DOCUMENT RESUME

ED 309 959 SE 050 796

AUTHOR Nolen, Susan Bobbitt; Haladyna, Thomas M.
TITLE Psyching Out the Science Teacher: Student Motivation, Perceived Teacher Goals and Study Strategies.
PUB DATE 89
NOTE 29p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, March 27-31, 1989).
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Academic Aspiration; *Educational Objectives; High Schools; Learning Motivation; Models; Path Analysis; Research Design; Science Education; *Science Teachers; *Secondary School Science; *Student Attitudes; *Student Motivation; Study Skills; Surveys; *Teacher Influence

ABSTRACT

This paper describes a model of the influence of personal and environmental factors on students' valuing of two deep-processing strategies for studying expository texts. In the model, task orientation (a form of intrinsic motivation in which learning and understanding are the major goals) interacts with perceptions of the teacher's goals to influence both subsequent task orientation and strategy-value beliefs. Questionnaire data from 281 high school science students, collected near the beginning and end of a school year, were used to test the model. The questionnaires included measures of two additional variables thought by other theorists to influence study strategy use: perceived ability and attitude toward science. Individual differences in the initial level of students' task orientation appear to exert a powerful influence, both on later motivation and on their belief in the value of deep-processing strategies. Perceptions that their teacher wanted them to think independently as well as thoroughly master the material appear to positively influence both students' task orientation and their strategy-value beliefs over the course of a school year. Neither perceived ability nor attitude toward science added significantly to the model's explanatory power. The theoretical and practical implications of these findings are discussed, with an emphasis on the potential for teachers to affect student goals and strategies for studying science. (Author)

Psyching Out the Science Teacher: Student Motivation, Perceived Teacher Goals and Study Strategies

Susan Bobbitt Nolen
Thomas M. Haladyna
Arizona State University, West Campus

Paper presented at the annual meeting of the American Educational Research Association, March 26-31, 1989, San Francisco.

This project was supported in part by a Faculty Grant-in-Aid to the first author and by a Research Incentive Award, both from Arizona State University. Thanks to Bonnie Thompson, her colleagues and their students for assistance in data collection; and to John Nicholls and Theresa Thorkildsen for helpful comments on earlier drafts of this article.

RUNNING HEAD: Psyching out the science teacher

Abstract

This paper describes a model of the influence of personal and environmental factors on students' valuing of two deep-processing strategies for studying expository texts. In the model, task orientation (a form of intrinsic motivation in which learning and understanding are the major goals) interacts with perceptions of the teacher's goals to influence both subsequent task orientation and strategy-value beliefs. Questionnaire data from 281 high school science students, collected near the beginning and end of the school year, were used to test the model. The questionnaires included measures of two additional variables thought by other theorists to influence study strategy use: perceived ability and attitude toward science. Individual differences in the initial level of students' task orientation appear to exert a powerful influence, both on later motivation and on their belief in the value of deep-processing strategies. Perceptions that their teacher wanted them to think independently as well as thoroughly master the material appear to positively influence both students' task orientation and their strategy-value beliefs over the course of a school year. Neither perceived ability nor attitude toward science added significantly to the model's explanatory power. The theoretical and practical implications of these findings are discussed, with an emphasis on the potential for teachers to affect student goals and strategies for studying in science.

Psyching Out the Science Teacher:

Student Motivation, Perceived Teacher Goals and Study Strategies

Studying is a ubiquitous part of formal education, at least at secondary and post-secondary levels. Students are generally expected to learn at least part of the content of courses in science, history, civics, psychology, and the like by reading expository text. In keeping with the current interest in learning strategies, researchers have sought ways to turn less-effective studiers into proficient ones by teaching them better study strategies (Levin, 1986).

Studying activities are mostly self-directed, carried out without direct guidance from instructors (Thomas & Rohwer, 1986). Researchers are, therefore, showing increased interest in <u>why</u> students choose to employ (or not to employ) specific strategies while studying. One factor influencing this decision is the studier's belief in its strategic value. In other words, "Will this strategy help me to attain my goal?" Paris, Newman and McVey (1982), Nolen (in press), Schunk & Rice (1987), and others have demonstrated that strategy-value beliefs influence students' spontaneous use of these strategies while studying. The aim of this study is to identify factors that influence students' beliefs in the value of effective study strategies.

To this end, a model of the determinants of students' strategy-value beliefs was developed and tested. The proposed model incorporates the influences of two kinds of goals for studying: what the student wants to accomplish and what that student thinks his or her <u>teacher</u> wants students to accomplish. Given students' entering opinion of the usefulness of these strategies, how do these two sets of goals influence students' opinions over the course of the school year? The longitudinal nature of the study allows us to explore what is probably a gradually-progressing interaction of students' motivational orientation and perception of teacher goals over an extended period of time.

Effective strategies for studying science texts.

Levin (1982, 1986) argues that the effectiveness of a study strategy depends upon the task. Strategies needed for understanding the main idea of a passage differ from those useful for remembering details and facts. In the present study we are concerned with science students studying expository text (textbook chapters). We focus on two types of study strategies, which, when used together, are thought to promote deep processing of textual information (Anderson, 1980; Entwhistle & Ramsden, 1983).

