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AUTHOR Morris, Deborah R.; Gredler, Margaret E.; Schwartz, Linda S.
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ABSTRACT

A sample of 72 nuclear power plant operators in requalification training at a southeastern nuclear power facility was studied to investigate the role of trainees' perceptions of their self-regulatory activities in explaining achievement in an industrial training setting. Respondents completed the Self-Regulatory Activities Survey, which was a 46-item questionnaire consisting of the 24 items of the Self-Efficacy for Self-Regulated Learning survey and the 22 items on self-regulatory practices from the Inventory of Learning Styles. The responses were subjected to a stepwise multiple regression analysis with achievement scores as the dependent variable. The hypothesized explanatory variables were educational level, years of experience, operator classification, and each of the five factors of the Self-Regulatory Activities Survey. The scores ranged from 13 to 20, the mean for achievement was 17.37, and the standard deviation was 1.90. The stepwise regression indicated that, together, the following five variables contributed to 33% of the variance: processing ability, experience, job level, external regulation strategies, and learning strategies. The stability of the self-regulation constructs identified in the training setting was said to be especially important in business and industry as was the finding that learning strategies and information processing strategies can be taught to employees. (Contains 13 references.) (MN)

The Role of Self-Regulated Learning in an Industrial Training Environment

Deborah R. Morris
Duke Energy Corporation

Margaret E. Gredler
University of South Carolina

Linda S. Schwartz
Valdosta State University

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Identifying trainee characteristics that contribute to successful learning is important, given the costs of employee training. In the nuclear power industry, for example, plant operators spend approximately 20% of their time, two weeks out of every ten, in requalification training. Failure to maintain certain numerical grade averages results in placement in remediation or removal from one's job.

One learner characteristic that has received attention in recent years is learner self-efficacy. Introduced by Bandura (1986, 1991), self-efficacy refers to one's beliefs in his or her ability to master difficult situations. Included are self-efficacy for various academic subjects, such as mathematics, and difficult activities, such as giving up smoking.

One aspect of self-efficacy is the learner's beliefs in his other self-regulatory capabilities. Briefly, self-regulation operates through a set of psychological subfunctions: self-observation, self-judgment, and self-direction (Bandura, 1986, 1991). These subfunctions include self-monitoring of one's activities, applying standards to judge and direct one's performance, and using appropriate strategies to achieve success (Zimmerman and Martinez-Pons, 1986, 1988, 1990).

Research on learners' beliefs in their self-regulatory capabilities (referred to as efficacy of self-regulated learning) indicates a positive correlation with achievement in school and college settings (Zimmerman and Bandura, 1994; Zimmerman, Bandura, and Martinez-Pons, 1992; Williams, 1996). However, little research on this student characteristic has been conducted in the industrial setting. In one study, Vermunt and van Zuilichem (1992) found that perceptions of self-regulatory activities were related to

functional levels in the organization. Participants in the study were 263 workers in a European cigarette factory.

The purpose of the present study was to (1) investigate the role of trainee perceptions of their self-regulatory activities in explaining achievement in an industrial training setting, and (2) determine the nature of the constructs measured by the Self-Regulatory Activities Survey.

Sample

Seventy-two nuclear power plant operators in requalification training at a southeastern facility participated in the study. Thirty-six were licensed reactor operators, and thirty-six were licensed senior reactor operators. Employees in the entry level position, nonlicensed operators, were not included because they did not participate in the same classroom instruction. Mean number of years at the current job level was 6.86 for reactor operators and 9.15 for senior reactor operators. The median educational level was college non-degree.

Instrumentation

Self-regulation of learning was measured by a 46-item questionnaire. The questionnaire consisted of two scales: Self-Efficacy for Self-Regulated Learning (SESRL) (24 items) (Gredler and Schwartz, 1996) and 22 items on self-regulatory practices from the Inventory of Learning Styles (Vermunt, 1992). The researcher obtained permission from the developers for use of these scales. Some items were modified slightly for the nuclear power plant training classroom. The term "lesson plan materials" was substituted for "textbook," "instructor" was substituted for "teacher,"

"training week" was substituted for "course," and "segment exams" was substituted for "test."

The focus of the 46 items was (1) how well learners perceived they execute general self-regulation strategies (11 items); (2) perceived frequency of execution of particular strategies (28 items); and (3) reliance on the sequence of instruction (or instructor) for regulation of one's learning (referred to as external regulation (7 items). Subjects rated each item from "not well at all" or "not at all" or "seldom or never" to "very well" or "very often" or "almost always." The 46-item questionnaire was combined into one instrument and was renamed "Self-Regulatory Activities Survey."

The sample for the investigation of survey components consisted of 571 nonlicensed operators, reactor operators, and senior reactor operators at five nuclear power plants in the southeast. The majority of the sample were male (N = 554) and 17 were female. The median educational level was college non-degree, and the mean number of years in the current job level was 6.5 years.

