	.679 (.734)	.564 (.826)	.667 (.745)	.672 (.740)	.649 (.761)
5.	I do well on math assignments (ME-9)[1M]	.827 (.562)	.810 (.586)	.854 (.520)	.801 (.599)	.831 (.556)	.818 (.575)	.815 (.580)
6.	I do well on even the most difficult math assignments (ME-12)[3]	.793 (.610)	.812 (.584)	.766 (.643)	.724 (.690)	.827 (.562)	.775 (.632)	.841 (.542)
7.	Seeing adults do well in math pushes me to do better (VA-4)[2]	.699 (.716)	.720 (.694)	.683 (.731)	.705 (.709)	.682 (.731)	.683 (.731)	.730 (.683)
8.	When I see how my math teacher solves a problem, I can picture myself solving the problem in the same way (VA-6)[2]	.745 (.667)	.756 (.654)	.737 (.676)	.766(.643)	.753 (.658)	.739 (.674)	.745 (.668)
9.	Seeing kids do better than me in math pushes me to do better (VP-1)[1]	.627 (.779)	.596 (.803)	.657 (.753)	.669 (.743)	.614 (.789)	.620 (.785)	.637 (.771)
10.	When I see how another student solves a math problem, I can see myself solving the problem in the same way (VP-9)[2]	.681 (.732)	.639 (.770)	.718 (.696)	.619 (.786)	.697 (.718)	.696 (.719)	.635 (.773)
11.	I imagine myself working through challenging math problems successfully (VS-4)[1]	.714 (.700)	.761 (.649)	.670 (.742)	.710 (.704)	.719 (.695)	.701 (.714)	.724 (.690)
12.	I compete with myself in math (VS-5)[3]	.631 (.776)	.563 (.827)	.700 (.714)	.691 (.723)	.582 (.813)	.655 (.756)	.669 (.744)
13.	My math teachers have told that I am good at learning math (P-4)[1M]	.704 (.710)	.680 (.733)	.728 (.686)	.643 (.766)	.711 (.703)	.702 (.712)	.751 (.660)
14.	People have told me that I have a talent for math (P-5)[3]	.741 (.672)	.740 (.673)	.739 (.673)	.723 (.691)	.744 (.668)	.752(.660)	.717 (.697)
15.	Adults in my family have told me what a good math student I am (P-7)[2]	.741(.671)	.737 (.676)	.746 (.666)	.675 (.738)	.761 (.648)	.754 (.657)	.697 (.717)
16.	I have been praised for my ability in math (P-13)[1M]	.812 (.584)	.830 (.557)	.790 (.613)	.790 (.614)	.815 (.579)	.819 (.573)	.781 (.625)
17.	Other students have told me that I'm good at learning math (P-14)2M	.792 (.610)	.829 (.559)	.765 (.644)	.743 (.669)	.816 (.578)	.797 (.604)	.835 (.551)
18.	My classmates like to work with me in math because they think I'm good at it (P-16)[1M]	.715 (.700)	.762 (.647)	.667 (.745)	.666 (.746)	.718 (.696)	.736 (.677)	.699 (.715)
19.	Just being in math class makes feel stressed and nervous (PH-2)[*1M]	.779 (.626)	.827 (.562)	.722 (.691)	.644 (.765)	.815 (.579)	.784 (.621)	.805 (.593)
20.	Doing math work takes all of my energy (PH-3)[*2]	.612 (.791)	.617 (.787)	.607 (.795)	.449 (.893)	.672 (.740)	.604 (.797)	.633 (.774)
21.	I start to feel stressed-out as soon as I begin my math work (PH-5)[*1]	.823 (.568)	.843 (.538)	.797 (.604)	.799 (.601)	.837 (.547)	.824 (.567)	.843 (.538)
22.	My mind goes blank and I am unable to think clearly when doing math work (PH-7)[*1]	.693 (.721)	.715(.699)	.668 (.744)	.657 (.754)	.725 (.689)	.663 (.748)	.757(.653)
23.	I get depressed when I think about learning math (PH-9)[*1M]	.694 (.720)	.724 (.690)	.660 (.751)	.635 (.773)	.729 (.684)	.683 (.731)	.696 (.718)
24.	My whole body becomes tense when I have to do math (PH-12)[*1]	.777 (.630)	.785 (.620)	.767 (.642)	.753 (.658)	.807 (.591)	.783 (.622)	.784 (.621)

Note: All item loadings are statistically significant. Error variances are presented in parentheses to the right of each standardized estimate. Numeric superscripts denote the study phase in which each item was first introduced. Items that were modified in subsequent phases are followed by the superscript "M."
ME, Mastery Experience; VA, Vicarious Experience from Adults, VP, Vicarious Experience from Peers; VS, Vicarious Experience from Self; P, Social Persuasions; PH, Physiological State.
[*] Reverse-scored item.

