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ABSTRACT

Assumptions underlying the multifaceted, hierarchical structure of self-efficacy previously hypothesized by R. Shavelson, J. Hubner, and G. Stanton (1976) for the construct of self-concept were tested. The self-efficacy interpretation of the Science Self-Efficacy Scale (H. Kennedy, 1996), a relatively new measure, was studied with 331 (151 female and 180 male) college students and multiple measures of science, mathematics, and self-regulated learning self-efficacy facets. Results support a multifaceted, hierarchical interpretation. A second-order self-efficacy latent named academic self-efficacy was shown to be reflected by the three first-order self-efficacy factors of science, mathematics, and self-regulated learning. (Contains 2 tables, 1 figure, and 22 references.) (SLD)

Second Order Model of Self-Efficacy Measures

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Author's Notes

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Abstract

The purpose of the study was to test assumptions underlying the multifaceted, hierarchical structure of self-efficacy previously hypothesized by Shavelson, Hubner, and Stanton (1976) for the construct of self-concept. In the procedure, the study examines self-efficacy interpretation of the Science Self-efficacy Scale, a relatively new measure. With 331 (151 young women and 180 young men) college students and multiple measures of science, mathematics and self-regulated learning self-efficacy facets, the study found support for a multifaceted, hierarchical interpretation. A second-order self-efficacy latent named academic self-efficacy was shown to be reflected by the three first order self-efficacy factors of science, math, and self-regulated learning.

Second Order Model of Self-Efficacy Measures

Researchers (Vispoel & Chen, 1990) have sought to validate the interpretations of the instruments designed to measure self-efficacy. However, the literature has not addressed the conceptual structure of self-efficacy in academic and social areas analogous to previous constructs such as self-concept. In broad terms, the purpose of the present study was to provide new evidence bearing on the properties of self-efficacy structure in conceptualizing the academic domain of self-efficacy.

Self-Efficacy Structure

Presently, no theoretical structural models of self-efficacy have been proposed. In the literature, the model of self-concept by Shavelson, Hubner, & Stanton (1976) has been examined the most rigorously in multiple studies (Byrne, 1986; Byrne & Shavelson, 1986; Marsh, Barnes, Cairns, & Tidman, 1984; Shavelson & Bolus, 1982). It provides the theoretical framework for the present study.

Bandura (1986) postulated that efficacy differs from other types of self-appraisal, including self-concept and self-esteem. Consequently Shibutani (1986) defined self-concept as tantamount to the variety of roles people ascribe to themselves, whereas self-esteem is analogous to the value people place on a given role: "I am a college student" refers to one's conceptions of self. "I am a good college student" refers to the degree of value placed on that conception. Self-efficacy cuts across these various conceptions of self to focus on the degree of confidence a person has to perform a given target behavior, as opposed to the type of role instantiated by performing the behavior, or the degree of esteem ascribed to that role.

Self-efficacy theory provides a framework for understanding how people contribute to the socialization process of individuals. People are sources of encouragement and sources of vicarious learning for the individual. Of the self-appraisal theories, self-efficacy appears to be the most central and pervasive mechanism of personal agency controlling human motivation, affect, and action. The principles of self-efficacy operate on behavior through motivational, cognitive, and affective mediating processes (Bandura, 1989). Based upon this reasoning, the self-efficacy structure may be hypothesized as being multidimensional and hierarchical, where perceiving ability to perform the specific task in the first-order (e.g. academic: science, mathematics), then to perceptions about the task in academic and nonacademic , and finally to a general perception and confidence about the task. In considering the hierarchy and multidimensionality of self-efficacy, it may be further postulated, as Shavelson Hubner, and Stanton (1976) did with self-concept, that self-efficacy becomes increasingly multifaceted with age and is differentiable from other psychological constructs.

Multidimensional structure of self-efficacy. The multidimensional nature of self-efficacy may be addressed in numerous studies with widely varying age groups. The findings from the study by Sherer, Maddux, Mercandante, Prentice-Dunn, Jacobs, and Rogers (1982) showed a significant support for the mutidimensionality of self-efficacy from the context of a variable named general self-efficacy. Based upon reported studies (Lent, Brown, & Larkin, 1987; Owen & Froman, 1988), academic self-efficacy was measurable and shown to be a separate facet of self-efficacy. The more specific self-efficacies related to mathematics, science, and self-regulated learning have also been interpreted as distinct but correlated with one another (Kennedy, 1996). However, until

this paper, no research has addressed the relationship between the subject-matter facets and academic self-efficacy (at any age level).

