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ABSTRACT

A study evaluated experimentally a technology education program designed to provide mastery experiences described in Bandura's self-efficacy theory (1986) and predicted to improve career decision making. Seventh graders (n=97) and eighth graders (n=72) were stratified on grade level and randomly assigned either to a commercially published technology education program with self-efficacy components or to control curricula. Over 7 weeks, the experimental program attempted to foster exploration and performance accomplishments in the students' choice of 3 out of 21 possible technical and scientific careers. Pre- and posttest instruments assessed technical/scientific self-efficacy and career interest. Three separate MANOVAs showed no treatment effects were found, possibly because students in the experimental group were allowed to choose modules that might reflect their own interests, thus influencing their favorable ratings of the program. (Contains 37 references.) (YLB)

Running Head: Technical and Scientific Career Outcomes

Experimental Evaluation of Self-Efficacy Treatment On Technical/Scientific Career Outcomes

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Abstract

This study experimentally evaluated a technology education program designed to provide mastery experiences described in self-efficacy theory (Bandura, 1986) and predicted to improve career decision making (Hackett and Betz, 1981). Seventh and eighth grade students ($n = 169$) were stratified on grade level and randomly assigned either to a published technology education program or to control curricula. Over a seven week period, the experimental program attempted to foster exploration and performance accomplishments in the students' choice of 3 (out of 21 possible) technical and scientific careers. Pre- and post-test instruments assessed technical/scientific self-efficacy and career interest. No treatment effects were found. Implications and suggested improvements to the treatment are discussed.

Experimental Evaluation of Self-Efficacy Treatment On Technical/Scientific Career Outcomes

Women's talents and abilities continue to be underused in many traditionally higher paying, male-dominated technical and scientific fields (Betz & Fitzgerald, 1987). Current data on young girls' career plans do not foretell an increase in female representation in technical and scientific fields anytime soon. For example, in 1993 only 2.9 percent of women entering college planned to major in engineering, and only 1 percent planned to enter technical fields; comparable figures for men were 15.8 and 5.4 percent, respectively (American Council on Education, 1994). Moreover, a recent national poll reported that 52 percent of high school boys think they would enjoy being scientists, in contrast to only 29 percent of high school girls (American Association of University Women, 1994). And among high school students identified as mathematically gifted, female students were less likely than their male counterparts to choose a math/science major in college (40% vs. 72%) or to pursue a math/science career goal (24% vs. 56%) (Benbow, 1992).

Factors that restrict the number of women who choose careers in technical and scientific fields have been identified by Hackett and Betz (1981) in a "self-efficacy" theory for the career development of women derived from Bandura (1977). Self-efficacy beliefs are judgments about one's ability "to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Such beliefs affect whether behavior is initiated, how much effort is put forth, and the persistence of the behavior (Hackett & Betz, 1981).

Bandura (1982, 1986) suggested that self-efficacy, knowledge (or skill), and action are interrelated; successful performance generally requires a combination of skill and strong self-efficacy. On the other hand, self-efficacy may influence behavior regardless of underlying skill levels. Thus, in addition to knowledge and skill building, self-efficacy beliefs should also be strengthened if behavior is to be initiated and continued. Bandura (1977, 1986) proposed four sources for self-efficacy judgments: performance attainments (or mastery experiences); vicarious experiences (such as observing the performance of models); verbal persuasion (i.e., social influences regarding one's abilities); and physiological states (such as arousal or anxiety) (Bandura, 1977, 1986); but of the four sources, performance attainments are the most powerful.

Hackett and Betz (1981, 1992) suggested that women's socialization experiences result in low self-efficacy judgments about many career-related behaviors. For example, childhood participation in gender-stereotypic activities and lack of participation in male-stereotypic activities restrict the acquisition of self-efficacy beliefs in activities traditionally viewed as male-oriented. Low self-efficacy, then, limits career exploration and development, and results in the gender differences in career choice patterns evident today. Hackett and Betz thus proposed that helping women consider a greater number of options, via enhanced and more realistic self-efficacy beliefs, would lead to more effective career decision-making.