Elaboration strategies, or integrating new information into that which has been previously learned, include "figure out how it fits in with what you learned in class" and "figure out how the information might be useful in the real world." Elaboration strategies improve learning and recall by helping students to construct meaningful connections among related concepts. At the same time, students must monitor their ongoing comprehension and memory in order to make appropriate use of elaboration strategies. Monitoring includes such strategies as "asking yourself questions while you read to make sure you understand" and "stopping once in awhile to see if you can remember what you just read." Taken together, students' views about these two types of strategies were used in this study to measure their beliefs about the usefulness of effective study strategies.

This focus is congruent with recent national concern for the outcomes of science education. The National Science Teachers Association, the National Science Foundation, and the National Science Board have stated that one of the major priorities of science educators should be to help all students integrate what they learn about science and technology with their understanding of their world and their knowledge of societal issues (Brunkhorst & Yager, 1986). To fulfill this goal, we must identify factors that lead science students to believe that study strategies that promote this meaningful integration are useful.

Potential determinants of strategy-value beliefs.

Task orientation and study strategies. Recent research (Nolen, in press; Nolen & Haladyna, in press) has provided evidence of a relationship between students' motivational orientation or goals for learning and their beliefs about and use of effective strategies. This research demonstrated that task orientation, a goal of learning and understanding for its own sake, is related to valuing and use of study strategies that depend on deep processing of information. This is consistent with evidence that task orientation, more than other orientations (e.g., ego orientation), is related to significant adult accomplishment (Nicholls, 1988; Spence & Helmreich, 1983). The present study sought to measure both the influence of initial individual differences in task orientation on subsequent orientation and strategy beliefs, and the influence of environmental factors on task orientation.

Although Nolen (in press) identified a relatively stable trait-like task orientation in her subjects, she also found evidence for a situation-specific differences in the expression of this orientation. Thus a student's level of task orientation for a subject could change over time in response to environmental factors that either encourage or discourage learning for its own sake. One of these influences may be students' perceptions of their teacher's goals for student learning.

Perceptions of teacher goals. Because teachers have the final say on such indicators of academic success as student grades, it seems reasonable that students seek information and form opinions about "what the teacher wants." Students adept at thus "figuring out the teacher" presumably use this knowledge to predict test content, enabling them to tailor their study strategies to fit the task. Rickards and Friedman (1978), for example, found that reading notes taken by students expecting an essay examination were qualitatively, but not quantitatively, different than those taken by students expecting a multiple choice test. The latter focused their notetaking efforts on facts and details, while those expecting essay tests concentrated on information of higher structural importance, such as main ideas and topic sentences.

Teacher statements about the purpose of learning or studying may also influence student studying goals. Nolen (in press) suggested that the success of some strategy training programs in promoting spontaneous transfer of text-comprehension strategies (see, e.g., Palincsar, 1986) was due, in part, to trainees adopting the goals trainers repeatedly emphasized: increasing one's understanding and memory for textual information. We predicted, therefore, that if students think that the teacher wants them to understand material and relate it to their own lives, as well as to think creatively and independently about it, they will come to value strategies (like monitoring and elaboration) that lead to those goals.

In related research, Ames and Archer (1987) reported that, for the academically advanced students in their sample, "class goal orientation" was related to students' reported habitual use of study strategies, including monitoring, planning and elaboration strategies. Unfortunately, their class goal scales (mastery vs. performance) included items referring to the individual ("In this class I work hard to learn"), the teacher ("The teacher wants us to try new things"), and other students ("Students feel bad when they do not do as well as others"). By combining items with different referents, the meaning of the scale becomes unclear. In the present study personal task orientation and perceptions of teacher goals were measured separately, rather than combined. Although both of these are individual difference variables, students' perceptions of teacher goals should be more directly influenced by teacher behavior. To understand the teacher's role in the evolution of strategy-value beliefs, it is important to investigate their relationships to these two variables separately.

Rather than investigate either the teachers' behavior or their professed goals for student learning, we have concentrated on their students' <u>perceptions</u> of those goals. Ryan and Grolnick (1986) suggest that it is necessary to assess the "functional significance of the environment for the individual when concerned with the effects of the environment on self-related variables" (p.557). In essence, as each child perceives the environment differently, their interpretations of teacher behavior, rather than the behaviors themselves, would influence students' goals and their views about the value of certain strategies.

Although perceptions of teacher goals may influence a students' goals and strategies, it also seemed likely that students' personal goals (their motivational orientation) influence their perceptions of teacher goals. Nicholls, Patashnick & Nolen (1985), for example, found that students' personal goals tended to be congruent with their beliefs about what strategies generally lead to success in school. This finding is consistent with research indicating that individuals seek and recall information that supports their beliefs (Nisbett & Ross, 1980; Snyder & Cantor, 1979; Swann & Reid, 1981). Therefore the potential influence of individual differences in task orientation on students' perceptions of the teacher's goals was incorporated into the model.