Hierarchical structure of self-efficacy. The literature reviewed confirmed that self-efficacy is a variable that has been either a predictor (Betz & Hackett, 1983; Lent, Brown, & Larkin, 1984; Solberg, O'Brien, Villareal, Kennel, & Davis, 1993), covariable (Cooper & Robinson, 1991; Hackett, 1985; Lent, Brown, & Larkin, 1987), or outcome variable (Hackett & Betz, 1982; Owen & Froman, 1988; Sherer, Maddux, Mercandante, Prentice-Dunn, Jacobs, & Rogers, 1982). Each case has been shown to have difficulties and uniqueness. The research presented here is only part of a whole body of work which has evolved to find support for Bandura's (1977) self-efficacy theory. Nevertheless, research prior to this article has not tested the question of self-efficacy having a hierarchical structure with students at any age level.

In the present study, to pursue the structure of self-efficacy in the dimensions of multifacetedness and hierarchy, the academic domains of science and mathematics were selected for their interrelated nature in certain academic tasks. The domain of self-regulated learning was selected for its more global perception of fusing skill and will in the utilization of cognitive skills. All three academic domain constructs demonstrate features of cognitive social-learning which is a integral part of self-efficacy.

Therefore, in this article, a second-order CFA model for the self-efficacy latent variables is tested and the following question is asked: Do college students have a distinct academic self-efficacy which is affected by their science self-efficacy, mathematics self-efficacy, and self-efficacy for self-regulated learning?

Method

Sample and Procedure

Participants (N = 331) were predominantly first- and second-year undergraduates attending a major private university in Los Angeles, California. There were 151 women and 180 men. The distribution of age was 24 at seventeen years and younger, 108 at eighteen years, 88 at 19 years, 50 at twenty years, and 61 at twenty-one and older. Approximately 48% of the sample were white,non-Hispanic; 20% of the sample were Asian or Pacific Islander; 13% were black, non-Hispanic; 12% were Hispanic; 4% were Native American; and 2% were non-Resident alien. The college major for women was approximately 50% *not either mathematics or science oriented*, 27% *biological science oriented*, 19% *mathematics oriented*, and 4% *physical science oriented*. For men, the college major was 44% *not either mathematics or science oriented*, 40% *mathematics oriented*, 9% *biological science oriented*, and 6% *physical science oriented*. Approximately 49% have a GPA above 3.0 and 93% have a GPA of 2.1 and above. Students were asked to participate voluntarily in a study on personal confidence to perform everyday science tasks. Individuals who agreed to participate (approximately 90% of all the students) completed the questionnaire packet during one class session of the third or fourth week of the semester.

Instrumentation

The self-efficacy test battery consisted of 3 academic-domain specific measures, science, mathematics, and self-regulated learning. All were self-report rating scales that were designed for use with a high school and/or college population. Science self-efficacy was measured by using the Science Self-Efficacy Scale (SSES) (Kennedy, 1996) composed of two subscales: (a) the science

tasks subscale, consisting of 40 items involving *everyday* science tasks (e.g. brewing a pot of coffee); and (b) the science courses subscale, consisting of 20 science-related college courses. The measurement of mathematics self-efficacy was conducted using the Mathematics Self-Efficacy Scale (MSES) (Betz & Hackett, 1993). The scale was composed of two subscales: (a) the math tasks subscale, consisting of 18 items involving *everyday* math tasks (e. g., computing gas mileage); and (b) the math courses subscale, consisting of 16 math-related college courses. Self-efficacy for self-regulated learning was assessed using the Self-Efficacy for Self-Regulated Learning Scale (SESRL) (Zimmerman, Bandura, & Martinez-Pons, 1992) where the questions measured the students' perceived capability to use a variety of self-regulated learning strategies.

The mentioned self-efficacy scales use a 5-point Likert-type scale with responses ranging from *no confidence at all* (1) to *complete confidence* (5). Kennedy (1996) reported internal consistency reliability coefficients as follows on the total scales: SSES α at 0.95, MSES α at 0.96, and SESRL α at 0.93. On the subscales the coefficient alpha ranged as follows: 0.87 to 0.93 for SSES, 0.83 to 0.94 for MSES, and 0.72 to 0.88 for SESRL.

Results

This study examines a CFA model that comprises a second-order factor. The application was conducted based upon the fully developed assessment measures of the previously mentioned self-efficacy latents that have demonstrated satisfactory factorial validity. Justification for CFA procedures in this present instance were based on the evidence provided by the study that the data were more adequately represented by a hierarchical factorial structure. To be concise, the first-order factors are explained by some higher order structure that, in the case of the present study's self-efficacy, is a single second-order factor of academic self-efficacy.

The analysis for the CFA model is based upon the correlation matrix reported in Table 1. The model fit indexes for the second-order latent based upon the self-efficacy measures of science, mathematics, and self-regulated learning are contained in Table 2. The results of the three factor model labeled Final CFA are included to develop a better sense of how the models compared.