During the fifteen years since Hackett and Betz's initial work, many studies have examined the relationships among variables in this area. For example, career and academic self-efficacy beliefs are related to career choice behavior (Betz & Hackett, 1983; Hackett & Betz, 1989; Lent, Lopez & Bieschke, 1991; Rotberg, Brown, & Ware, 1987) and predict success and persistence in certain fields (Lent, Brown, & Larkin, 1984; Lent, Brown, & Larkin, 1986). In addition, self-efficacy for traditional occupations (same-gender dominated) is higher than self-efficacy for nontraditional occupations (opposite-gender dominated) (Church, Teresa, Rosebrook, & Szendre, 1992; Hannah & Kahn, 1989; Lauver & Jones, 1991). Some findings, though, indicate that women have higher self-efficacy beliefs about traditional than nontraditional occupations, while males are equivalent in both areas (Clement, 1987; Matsui, Ikeda, & Ohnishi, 1989). Generally, however, women and men consider traditional occupations more often than nontraditional occupations (Church et al., 1992; Lauver & Jones, 1991; Stickel & Bonett, 1991).

A number of recent correlational studies have explored the relationship between self-efficacy beliefs and career choice behaviors in technical and scientific fields. For example, Lent et al. (1991) reported that university student men evidenced higher mathematics self-efficacy than women, which contributed to the science-relatedness of their interests and career choices. The authors noted, consistent with Hackett and Betz, that the effects of gender on self-efficacy are mediated by differential efficacy-building experiences for the two sexes.

Furthermore, Lapan, Boggs, & Morrill (1989) found that although males reported higher efficacy on science-related occupations and scored higher on science-related interest scales, high school mathematics preparation and mathematics self-efficacy were responsible for these differences. Thus, efficacy-related experiences are important contributors to gender differences in mathematical, technical, and scientific self-efficacy, as well as subsequent interest in related career areas.

The methods for assessing career interests include interest inventories (Lapan et al., 1989; Lent, Larkin, & Brown, 1989), reported choice of college major or intended career (Betz & Hackett, 1983; Lent et al., 1991), and ratings of specific occupations listed (Church et al., 1992; Lent et al., 1986; Rotberg et al., 1987). Recently, methodological concerns have been voiced about the specificity of the interest and self-efficacy beliefs involved and their inter-relatedness. In a meta-analysis of self-efficacy beliefs and academic outcomes, Multon, Brown, and Lent (1991) reported that the largest effect sizes involved specific and highly concordant self-efficacy and performance indices. Several authors acknowledge, however, that although specific measures of self-efficacy and outcome behaviors provide precision and better prediction they do so at the cost of lesser generalizability (Lent & Hackett, 1987; Pajares & Miller, 1995). Lent and Hackett (1987) suggested that a moderate level of specificity is desirable for most research questions. Rather than examining self-efficacy beliefs regarding something as general as being a scientist or as specific as the skills required for a circumscribed chemical engineering task, it is more appropriate to examine self-efficacy beliefs and interests in careers which encompass the performance accomplishment experiences provided by a particular intervention.

The ex post facto studies discussed thus far have employed correlations and path analyses to explicate the relations among career self-efficacy and behavior. To date, only a few analog experimental studies exist. For example, Hackett and colleagues (Campbell & Hackett, 1986; Hackett, Betz, O'Halloran, & Romac, 1990; Hackett & Campbell, 1987) examined the effect of manipulating success or failure on self-efficacy and interest, and found differences as predicted. Such studies have set the stage for an investigation of the causal links among career-related interventions, self-efficacy, and behavior.

Many authors have called for such causal research (Hackett & Lent, 1992; Lent, Brown, & Larkin, 1986; Lent & Hackett, 1987). For example, one might provide experiences that improve technical and scientific self-efficacy and subsequently lead to more complete career exploration. The timing of the intervention is important developmentally. Preparation in mathematics is viewed as the "critical filter" which screens out individuals who might pursue higher paying technical and scientific fields; students who enter college under-prepared in mathematics often are unable to catch up and compete (Sells, 1980). Nevertheless, high school females take fewer math courses than males (Meece, Wigfield, & Eccles, 1990; Sells, 1980). Thus, curriculum decisions made in high school can restrict career consideration and subsequently limit the opportunities of young women. Thus, early adolescence is a crucial time for any intervention designed to promote full career consideration. Experiences that provide realistic self-efficacy beliefs at an early age could pave the way for continued career exploration.