The proposed model, then, contains five latent variables: (1) initial task orientation, (2) initial strategy-value beliefs (3) perceived teacher goals (4) year-end task orientation, and (5) year-end strategy-value beliefs (see Figure 1).

Figure 1 about here

Additional influences on strategy-value beliefs

In addition to the five variables in the model proposed here, previous researchers have suggested other potential influences on students' beliefs about the usefulness of learning strategies. To more fully test the adequacy of the model, two of these variables and their associated measures (shown with broken lines in Figure 1) were included in an expanded version, and then tested for their contribution to the its explanatory power.

Under various labels, students' perceived ability has been included in previous models of strategy use (Ames & Archer, 1987; Dubois, 1987; Blumenfeld & Meece, 1987; Pintrich, 1987; Schunk, 1987; Thomas & Rohwer, 1986). In general, students who feel competent or able to learn are thought to be more strategic in their approach to learning, because they expect those strategies to help them be successful (Brown, in press). If this hypothesis is correct, there should also be a positive relationship between perceived ability and strategy-value beliefs. To test this idea, perceived ability was added to the model.

Attitude toward science is another variable that has been widely studied (see Haladyna & Shaughnessy, 1982; Schibeci, 1983; Schibeci & Riley, 1986). Attitude toward science (interest in science and importance of science learning) may influence strategy-value beliefs in ways separate from motivational orientation. Students who feel successful when they learn in science class may vary in interest and liking for science, which may in turn affect the extent to which they feel it is useful to employ effortful study strategies (Brown, in press). Attitude was added to the model to examine its role in determining strategy-value beliefs.

Method

Subjects

Subjects were 281 high school science students (9th through 12th grade) in 20 classrooms in a suburban/rural high school in the Southwest. The sample ranged from 13 to 18 years of age, and was 56.8% white, 29.5% Hispanic, and 13.7% other minority groups.

Measures

Each latent variable was measured by two instruments drawn from previous work by the authors and others (Nicholls, et al., 1985; Nolen, in press; Nolen & Haladyna, in press). Items from each measure were grouped into conceptually-based subscales, and these structures were then verified using LISREL VI confirmatory factor analysis procedures (Jöreskog & Sörbom, 1985). Items on all but one scale asked for agreement ratings on 5-point Likert scales (5 = Strongly Agree, 1 = Strongly Disagree). The Perceived Ability Scale used 7-point scales, anchored by "Excellent" (7) and "Very Poor" (1). Item means and standard deviations, internal consistency reliability (alpha) coefficients and factor loadings (lambda) for the component subscales of each measure are shown in Table 1.

Table 1 about here

Strategy-Value Beliefs. Students' beliefs about the usefulness of strategies were measured by presenting a list of things students might do if they wanted to learn and understand a chapter in a science text. Students were asked to rate, on a 5-point Likert scale, their agreement that each strategy was useful when one "really wanted to learn and understand something in a science text." The survey was a modified version of one used by Nolen (Nolen, in press, 1987; Nolen & Haladyna, in press). Scores on the survey's scales have in these studies been shown to have acceptable reliability (alphas ranging from .60 to .90), and to correlate positively with both student self-reports and observations of studying behavior. We used two of these scales that measure views about deep-processing strategies: (1) Monitoring of comprehension and memory (e.g., "...stop and ask myself questions to see if I understand," and (2) Elaboration of ideas (for example, "...try to figure out how it fits in with what I've already learned in science class.")

Task orientation was measured using an adaptation for science classes of the motivational orientation survey developed by Nicholls, Patashnick & Nolen (1985). Scales from this survey have been used in a number of studies of student motivation (Nicholls, in press; Nicholls, Cobb, Wood, Yackel,& Patashnick, 1988; Nicholls & Thorkildsen, 1987; Thorkildsen, 1988) and have been found to have acceptable internal consistency reliability. That these studies have found that the measure relates to measures of related variables in theoretically predictable ways attests to its construct validity.

In the version used here, students indicate their agreement on a 5-point Likert scale with statements about what makes them feel successful in science class. In the present study, students responded to items from four subscales of the survey: Task Orientation I and II, Ego Orientation, and Work Avoidance. Because of their past relationship to strategy use and strategy-value beliefs, only the two Task Orientation scales are analyzed here. Task Orientation I included items that indicated pleasure in learning through hard work (e.g., "I feel most successful if I solve a problem by working hard."). Task Orientation II items indicated feeling successful when learning and thinking about new information (e.g., "I feel most successful if I get a new idea about how things work," or "...if I learned something interesting;").

The two attitude scales measured students' Interest in Science and their perceptions of the Importance of learning about science. A third scale (Perceived Ability) asked students to evaluate their ability to do a variety of school science tasks (e.g., taking tests, lab work, etc.).

In the spring, two sets of scales were added to those administered in the fall. Items in the Perceived Teacher Goals Scales asked students to rate their agreement with statements about their teacher's goals. Two scales predicted to be related to both strategy-value beliefs and task orientation were used in the analyses: (1) Mastery and integration of material, and (2) Independent Thinking (e.g., teacher wants us to ask good scientific questions, to solve problems on our own).