The modification from Final CFA to Second-Order was to show that the first-order self-efficacy factors were explained by some higher order structure, academic self-efficacy. Based upon this modification to the second-order model, the comparative fit index had a slight increase of 0.01. The ratio of chi-square to degrees of freedom changed from 7.2 for the three factor model to 8.3 for the second-order. These statistics indicate that the data were not a perfect fit but were adequate. The fit indexes were greater than 0.90 and support the construction of the structural models.

The standardized CFA loadings and residuals for the second-order model are presented in Figure 1. The loadings on the measured variables, when all significant, indicated that the measured variables reflected the latent constructs. The loadings on the latent variables were all significant, demonstrating that the first-order latents reflected the second-order construct.

Discussion

The second-order model showed that the responses to the three self-efficacy measures were explained by three first-order factors (Science Self-Efficacy, Math Self-Efficacy, and Self-Efficacy for Self-Regulated Learning). Furthermore, the model demonstrated that the covariation among the three first-order factors was explained fully by their regression on the second-order factor.

The notable point with respect to the application presented was that, given the same number of parameters to be estimated, fit statistics related to a model parameterized initially as a first-order structure and then as a second-order structure will be equivalent (Byrne, 1994). The difference between the comparative models was that the second-order was a special case of the first-order model when the structure was imposed on the correlation pattern among the first-order factors. The judgement to utilize the self-efficacy measures as either first-order or second-order structures in the structural model rested on the substantive meaningfulness as dictated by the underlying theory.

The data from this study supported the query that academic self-efficacy was composed of science self-efficacy, math self-efficacy, and self-efficacy for self-regulated learning. When Shavelson, Hubner, and Stanton (1976) suggested that self-concept was a multifaceted and hierarchical construct there was much confusion in the literature which continues to impact present research. Similarly, this study demonstrated that self-efficacy could be divided into differing facets. Bandura, Adams, and Beyer (1977) reported evidence that the experiences of personal mastery contribute to efficacy expectancies that generalize actions other than the target behavior. It was therefore hypothesized that the second-order latent named academic self-efficacy would be measured by the first-order latents of science self-efficacy, mathematics self-efficacy and self-efficacy for self-regulated learning.

Supported by the data from the present study, the second-order latent was named academic self-efficacy. The three first-order latents of science self-efficacy, mathematics self-efficacy, and self-efficacy for self-regulated learning reflected the construct of academic self-efficacy. Furthermore, the possible choice of academic activities, the amount of effort expended in learning,

and the level of persistence in aversive academic situations might be determined by the student's academic self-efficacy.

The most remarkable innovation of this research was the second-order latent named academic self-efficacy. By the naming of this specific latent, the finding implied that self-efficacy is a multifaceted and hierarchical construct. Consequently, this investigation added to our understanding of students' perceived self-efficacy.

Limitations and Suggestions

The results observed in the present study need to be qualified by the study's limitations. First, the data obtained for the study were drawn from a single institution. The consequence of this is that the ability to generalize results from this study to other academic domains and related second-order domains of self-efficacy is limited. A suggestion is the need for replication with students from other institutions.

Second, limitations of the measures used in this study are noteworthy. All scales used in this study relied on participants' self-reports requiring perceptions of one's ability to perform in a specified domain. The internal and external validity of the measures is limited to this study. The development of more complete and psychometrically sound measures of self-efficacy in specified academic domains is warranted and would strengthen future investigations of discriminant validity within self-efficacy.

Finally, data from the present study were not experimental or longitudinal. The effect is that cause-and-effect relationships were impossible to establish. Although confirmatory factor analysis in tandem with structural equation modeling allows one to postulate causal relationships, the present study's model specifications was based on only three discriminantly valid measures. A

consequence is that the cause-and-effect relationships suggested by the model in this study may not represent the true causal nature of the relationships among the constructs. Future research will benefit from the collection of more data from a multitude of academic domains such as history, social science, language arts, art, and music to name a few. This will allow for the exploration to proceed more precisely while measuring a possible change in the direction of causality among relationships. The ideal study would incorporate the basic academic domains developed and pursued during the entire process of a learner's academic experience commencing in elementary school and on into higher education and lifelong learning.

Conclusion

The findings from this study recommended that further research be done in understanding the concept of self-efficacy through a replication of the present work. In future research, the present model should be extended to include other academic-domain specific measures. The exploration of perceived self-efficacy as a multifaceted and hierarchical construct requires defining the concept more clearly and utilizing assessment measures that reflect the context. Further clarification of the relationship between specific academic-domain self-efficacies and the second-order latent of academic self-efficacy appears to be an important future step in understanding the causal processes of self-efficacy and how it affects academic attainment and career decision making. This study indicates the establishment of the importance of developing the structure of self-efficacy and modeling its causal relationships. The utility of this understanding will aid counselors in advising students as to their abilities in their selected area of academic study and career.