This study evaluated a commercially published technology education program (Herlihy & Company, 1992) that has a number of components comparable to what might be derived from self-efficacy theory. In so far as the program faithfully operationalized the critical elements of self-efficacy theory, this study could be construed as an experimental test of that theory in a naturalistic setting. Essentially, we examined the effects of a program that provides relevant performance accomplishment experiences, on the technical and scientific self-efficacy and career interests of seventh and eighth grade students. Data was gathered on both boys and girls; however, since there is some evidence in the literature to presume that the technical and scientific self-efficacy of boys is higher than girls, particular attention was paid to changes evidenced by the girls in this study.

Method

Participants

Participants were 97 seventh-grade (48 female and 49 male) and 72 eighth-grade (30 female and 42 male) public school students in a large southwestern city. Their ages ranged from

11 to 14 (M = 12.67). The majority (62%) were White; Mexican-Americans (20%), and African Americans (7%) comprised the largest minority groups represented. Nineteen additional special education students concurrently received treatment; their scores were not analyzed, however, because many were not able to complete the assessment instruments.

Measures

Outcomes of the technology education program were assessed with a battery of devices reflecting general and specific self-efficacy, general and specific career interests, and intended career choice and major, in so far as these variables pertain to technical and scientific fields.

General and Specific Self-Efficacy, pertaining to technical and scientific careers, were derived from our revision of an instrument used by Lent, Brown, & Larkin (Self-Efficacy for Technical/Scientific Fields-Educational Requirements Scale, 1984, 1986, 1987). Respondents indicate confidence in their ability to complete the educational requirements of technical and scientific fields on 10-point scales ranging from not at all confident to completely confident. Lent et al. (1984) reported 8-week test-retest and internal consistency reliabilities of .89, as well as adequate predictive and discriminant validity. We pilot tested our revised instrument and found an internal consistency coefficient of .95; moreover, the pretest alpha reliability for the participants in our study were .97. Our two scores, General and Specific Self-Efficacy were calculated as follows:

General Self-Efficacy. Seven of the original fifteen occupational titles were modified and fifteen new occupational titles were added to match the technology education modules in our treatment that were available to the participants. Moreover, we supplemented the occupational titles with five to ten word descriptions constructed from the Dictionary of Occupational Titles

(1991) and the Occupational Outlook Handbook (1996).

Specific Self-Efficacy. The technology education program permits students to select three modules, cafeteria style, from a menu of 21 alternatives. A Specific Self-Efficacy score for each experimental student was calculated by recording the scores from these three modules and dividing that total by the number of modules completed. Scores for students in the control condition were computed in a similar fashion. However, since control students did not select modules, we yoked them to matching students in the experimental condition. Yoking was accomplished by rank ordering students in the experimental and control condition on their General Self-Efficacy scores, and then subsequently forming successively ranked pairs. For example, the modules selected by the highest experimental student were assigned to the highest control student, and so on.

General and Specific Career Interest, likewise pertaining to technical and scientific fields, were derived from an instrument used by Rotberg, Brown, and Ware (1987). Students are asked to rate their interest in each occupation on 5-point Likert scales. Rotberg et al. reported test-retest reliabilities of .69 to .76 depending on the traditionality of the careers. We revised and pilot tested this instrument, and found an internal consistency coefficient of .93; moreover, the pretest scores of participants in our study yielded an alpha coefficient of .93 as well. We modified Rotberg's list of fifteen occupations to reflect the same occupations included in the self-efficacy measure. General Career Interest was thus based on the same twenty-eight occupational titles. As with self-efficacy, a Specific Career Interest score for each experimental student was calculated by recording the scores from the three modules selected and dividing that total by the number of modules completed. Scores for students in the control condition were computed by yoking; in this instance, however, the rank ordering was done on the basis of General Career Interest scores.

Intended Career Choice and Intended Major were extracted from questionnaires and rated on proximity to technical and scientific careers. Students were asked to "Please list the career(s) in which you are most interested at this time" and "Please list the college major or technical training you are considering at this time." Their responses were classified by a doctoral student in counseling psychology (experimentally blind to the hypotheses and participants' treatment conditions) according to Goldman and Hewitt's (1976) science-nonscience continuum. This assessment procedure has been used in several recent studies (Hackett & Betz, 1989; Lent et al., 1991; Pajares & Miller, 1995). Scores range from 5 (e.g., engineering) to 1 (e.g., art).