Procedure

Students voluntarily completed surveys in their regular science classrooms during the third week of school in the fall, and again in late April of the same school year. Survey administration took between 20 and 25 minutes in each class; directions were read to students and also provided in the survey booklet.

Students were told that their opinions were important, and that anonymity of responses would be preserved. All but two measures were given in both fall (mid-September) and spring (late April) of the same academic year. The exceptions to this were the Perceived Teacher Goals scales. Because these were assumed to depend on extended experience in the classroom over the school year, they were administered only as part of the spring survey.

Analysis

After confirmatory factor analysis, mean item responses for each subscale were computed for each student. Using the maximum likelihood method in LISREL VI, and procedures described in Jöreskog & Sörbom (1985), variables presumed to influence either task orientation or strategy-value beliefs, or both, were tested for contributions to the model. Variables that were not related to these two outcome variables were eliminated from the model. Then canonical correlation and multiple regression analyses were used to determine the predictive power of the model for the total sample and for several subsamples.

Results

Evolution of the model

Figure 1 shows the proposed model, with the addition of perceived ability and attitude, variables which various researchers have suggested might influence students' motivation and beliefs about strategy value. (LISREL VI) analysis led to the deletion from this expanded model of latent variables that were not significantly related to either beginning or year-end strategy-value beliefs, and paths which were statistically non-significant. The latent variables *perceived ability* and *attitude toward science* were stable over the course of the year (for fall to spring *perceived ability*, gamma = .68, for *attitude*, gamma = .66). Although both *attitude toward science* and *perceived ability* were correlated with *task orientation* in the fall (phi = .79 and .46, respectively), neither appeared to have an effect (direct or indirect) on *strategy-value beliefs* either in the fall or spring. This is consistent with previous work (Nicholls, in press; Nicholls, et al., 1985; Nolen, 1988; Nolen & Haladyna, in press) in which perceived ability has not been strongly related to motivational orientation or strategy-value beliefs. The relationship of *task orientation* to both *perceived ability* and *attitude* evident in the fall was not repeated in the spring. In fact, except for their stability over time, the only significant relationship involving these two variables in the spring was a moderate positive relationship (beta = .44) between *perceived teacher goals* and *attitude toward science*. Because neither *attitude* nor *perceived ability* added to the model's power to explain strategy-value beliefs, they do not appear in the final version.

Figure 2 about here

The final model

As can be seen in Figure 2, the final LISREL model is similar to the one predicted (Figure 1). Path coefficients indicate the strength of the relationship between latent variables (in circles). Arrows from latent variables to observed scores on measures (in boxes) indicate their loadings on those variables. In the model, fall *task orientation* affects spring *task orientation* both directly, and indirectly through *perceived teacher goals*. Although a teacher's actions undoubtedly influence these perceptions, it seems clear from this strong relationship that students' task orientation colors their perceptions of what the teacher is trying to achieve.

Subsequent orientation seems to be influenced both by students' initial (general) task orientation and by their (situationally influenced) teacher goal perceptions. The combined effect of direct and indirect influences (total effect) of initial *task orientation* on later *orientation* was .57; the total effect of *perceived teacher goals* on spring *task orientation* was .46. Similarly, their beliefs about which strategies are useful in promoting learning and understanding are influenced by both fall *task orientation* (total effect = .54) and their perceptions of their teachers' goals (total effect = .51).

Goodness-of-fit was calculated for both the total sample and for two subsamples of the data, using procedures described by Jöreskog and Sörbom (1985). Ninth-graders (13-15 year-olds) and those eleventh- and twelfth-graders (16-18 year-olds) enrolled in regular (i.e., not remedial) science classes were analyzed separately. The goodness-of-fit, adjusted goodness-of-fit, and residual mean square error for each sample are (respectively): .900, .804, and .062 for the total sample (N = 281); .863, .730, and .074 for freshmen (n = 129); and .910, .815, and .086 for juniors and seniors (n = 89), indicating a good fit of the model to the data from different sub-populations. Although the strengths of relationship vary somewhat from group to group, most paths had significant associated T values ($p < .001$) for all groups. (The exceptions to this were for the older group, the path from fall to spring strategy beliefs; for freshmen, the direct effect of perceived teacher goals on strategy-value beliefs; neither were significant ($p > .05$).

Explanatory power of the model was assessed using canonical correlation analyses. Canonical analysis is a multivariate technique that computes the correlations between linear combinations (canonical variates) of two sets of variables (see Cooley & Lohnes, 1971; Pedhazur, 1982, Thorndike, 1978). Here we estimated the relationship between the set of two spring strategy-value belief scale scores and the set of six scale scores expressing the three most influential latent variables (fall and spring *task orientation*, and *perceived teacher goals*). Two sets of canonical variates were formed for each sample.

Table 2 about here

The results of the canonical analyses are shown in Table 2. For the total sample (N = 281), only the first function explained a significant proportion of the shared variance between its canonical variates (R_c^2 = .509). (Cooley & Lohnes (1971, p.176) and Thorndike (1978, p. 183) suggested that only squared canonical correlations greater than .10 be considered meaningful.)