5. General discussion

Our goal in this investigation was to develop and validate items that assess the four theorized sources of self-efficacy (Bandura, 1997) in the area of middle school mathematics. We also aimed to examine the relationship between these sources and self-efficacy, other motivation constructs, and achievement. To this end, we carefully crafted items to assess the sources of self-efficacy as Bandura hypothesized, asked expert self-efficacy theorists to provide feedback on the validity of the items, administered the items to middle school students, and took into account the theoretical and statistical merits of the items when choosing those best suited for investigating the sources. The final, 24-item Sources of Middle School Mathematics Self-Efficacy Scale developed not only reflects the four sources hypothesized by Bandura but also displays strong psychometric properties and invariance across gender, ethnicity, and mathematics ability level. 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.

It bears noting that, even though the items designed to assess vicarious experience in this study were internally consistent and reflected the multidimensional nature of this source (i.e., tapped vicarious experience from adults, peers, self), vicarious experience remains a construct difficult to capture using traditional self-report, quantitative measures. The same vicarious experience may boost the mathematics efficacy beliefs of one study while lowering those of another. This is no doubt why Bandura (1997) asserted that "a distinction must be drawn between information conveyed by experienced events and information as selected, weighted, and integrated into self-efficacy judgments. A host of personal, social, and situational factors affect how direct and socially mediated experiences are cognitively interpreted" (p. 79). Empirical assessments that quantify the sources will continue to require scales particularly well-tuned to the cognitive appraisals students make of efficacy-building information, and researchers will need to be mindful of how the relationship between vicarious experience and self-efficacy may be affected by such appraisals.

Investigators who quantify the sources should also consider the role played by item wording, which can lead to different results (e.g., in factor analysis) that may reflect artifacts rather than conceptual differences in underlying constructs (Marsh, 1996). Some researchers have contended that the response patterns students use when answering certain positively and negatively worded items may reflect a substantial and meaningful personal bias (DiStefano & Motl, 2006; Horan, DiStefano, & Motl, 2003). With the exception of the items designed to assess physiological state and one mastery experience item, the items used in this study were positively worded. It is of course possible that negatively-worded items would have elicited different responses. In fact, in crafting items the researcher becomes quickly aware that valence is only one piece of the semantic puzzle. Compare an item from the final sources scale, "Adults in my family have told me what a good math student I am," to its reverse, "Adults in my family have not told me what a good math student I am." The two items assess quite different experiences, and neither can be said to evaluate the degree to which an individual receives negative persuasions. For such an assessment, the researcher would need to include yet another item such as: "Adults in my family have told me what a bad math student I am." This latter item would likely make known a new dimension of social persuasions, one untapped by positively-worded items such as those included in this and most other studies of the sources. Investigating the influence of such wording

Table 5
Means, Standard Deviations, and Zero-Order Correlations for Variables in Phase 3 for the Full Sample (N = 803)

Variable		Full Sample																		
		M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Mastery Experience	4.4	1.1																	
2.	aVicarious Experience	3.9	1.2	.51**																
3.	Social Persuasions	3.7	1.3	.73**	.61**															
4.	Physiological State	2.6	1.3	−.63**	−.39**	−.51**														
5.	Math Grade SE	4.9	1.0	.77**	.44**	.61**	−.55**													
6.	Math Skills SE	80.8	15.3	.62**	.43**	.52**	−.44**	.62**												
7.	Math Courses SE	3.4	1.5	.48**	.32**	.44**	−.35**	.46**	.51**											
8.	Self-Regulatory SE	4.4	1.1	.62**	.63**	.58**	−.57**	.60**	.57**	.42**										
9.	Self-Concept	4.4	1.0	.88**	.54**	.73**	−.65**	.73**	.62**	.49**	.65**									
10.	Inviting Self	4.3	1.1	.56**	.62**	.59**	−.47**	.56**	.49**	.35**	.72**	.58**								
11.	Inviting Others	4.5	1.0	.31**	.46**	.38**	−.28**	.34**	.33**	.22**	.51**	.32**	.60**							
12.	Task Goals	3.9	1.2	.44**	.72**	.52**	−.43**	.41**	.39**	.28**	.63**	.48**	.61**	.46**						
13.	Approach Goals	4.2	1.2	.12**	.34**	.20**	.02	.08*	.19**	.10*	.15**	.13**	.18**	.15**	.24**					
14.	Avoid Goals	3.1	1.2	−.23**	.04	−.11*	.37**	−.23**	−.16**	−.13**	−.18**	−.22**	−.10*	−.03	−.02	.45**				
15.	Self-Handicapping	2.6	1.2	−.28**	−.18**	−.16**	.31**	−.25**	−.23**	−.20**	−.32**	−.28**	−.21**	−.22**	−.18**	.00	.25**			
16.	Optimism	4.2	0.9	.48**	.46**	.47**	−.46**	.45**	.43**	.31**	.53**	.49**	.53**	.37**	.48**	.06	−.25**	−.23**		
17.	Teacher Rating	7.3	1.9	.46**	.06	.31**	−.28**	.42**	.44**	.30**	.21**	.42**	.14**	.16**	.05	.04	−.24**	−.20**	.19**	
18.	Semester GPA	85.4	8.2	.63**	.16**	.40**	−.34**	.59**	.45**	.33**	.33**	.56**	.26**	.24**	.14**	.01	−.23**	−.28**	.26**	.69**

Note. For calculations with Semester GPA, N = 784. SE = self-efficacy.
* $p < .05$.
** $p < .001$.

differences would be a valuable next step in the quantitative measurement of the sources.

