Sources of self-efficacy in mathematics: A validation study

Ellen L. Usher [a,*], Frank Pajares [b]

[a] University of Kentucky, Educational and Counseling Psychology, 249 Dickey Hall, Lexington, KY 40506-0017, USA
[b] Emory University, 1784 North Decatur Road, Suite 240, Atlanta, GA 30322, USA

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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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* Corresponding author. Fax: +1 859 257 5662.
  E-mail address: ellen.usher@uky.edu (E. L. Usher).

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 con-

crete 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 func-