Although R_c^2 estimates shared variance among the linear combinations of variables, it does not measure variance in strategy scale scores explained by the six measures in the other variable set. As a further check on the meaning of the canonical correlation, the redundancy index (Miller, 1969 (cited in Pedhazur, 1982); Stewart & Love, 1968) was used to measure this shared variance for each canonical function (see Table 2). For the total sample, approximately 45% of the variance in strategy scale scores was accounted for by task orientation and teacher goals scores. As suggested in Pedhazur (1982) and Thorndike (1978), these findings were cross-validated by analyzing data from three different sub-groups: students in accelerated and in basic 9th-grade science classes, and 11th- and 12th-grade students in regular science classes. Table 2 shows that results for each subsample were essentially similar to those obtained for the total sample. In addition, canonical structure for each subsample was quite similar to the structure of the variates obtained for the total group.

Discussion

The results of this study lend support to the proposed model of the determinants of strategy-value beliefs. Both students' goals (level of task orientation) and their perceptions of their teachers' goals (for students to master content and think independently) appear to influence subsequent task orientation, as well as beliefs in the value of effective strategies while studying. Furthermore, these two variables account for a substantial proportion of the variance in strategy-value beliefs in both the total sample and various subsamples of the data.

The data presented here increase our understanding of the interaction between individual differences in student motivational orientation and their perceptions of environmental conditions in the classroom. Individual differences in student task orientation (measured at the beginning of the year) had a fairly strong influence on both spring orientation and student perceptions of teacher goals. It is apparent from the data, however, that teachers also have an opportunity to influence student task orientation and strategy-value beliefs. This finding is consistent with the hypothesis (Brown, 1988; Nolen, 1988) that teacher's goal statements promoting understanding as an important goal may have contributed to the success of some study strategy-training programs. It is important now to identify the antecedents of students' perceptions of their teachers' goals, so that we can use this knowledge to enhance student motivation in ways that lead to the valuing of effective study strategies.

The variables that were tested and deleted from the model also have theoretical significance. Although attitude toward science related to task orientation, and later to perceived teacher goals, it did not predict students' strategy-value beliefs. Apparently being interested in science and believing in its importance are not sufficient to cause students to believe in the usefulness of monitoring and elaboration strategies. Task orientation embodies a goal of understanding in science class, and a willingness to expend the required effort. It would appear that strategy-value beliefs are influenced more by these factors than by a general positive attitude toward science.

Similarly, perceived ability, although correlated with task orientation in the fall, did not appear to influence students' strategy-value beliefs. This supports similar findings reported by Nolen (1988). Although ability doubtless influences the skill with which these strategies are used (see Brown, Bransford, Ferrara & Campione, 1983), neither study found a link between perceived ability and beliefs in the value of using effective strategies. This is an important consideration, as knowledge of how to use strategies will only be beneficial if students value the goal to which these strategies lead. The results reported here support the contention that students also connect the goal of learning and understanding embodied in task orientation with the kinds of strategies likely to lead to that goal.

However, believing that a strategy is valuable doesn't guarantee it will be effectively applied. Paris and Cross (1983) have refered to strategy use as a matter of "skill and will." The present study addresses some of the "will" factors, as strategy-training studies have focused on "skill." The measures used here might be used in future studies to explore the reasons why many students who have learned effective strategies apparently fail to use them spontaneously later.

Caution should be used in interpreting these findings as the sample, although of sufficient size for the analyses, was drawn from a single high school. The effects of school climate on these variables remain at present untested. In addition, future studies should test the generalizability of this theory for subjects other than science that also require students to study expository texts. Some support for the generalizability of the model was provided by the fact that LISREL models and canonical structure was similar across subsamples which differed in age and/or ability.

This study adds to our understanding of the interaction of student traits and controllable environmental variables in determining students' approach to studying in science. Although the motivational orientation that a student brings to school in the fall appears predictive of later orientation and strategy beliefs, it also seems possible that teachers can influence these outcomes by stressing the goals of mastery of content and independent thinking. These goals may be especially important in teaching science, as they appear to encourage students to value monitoring and elaboration strategies. In a world that is increasingly influenced by new developments in science and technology, leading students to value (and use) these strategies should help equip them to keep track of the level of their understanding of scientific and technological information, to fit that information into what they already know, and to relate it to the world around them.

REFERENCES

Ames, C. & Archer, J. (1987). Learning strategies and achievement motivation: products of classroom goal orientation? Paper presented at the annual meeting of the American Educational Research Association, Washington DC.

Anderson, J. (1980). Cognitive psychology and its implications. San Francisco: Freeman.

Blumenfeld, P. C. & Meece, J. L. (1987). Task factors, teacher behavior, and students' involvement and use of learning strategies in science. The Elementary School Journal, 88, 235-250.

Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J. C. (1983). Learning, remembering and understanding. In P. Mussen (Ed.) Manual of child psychology: Vol. 3. Cognitive development. New York: Wiley.

Brown, A. L. (in press). Motivation to learn and understand: On taking charge of one's own learning. Cognition & Instruction.