Results from Phase 3 of the study revealed that each of the four sources of self-efficacy correlated significantly with the four mathematics self-efficacy measures and with motivation-related constructs such as mathematics self-concept, invitations, task goals, and optimism. Results from the regression analyses support Bandura's (1997) hypothesis and past research findings that mastery experience is the most powerful source of self-efficacy.

Three cautions are warranted. First, as results from this study demonstrate, the nature of the relationship between the sources and self-efficacy will differ as a function of the specific self-efficacy measures used. One might expect, for example, that perceived mastery experiences would have a stronger relationship with grade self-efficacy than would other sources, particularly in contexts where grades are emphasized as meaningful indicators of one's competence. Similarly, just as self-efficacy judgments best predict achievement outcomes when both variables are measured at similar levels of specificity, the sources may be maximally predictive when measured at the same level of specificity as the self-efficacy judgments they are intended to predict (e.g., sources of self-efficacy in mathematics would not likely be related to students' writing self-efficacy beliefs).

Second, the relationship between the sources and self-efficacy should not be generalized to other settings and contexts. The sources that nourish students' mathematics confidence may differ from those in other academic domains, such as writing or foreign language learning, or across other grade levels. The rules people use to integrate information that is diagnostic of their efficacy in a particular domain may also be nonlinear. As Bandura (1997) has explained, "how [people] weight the different factors and the rules they use to integrate them are inferred from their judgments across different configurations of information" (p. 114). This study is limited to only one such configuration, namely, middle school mathematics.

Third, conclusions about the relative influence of the four sources on self-efficacy outcomes should never be made in the absence of a detailed description of study participants. For example, previous research findings have suggested that the relationship between the other three sources and self-efficacy may differ as a function gender and ethnicity (Klassen, 2004; Usher & Pajares, 2006b). Though investigating this possibility was beyond the scope of this validation study, we believe these relationships merit additional empirical attention, both through quantitative and qualitative methodological approaches. In addition, researchers should seek to determine how these relationships might vary by other individual-level or school-level characteristics or as a function of the interactions of contextual variables. Addressing these research questions through a qualitative lens might permit researchers to illuminate the blind spots inherent in solely quantitative approaches.

Table 6
Standardized Regression Coefficients, Structure Coefficients, and Uniqueness Indicators for the Prediction of Self-Efficacy in Phase 3

Variables	MGSE	MSSE	MCSE	SE for SR
Mastery Experience (β)	.643***	.471***	.304***	.218***
Structure coefficient	.991	.975	.960	.828
Uniqueness	25%	20%	14%	3%
Vicarious Experience (β)	.027	.119**	.045	.385***
Structure coefficient	.565	.671	.639	.843
Uniqueness	0%	2%	1%	16%
Social Persuasions (β)	.076*	.076	.156*	.054
Structure coefficient	.785	.817	.874	.775
Uniqueness	0%	1%	4%	0%
Physiological State (β)	−.094*	−.058	−.065	.265*†
Structure coefficient	−.705	−.686	−.704	−.720
Uniqueness	1%	0%	1%	1%
Model R^2	.61***	.41***	.25***	.56***

Note. MGSE, mathematics grade self-efficacy; MSSE, mathematics skills self-efficacy; MCSE, mathematics courses self-efficacy; SE for SR, self-efficacy for self-regulated learning. All four independent variables were included simultaneously in each regression.

† Indicates that the quadratic term for physiological state was significant in this model. Estimates represent the quadratic term, and beta coefficients should be interpreted accordingly.

* $p < .05$.

** $p < .001$.

*** $p < .0001$.

A logical next step for future research would be for investigators to examine the validity of the items in the sources of self-efficacy scale developed in this study across different contexts and domains. This would require administering the items to students at elementary, secondary, and postsecondary levels, and to students in diverse socioeconomic settings, both urban and rural. Researchers should also take a closer look at how the sources operate in predominantly African American or Hispanic settings and in contexts outside the U.S.

Results from this study may also inform classroom practice. As our findings demonstrate, perceived mastery experience is a powerful source of students' mathematics self-efficacy. Students who feel they have mastered skills and succeeded at challenging assignments experience a boost in their efficacy beliefs (Bandura, 1997). Mathematics teachers should therefore aim to deliver instruction in a way that maximizes the opportunity for such experiences, however incremental (see Pajares, 2006). The sources scale offered here may also provide middle school teachers with a quick assessment tool for understanding the antecedents of their students' self-efficacy beliefs. Such an understanding would certainly be useful to all who are interested in nurturing students' competence *and* confidence.

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