Demand Characteristics. A six-item Likert scale derived from Borkovec and Nau (1972) ascertained the possibility of differential demand characteristics inherent in the experiment. Differences between treatment and control participants on this measure would suggest that placebo factors were operative, and hence were not expected. Specific questions concerned whether students believed the course to be important, interesting, valuable later in life, better than other courses, better than studying at home, and worth recommending to other students.

Procedure

Prior to the start of the fall semester, students were blocked on grade and randomly assigned to experimental and control conditions. Normal course scheduling constraints required treating the students in two flights. Half of the experimental students were treated in the first quarter; their control counterparts received instruction in art. The other half of the participants in this study were assigned to physical education in the first quarter and received either the experimental treatment or art instruction in the second quarter. All assessments (pre- and post-testing) occurred at the beginning and end of the semester with the exception of the demand measure, which was given two weeks into the experimental and control treatments.

The experimental treatment was administered by a technology education teacher for fifty minutes each school day over a seven-week period. On the first day of class, the teacher explained how the TE module system works, pointed out each workstation, and briefly described some of the projects to be completed for each module. The students received a notebook for each module describing the activities to be performed. Some modules incorporated additional videotaped information. Workstations were placed around the room for hands-on experiences. On the second day, students found partners who were interested in the same module and began to work. The teacher acted as facilitator, answering questions when needed. After two weeks, students selected a second technology education module to complete and a partner, and after additional two weeks, the third module was selected and completed.

Twenty-one modules were available; students chose three to complete during the seven-week term. The modules are: aerospace, alternate energy, applied physics, arc welding, audio-video, computer aided design, computer fundamentals, computer numerical control, drafting, electronic publishing, engineering, fluid power, material testing, material and process, multimedia, problem solving, research and development, robotics, sheet metal, small gas engines, and technology tomorrow. The notebook accompanying each module described (usually) ten activities, one to be performed each day. The students earned points for attendance, performing the tasks, and completing the module test.

The physics module, for example, consisted of the following activities over a 10-day period: (1) reading several pages about lasers, to answering study questions, and watching a videotape about lasers; (2) learning how to use a computer program and the names of objects in a laser optic kit; (3) using laser optics to examine a series of objects; transmitting sound using fiber optics; (5) learning about simple machines and completing a mechanical experiment; (6) completing lessons on mechanical systems using a computer; (7) studying about force and mechanical power; (8) performing experiments with levers, sprockets, and chains; (9) completing several experiments with pulleys, wheels, and inclined planes; and (10) finishing any remaining work and taking the module test.

Results

Preliminary Analysis

Attrition. Of the original 169 participants, 30 were absent on the days designated for pre- or post-testing. Analyses on the self-efficacy and interest measures thus included data from 72 experimental and 67 control participants. The intended career choice and major instruments, applied to the seventh and eighth graders in our study, were designed to tap attitudes toward technical and scientific careers rather than reflect realistic planning. Only 60 participants provided complete data on these devices. Hence, separate analyses were conducted on these measures to avoid losing the other 79 participants who provided complete data on all measures.

Psychometric Properties. Pre-post correlations for the measures in this study ranged from approximately .5 to .8. Pretest correlations between measures were lower, ranging from about .3 to .6.

Pretest Differences A 2 x 2 x 2 MANOVA (treatment by gender by grade, multivariate analysis of variance) on pretest scores indicated no pretest differences between experimental and control participants. Gender and grade differences, however, did appear on some instruments.

Girls scored lower than boys on Intended Major, F(1, 82) = 7.03, p = .01. And eighth graders scored higher than seventh graders on General Self-Efficacy, F(1, 82) = 6.15, p = .02, and General Career Interest, F(1, 82) = 4.80, p = .03.

Demand Differences

A t-test on the demand measure indicated significantly higher ratings for the technology education course in comparison to than the art course, t(147) = 3.54, p = .001.

Treatment Effects

Table 1 summarizes the means and standard deviations produced by the experimental and control treatments on each testing occasion. These data are collapsed over gender and grade because neither variable interacted with treatment on any outcome measure.

Insert Table 1 about here

Three separate MANOVAs were conducted on logically clustered pairs of measures, General Self-Efficacy and General Career Interest comprised the first pair; Specific Self-Efficacy and Career Interest the second; and Intended Career Choice and Intended Major, the third. None of the three 2 x 2 x 2 x 2 (treatment by gender by grade by repeated-measures) MANOVAs yielded any interactions involving treatment and repeated-measures on any outcome measure. Thus, no evidence favoring the experimental treatment appeared in this study.