Brunkhorst, H. K. (1986). A new rationale for science education--1985. School Science and Mathematics, 86, 364-374.

Cooley, W. W., & Lohnes, P. R. (1971). Multivariate data analysis. New York: Wiley.

Dubois, N. (1987). Training students to become autonomous learners. Paper presented at the annual meeting of the American Educational Research Association, Washington DC.

Entwhistle, N. J., & Ramsden, P. (1983). Understanding student learning. London: Croom Helm.

Haladyna, T. M., & Shaughnessy (1982). Attitudes toward science: A quantitative synthesis. Science Education, 66, 547-563.

Jöreskog, K. G., & Sörbom, D. (1985). LISREL VI: Analysis of linear structural relationships by the method of maximum likelihood, user's guide. Mooresville, IN: Scientific Software, Inc.

Levin, J. R. (1982). Pictures as prose-learning devices. In A. Flammer & W. Kintsch (Eds.), Discourse processing (pp. 412-444). Amsterdam: North-Holland.

Levin, J. R. (1986). Four cognitive principles of learning-strategy instruction. Educational Psychologist, 21, 3-18.

Nicholls, J. G. (in press). The competitive ethos and democratic education. Cambridge, MA: Harvard University Press.

Nicholls, J. G., Cobb, P., Wood, T., Yackel, E, & Patashnick, M. (1988). Goals and beliefs in mathematics: Individual differences and consequences of a constructivist program. Unpublished manuscript.

Nicholls, J. G., Patashnick, M., & Nolen, S. B. (1985). Adolescents' theories of education. Journal of Educational Psychology, 77, 683-692.

Nicholls, J. G. & Thorkildsen, T. A. (1987). Achievement goals and beliefs: Individual and classroom differences. Paper presented at the meeting of the Society for Experimental Social Psychology, Charlottesville, VA, October, 1987.

Nisbett, R., & Ross, L. (1980). Human inference: Strategies and shortcomings of social judgment. Englewood Cliffs, NJ: Erlbaum.

Nolen, S. B. (in press). Reasons for studying: motivational orientations and study strategies. Cognition and Instruction.

Nolen, S. B. (1987). The hows and whys of studying: The relationship of goals to strategies. Paper presented at the annual meeting of the American Educational Research Association, Washington, DC.

Nolen, S. B., & Haladyna, T. H. (in press). Motivation and studying in high school science. To appear in The Journal of Research in Science Teaching.

Palincsar, A. S. (1986). The role of dialogue in providing scaffolded instruction. Educational Psychologist, 21, 73-98.

Paris, S. G., Newman, R. S., & McVey, K. A. (1982). Learning the functional significance of mnemonic actions: A microgenetic study. Journal of Experimental Child Psychology, 34, 490-509.

Pedhazur, E. J. (1982). Multiple regression in behavioral research: Explanation and prediction (2nd Ed.). New York: Holt Rinehart.

Pintrich, P. R. (1987). Motivated learning strategies in the college classroom. Paper presented at the annual meeting of the American Educational Research Association, Washington, D. C.

Rickards, J. P., & Friedman, F. (1978). The encoding versus the external storage hypothesis in note taking. Contemporary Educational Psychology, 3, 136-143.

Ryan, R. M., & Grolnick, W. S. (1986). Origins and pawns in the classroom: Self-report and projective assessments of individual differences in children's perceptions. Journal of Personality and Social Psychology, 50, 550-558.

Schibeci, R. A. (1983). Selecting appropriate attitudinal objectives for school science. Science Education, 67, 595-603.

Schibeci, R. A., & Riley, J. P. (1986). Influence of students' background and perceptions on science attitudes and achievement. Journal of Research in Science Teaching, 23, 177-187.

Schunk, D. H. (1987). Domain-specific measurement of students' self-regulated learning processes. Paper presented at the annual meeting of the American Educational Research Association, Washington DC.

Schunk, D. H., & Rice, M. J. (1987). Strategy value information and children's reading comprehension. Paper presented at the annual meeting of the American Educational Research Association, Washington DC.

Snyder, M., & Cantor, N. (1979). Testing theories about other people: The use of historical knowledge. Journal of Experimental Social Psychology, 15, 330-342.

Spence, J. T., & Helmreich, R. L. (1983). Achievement-related motives and behavior. In J. T. Spence (Ed.). Achievement and achievement motives: Psychological and sociological approaches (pp. 10-74). San Francisco: Freeman.

Stewart, D., & Love, W. (1968). A general canonical correlation index. Psychological Bulletin, 70, 160-163.

Swann, W. B., & Reid, S. J. (1981). Acquiring self-knowledge: The search for feedback that fits. Journal of Personality and Social Psychology, 41, 1119-1128.

Thomas, J. W., & Rohwer, W. D. (1986). Academic studying: the role of learning strategies. Educational Psychologist, 21, 19-41.

Thorkildsen, T. (1988). Theories of education among academically able adolescents. Contemporary Educational Psychology, 13, .

Thorndike, R. L. (1978). Correlational procedures for research. New York: Gardner Press.