The reliability of the Self-Regulatory Activities Survey, measured by Cronbach's alpha coefficient, was .83. Cronbach's alpha coefficient also was computed separately for the SESRL and ILS. The coefficients were .84 for SESRL and .64 for ILS. The Pearson product moment correlation for the relationship between scores on the SESRL and ILS scores was .45. A principal components analysis was used to determine the constructs measured by the survey.

The principal components analysis with varimax rotation using a five-factor solution identified five substantive constructs on which 36 of the 46 items loaded at least .40 on only one factor. (The other 10 items were deleted from the instrument.) The

factor categories were named after analyzing the items and defining common characteristics. The constructs, illustrated in Table 1, were Learning Strategies, Organizational and Planning Strategies, Processing Abilities, External Regulation Strategies, and Typical Study Strategies.

Achievement was measured by a 20-item multiple-choice test that was administered to reactor and senior reactor operators. The subjects were tested on integrated control system modification, a new topic for the licensed operators. All classroom tests are written to criteria set by the Nuclear Regulatory Commission and the Institute of Nuclear Power Operations. A passing score is 16 out of 20.

Methods

Research was conducted during the requalification program of nonlicensed, reactor, and senior reactor operators. All employees in these three classifications attend the requalification program to maintain and enhance their knowledge and skills of the nuclear power plant's operations. The program includes classroom instruction, drills and procedures on plant-referenced simulators, and examinations.

One researcher administered the Self-Regulatory Activities Survey on the first day of the operators' training week (Classroom Segment One) in July 1996. Thirty minutes were allotted on the requalification schedule for this activity. To counterbalance the administration of the SESRL and ILS, one-half of the survey forms began with items from the SESRL (Form A). The other half began with items from the ILS (Form B). The nuclear instructor administered the achievement test on Friday of the training week which addressed integrated control system modification.

A stepwise multiple regression was conducted with achievement scores as the dependent variable. The hypothesized explanatory variables were educational level, years of experience, operator classification (reactor or senior reactor operator), and each of the five factors of the Self-Regulatory Activities Survey.

Results

The mean for achievement was 17.37, and the standard deviation was 1.90; scores ranged from 13 to 20. Stepwise regression indicated that five variables significantly contributed to achievement variance. They are Factor III-Processing Ability (11%), experience (8.5%), job level (7.2%), Factor IV-External Regulation Strategies (3.8%), and Factor I-Learning Strategies (3.1%) for a total of 33% of the variance. Correlations between the explanatory variables ranged from -.16 to +.17, indicating that multicollinearity is not a problem.

Educational Importance

Two findings are of importance to training in business and industry. One is the stability of the self-regulation constructs identified in the training setting. Specifically, (1) three factors, General Organizational and Planning Strategies, Processing Ability, and Typical Study Strategies are the same constructs identified in a prior analysis of the 24-item SESRL (Gredler & Schwartz, 1997); and (2) the two constructs External Regulation and Learning Strategies are the constructs previously identified by Vermunt (1992) as external regulation and self-regulation. [The five items of one other SESRL factor, Task Preparation Strategies, did not load on any factor in this study. These items refer to out-of-class (outside-of-training) study activities. Such activities are not relevant

for the classroom segments of requalification training because in-class study time is allocated throughout the training week.]

The second key finding is that three of the contributors to post-test performance are manipulable. That is, learning strategies, making use of important sequential points in instruction, and processing strategies, such as ways to remember information, can be taught to trainees.

Recommendations

Nuclear power training settings are highly structured with instruction closely aligned to plant responsibilities. The requalification participants are immersed in the subject matter, meaning the content taught is directly applicable to the work environment. In such settings, the items on Factor I-Learning Strategies, Factor III-Processing Ability, and Factor IV-External Regulation Strategies are important.

In less application-oriented learning situations which require study outside of training, the complete Self-Regulatory Activities Survey should be used because of the inclusion of organization and planning strategies, task preparation, and typical study strategies.

A limitation of this study is that measures of subject characteristics that may account for some of the unexplained achievement variance were unavailable; specifically, verbal and quantitative reasoning and reading level. Future research should, when possible, include these variables.

Table 1. Constructs identified in the principal components analysis of the Learning Activities Survey (N = 571)

Factor	No. of Items	Examples
I. Learning Strategies	10	Think about the best ways to study a lesson; test learning by restating the main points
II. Organization and Planning Strategies	8	Plan your study time; arrange a place to study without distractions
III. Processing Ability	7	Remember information presented in class
IV. External Regulation Strategies	8	Study the subject matter in the same order as presented in class
V. Typical Study Strategies	3	Write things down you want to remember; reread notes when preparing for an exam

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