Effects Unrelated to Treatment

The MAVOVA on General Self-Efficacy and General Career Interest yielded an interaction involving grade and time, F (2, 63) = 3.75, p. = .03. Univariate follow-up ANOVAs indicated that the change occurred in self-efficacy. Following treatment, seventh graders reported greater General Self-Efficacy; eighth grade scores declined, regardless of treatment condition. No other effects emerged

The second MANOVA on Specific Self-Efficacy and Specific Career Interest yielded several interactions, including treatment by gender by grade, $F(2, 60.5) = 3.44$, $p = .04$, and gender by grade, $F(2, 60.5) = 5.51$, $p = .01$. The univariate follow-up effects were on specific career interest. Boys and girls had comparable Specific Career Interest in the eighth grade; however, in the seventh grade, girls' scores were lower than boys were. The MANOVA and follow-up ANOVAs also produced main effects for gender, $F(2, 60.5) = 3.73$, $p = .03$, indicating that Specific Career Interest for girls was lower than for boys. Finally, the MANOVA yielded an anticipated main effect for treatment, $F(2, 61.5) = 4.25$, $p = .02$. Follow-up ANOVAs showed that students in the experimental condition had higher Specific Career Interest for the modules that they selected than did their yoked control counterparts. No other effects emerged.

The final MANOVA on Intended Career Choice and Intended Major yielded a main effect for gender, $F(2,23.5) = 4.32$, $p = .02$, with the follow-up ANOVAs indicating a difference on Intended Major. Girls reported less interest in technical/scientific majors than boys did. No other effects were found.

Discussion

Although the experimental program registered no changes on the outcome measures selected, several observations are in order. In the first place, the experimental program did have a favorable impact on the Demand measure, a device intended to unravel possible placebo influences from other effects. Although the obtained outcome pattern suggests that the program had placebo effects and nothing more, on closer analysis, the Demand items themselves (e.g., pertaining to the importance of the course, its value later in life, etc.) coupled with positive anecdotal evidence from the students indicate the need for further study.

For example, the program's published instructions call for allowing the students the opportunity to select three of 21 modules for further study. Although such a procedure may contribute to favorable program ratings, the students likely selected the modules indicating, relatively speaking, their highest self-efficacy and career interest. It would be interesting to observe if an alteration in the program's procedure would affect the outcome pattern. Would assigning students to modules of low efficacy and interest, for instance, produce beneficial changes in technology and science by providing performance accomplishments in specific novel areas?

It is also worth noting that appropriate career interventions foster a basis for informed decisions, rather than channel students into preselected occupations. In spite of successful performance accomplishments, or indeed because of them, perhaps the program gave the students a realistic basis for tilting in a direction away from technology and science. To be sure, such programs are not developed, marketed, purchased, and adopted independent of the hope that some students will pursue such careers. But perhaps these programs need to be evaluated on the basis of smaller baseline shifts. Even though this study involved 169 students, a relatively large number for a true experimental design, a vastly larger n would be necessary to detect such shifts.

Finally, it should be understood that although the program incorporates elements of self-efficacy theory, it is by no means an adequate operational representation. Modifications that strengthen the treatment may necessary to effect changes on the measures employed. For example, although successful performance accomplishments are purportedly more powerful than modeling experiences, use of the former does not preclude employing the latter. Incorporating the opportunity to watch young and older women succeeding in these nontraditional areas might prove quite beneficial.

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Table 1
Means and Standard Deviations on all Measures for Experimental and Control Conditions on Both Testing Occasions

	Experimental		Control	
Variable	Pretest	Posttest	Pretest	Posttest
General Self-Efficacy				
M	4.65	4.40	4.51	4.74
SD	2.17	2.34	2.01	2.33
Specific Self-Efficacy				
M	5.04	4.94	4.47	4.65
SD	2.44	2.61	2.29	2.62
General Career Interest				
M	1.67	1.61	1.54	1.65
SD	.78	.80	.68	.72
Specific Career Interest				
M	1.93	2.13	1.62	1.65
SD	1.13	1.02	.97	.96
Intended Career Choice				
M	3.31	3.31	3.03	3.10
SD	1.26	1.42	1.64	1.66
Intended Major				
M	3.59	3.83	3.65	3.62
SD	1.27	1.26	1.38	1.38

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