Table 1.

Item means and standard deviations, internal consistency reliability (alpha) coefficients, and standardized factor loadings (lambda) for each scale.

	Fall				Spring			
Factor/Scale	Item Mean	S. D.	alpha	lambda	Item Mean	S. D.	alpha	lambda
Task Orientation								
Task I	4.08	.63	.68	.83	4.05	.71	.73	.87
Task II	4.02	.64	.76	.82	3.98	.64	.70	.84
Science Attitude								
Interest	2.80	.90	.76	.75	2.74	.93	.70	.74
Importance	3.69	.70	.75	.71	3.55	.85	.84	.89
Perceived Ability								
Written Work	4.22	1.18	.53	.74	4.37	1.32	.59	.80
Other Work	4.53	1.31	.77	.71	4.83	1.37	.77	.74
Strategy-Value Beliefs								
Monitoring	4.11	.59	.74	.70	3.63	.58	.81	.79
Elaboration	3.99	.69	.68	.75	3.50	.71	.75	.72
Perc'd Teacher Goals								
Mastery					3.73	.77	.80	.74
Indep. Thinking					3.70	.72	.66	.85

Table 2.

Results of canonical correlation analyses for total sample (N=281) and three subsamples.

		1st Variate			2nd Variate		
Sample	N	R_c	R_c^2	Rd	R_c	R_c^2	Rd
Total	281	.713	.509	.446	.279	.078	.004
9th grade							
Basic	74	.681	.463	.369	.426	.181	.037
Accelerated	55	.749	.602	.545	.291	.137	.013
11th/12th grade	89	.669	.447	.410	.260	.067	.005

Note: R_c = canonical correlation coefficient. Rd = redundancy index (proportion of variance explained).

Figures

Figure 1. Model (solid lines) plus additional tested variables (broken lines). Straight lines are causal paths; curved lines are correlations between latent variables.

Figure 2. Final LISREL model for total sample (N = 281). T values for all paths are significant at $p < .001$. Method of Maximum Likelihood (ML); standardized solution.