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Table 1

Correlation Matrix: Three Factor Model

		Math Self-Efficacy			Science Self-Efficacy			Self-Efficacy for Self-Regulated Learning	
		Part I-B	Part I-A	Part II	Part I-B	Part I-A	Part II	Part I	Part II
Math Self-Efficacy	Part I-A	0.90							
	Part II	0.65	0.61						
Science Self-Efficacy	Part I-B	0.54	0.52	0.33					
	Part I-A	0.55	0.52	0.32	0.93				
	Part II	0.51	0.48	0.80	0.41	0.39			
Self-Efficacy for Self-Regulated Learning	Part I	0.34	0.40	0.29	0.34	0.31	0.27		
	Part II	0.44	0.45	0.36	0.43	0.43	0.38	0.731	
	Part III	0.40	0.44	0.34	0.37	0.35	0.32	0.88	0.79

Note. All correlation coefficients in this table were significant at 0.001.

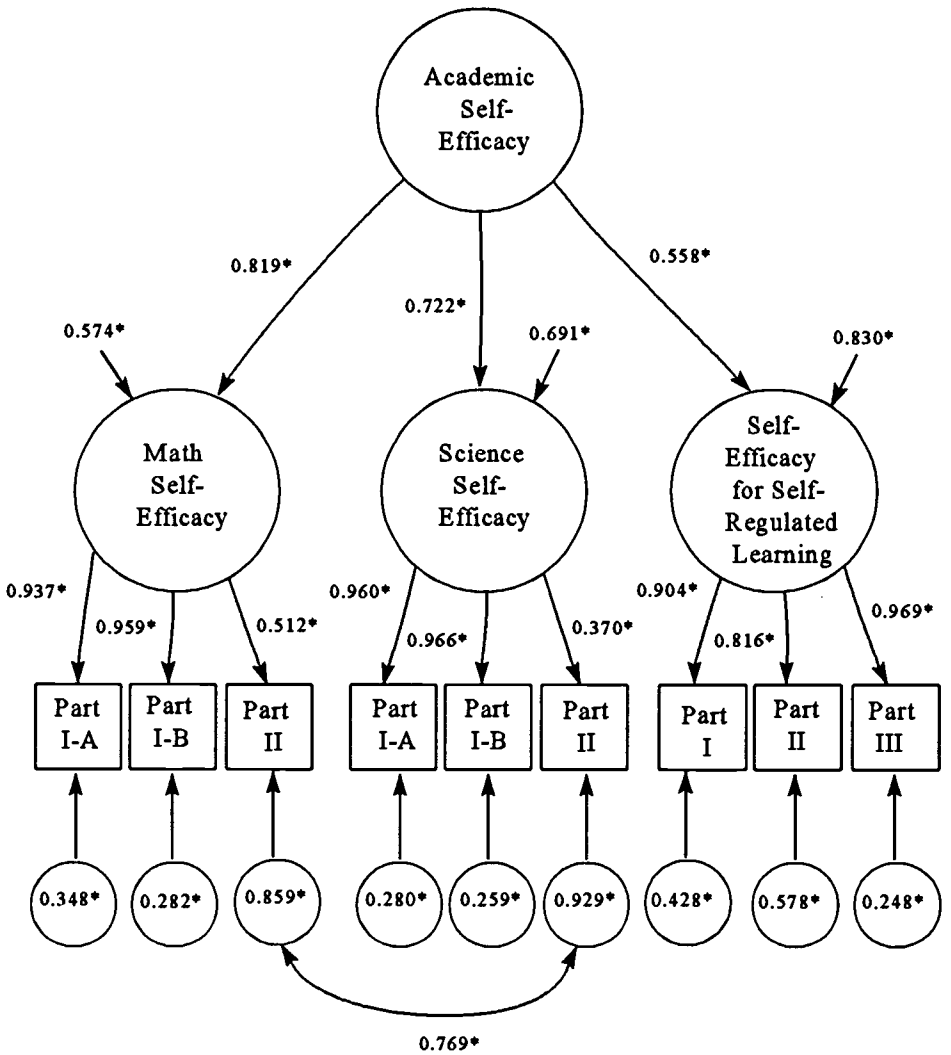
Table 2

Summary of Comparative Models of Academic Self-Efficacy

Model	X^2	df	p value	Comparative Fit Index
Three factor				
Final CFA	165	23	< 0.001	0.96
Second-Order	165	20	< 0.001	0.97

Figure Caption

Figure 1. Final CFA model for second-order, Academic Self-Efficacy. Correlations between factors and loadings between factors and the variables they predict are presented. (Large circles represent latent constructs, rectangles are measured variables, and small circles with numbers are residual variances. Factor loadings are standardized and significant correlations were determined by critical ratios on unstandardized coefficients. [*All coefficients in this model significant at 0.001].)



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