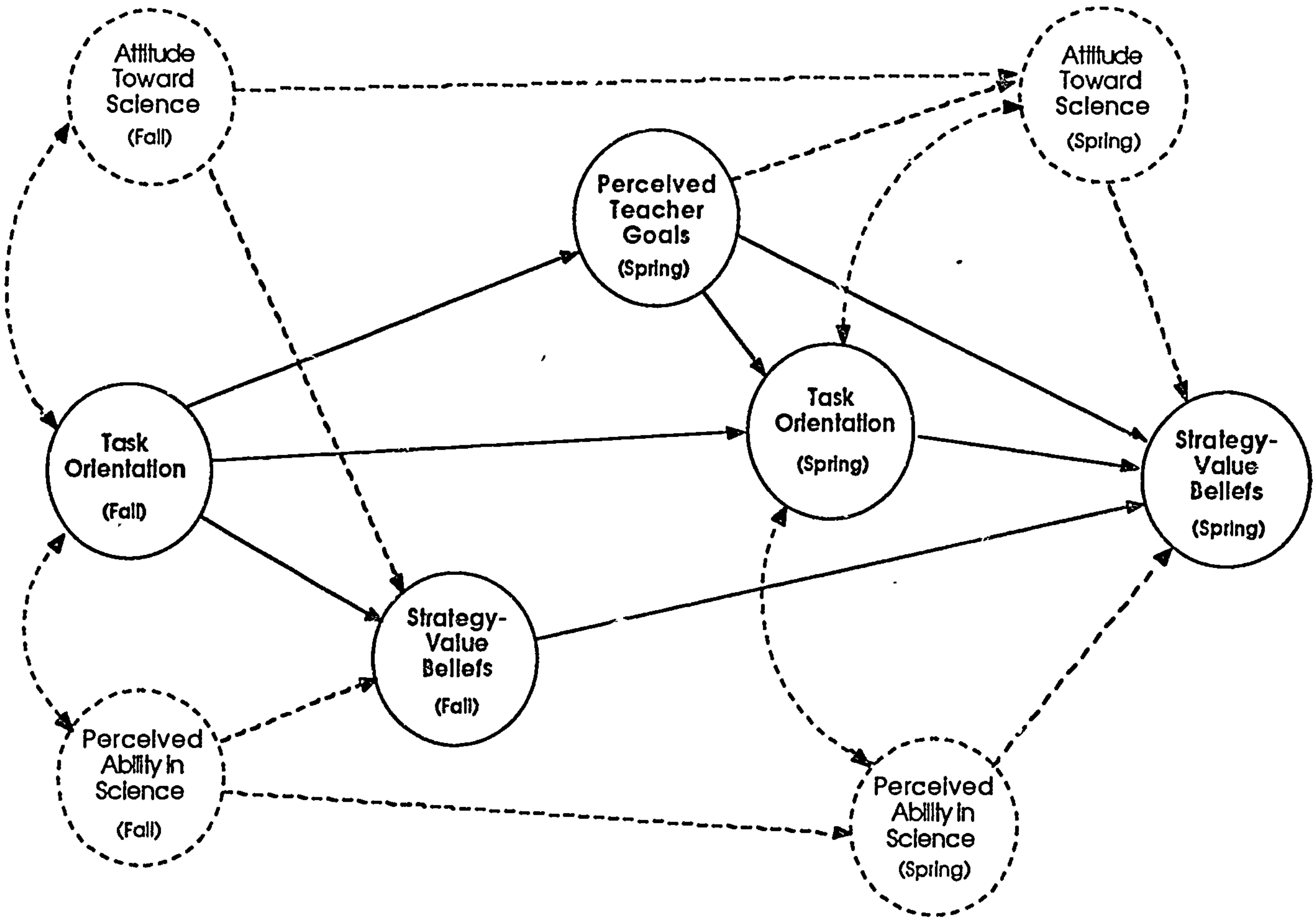

Figure 1. Model (solid lines) plus additional tested variables (broken lines). Straight lines are causal paths; curved lines are correlations between latent variables.

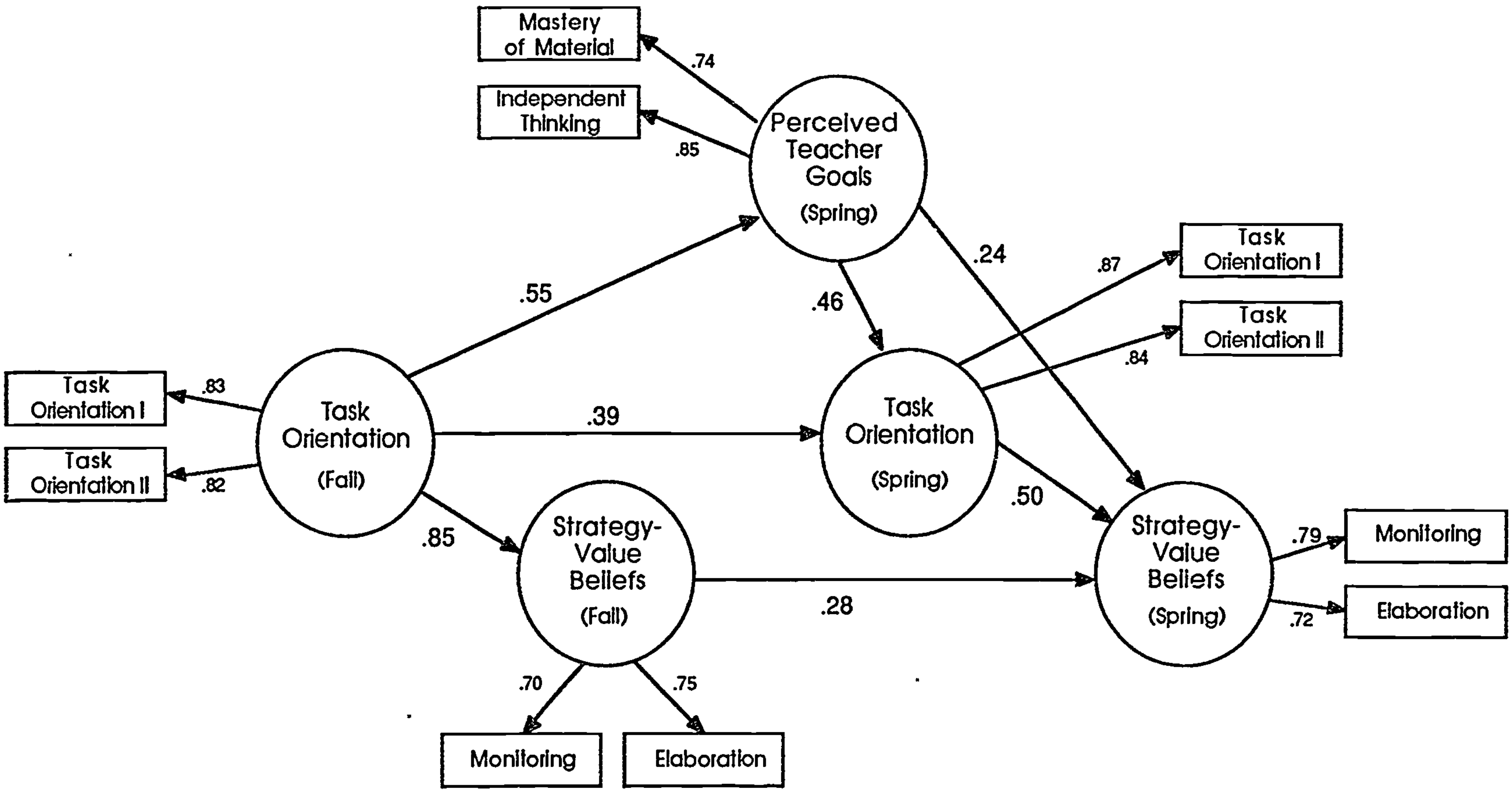

Figure 2. Final LISREL model for total sample (N = 281). T values for all paths are significant at p < .001. Method of Maximum Likelihood (ML); standardized solution.