DOCUMENT RESUME

ED 374 152 TM 022 081

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TITLE	The Relationship between College Students' Study Activities, Content Knowledge Structure, Academic Self-Efficacy and Classroom Achievement.
PUB DATE	Apr 94
NOTE	20p.; Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 4-8, 1994).
PUB TYPE	Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Academic Achievement; Cognitive Processes; *College Students; Correlation; Criterion Referenced Tests; Educational Theories; Higher Education; *Knowledge Level; Learning Strategies; Models; Predictor Variables; *Self Efficacy; *Student Characteristics; *Study; Study Habits
IDENTIFIERS	*Structure of Knowledge; Subject Content Knowledge

ABSTRACT

A theoretical model describes the components of academic studying focusing on antecedents as well as the consequences of studying. This study uses correlational means to explore the relationship among student characteristics, study activities, and outcomes for 42 education majors. Study activities were assessed with a self-report questionnaire. Also determined were academic self-efficacy, success on a concept similarity rating task, prior academic ability (current grade point average), and results of an achievement criterion test. Students with a higher sense of academic self-competence reported more engagement in higher-level cognitive strategies, and more efficacious students tended to perceive the source of engagement in generative processing as coming from their own thoughts rather than an external prompt. However, cognitive strategies by themselves do not add much to test performance for students already possessing strong self-efficacy perceptions. Academic self-efficacy and internal consistency of students' knowledge structures were significant predictors of classroom achievement. Six tables and four figures present study findings. (Contains 30 references.) (SLD)

THE RELATIONSHIP BETWEEN COLLEGE STUDENTS' STUDY ACTIVITIES, CONTENT KNOWLEDGE STRUCTURE, ACADEMIC SELF-EFFICACY AND CLASSROOM ACHIEVEMENT.

BY

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PAPER PRESENTED AT THE ANNUAL CONFERENCE OF THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION

APRIL, 1994
NEW ORLEANS, LA

Academic studying refers to all of the activities, cognitive and behavioral, that students engage in while preparing for, and completing the requirements of their courses. Such activities are engaged in for many different purposes and goals (e.g., preparing for exams, writing term papers, constructing responses to teacher's questions, reading the textbook, etc.), occur within many different contexts (e.g., inside as well as outside the classroom), occur over an extended period of time (e.g., for the duration of a unit of instruction), are primarily under the control of the student (i.e., self-directed or self-regulated), and are often ill-defined (e.g., the criterion is often unclear, students must decide what is important to study).

Current research has focused on students' self-regulated, or autonomous, learning processes and the relationship of these processes to academic achievement and performance. This research, for example, has shown that students vary considerably in the use of cognitive, metacognitive, problem solving and effort management strategies and that this variation is related to classroom achievement and learning (Derry, 1989; Pintrich & DeGroot, 1990; Rohwer & Thomas, 1986, 1989; Wienstein, Goetz & Alexander, 1988; Wienstein & Mayer, 1985; Zimmerman & Pons, 1988).

A theoretical model has been proposed that describes the components involved in academic studying as shown in Figure 1 (Thomas & Rohwer, 1986; Thomas & Rohwer, 1993). The model is unique in that it not only combines both process and component features but also focuses on the antecedents as well as the consequences of studying. According to this model there are four major factors that influence the incidence and the effectiveness of students' studying. Course characteristics include the nature of the content to be learned as well as the nature of demands placed on the student (course requirements and exams, tasks and material) and supports provided to students to meet those demands (Rohwer & Thomas, 1989). Student characteristics include knowledge possessed by the student such as domain-specific and general knowledge or experience, as well as motivational, volition-related factors such as self-efficacy and intrinsic motivation (Alexander & Judy, 1988; Pintrich & DeGroot, 1990; Schunk, 1987, 1990). Study activities include cognitive, metacognitive and effort management strategies and behaviors employed by the student to influence learning, understanding and remembering course content (Rohwer & Thomas, 1987; Wienstein & Mayer, 1985). Outcomes of studying include both products (e.g., students' interpretation of studied information) and capabilities (e.g., students' generalization of that interpretation to a new area). These products and capabilities are measured by classroom achievement tests as well as other kinds of course assignments.

The present study uses correlational means to explore the relationship among three components of this model: Student Characteristics, Study Activities and Outcomes. Specifically, student characteristics include students' subject matter knowledge structure of specific content information, students' academic self-efficacy, and students' prior academic achievement. Study activities include cognitive and effort management activities employed to influence the attainment of academic goals. Outcome includes student performance on a classroom achievement test. The specific model of interrelationships is presented in Figure 2 and described below.

The first set of hypotheses to be explored in this investigation involves the effect of student characteristics on engagement in particular study activities. Studying, to a great extent, involves integrating new information with one's prior knowledge. We expect that students possessing more content relevant, conceptually interrelated knowledge structures, will be more proficient at efficiently learning content and at using study activities (i.e., engaging in higher-level study activities) than less knowledgeable students (Armbruster & Anderson, 1981; Bransford, Stein, Shelton, & Owings, 1981; Brooks & Dansereau, 1983). Also, the structuredness of students' subject matter knowledge is likely to be more crucial when the criterion task demands the construction of higher-order representations and structural relationships for content information (Mayer, 1980). Finally, in as much as studying is a complex cognitive skill, we expect the quality of studying to be affected by prior academic achievement and general academic ability. More successful students tend to use more efficient and productive strategies and to use them more skillfully (Bransford, et al., 1981; Brown, Bransford, Ferrara & Campione, 1983; Brown, Smiley & Lawton, 1978).

Individual differences in students' motivation toward academic achievement is also expected to affect study activity engagement (Thomas, Bol, Warkentin, Wilson, Strage, Rohwer, 1993). In particular, perceived academic self-efficacy has been shown to relate positively to students' choice of study strategy, intensity of cognitive effort and persistence, and goal setting, monitoring, and regulation (Bandura, 1977, 1982, 1993; Stipek, 1988). And, in turn, students' use of a strategy can positively affect their motivation, academic self-concept and perceived efficacy to achieve a goal.

A second set of hypotheses relate to classroom achievement. Achievement is expected to be affected by how students process information and guide their learning efforts toward academic goals. In addition, the effect of other antecedent student characteristics on achievement are expected to be mediated by students' engagement in particular study activities. Finally, these other antecedent factors are expected to directly impact on criterion performance (Bransford, et al., 1981; Brown, et al. 1983; Thomas, et al. 1993).

Specifically, the interrelationships of these variables will be explored with regard to three research questions:

1. How does students' self-efficacy motivation, subject matter knowledge and prior academic achievement affect their engagement in particular study activities?
2. How does students' self-efficacy motivation, subject matter knowledge, prior academic achievement and study activities affect classroom achievement?
3. How well can a structural equation model of the component interrelationships predict classroom achievement?

Method

Participants:

The participants were 42 education majors enrolled in an upper division undergraduate Educational Psychology course. Students received 5 points of course credit. An informed consent letter was obtained from all students prior to the study.

Instruments:

Study Activities   Student's study activities were assessed using a computerized, self-report instrument: Study Activity Questionnaire (SAQ). The construction of the SAQ is based on a theoretical model of the components involved in studying (Thomas & Rohwer, 1993). Two general classes of activities are proposed: cognitive activities for enhancing understanding and memory; and self-management activities aimed at maintaining and enhancing one's concentration, effort, and time devoted to studying (Thomas & Rohwer, 1986; Warkentin, Bol, & Thomas, 1990). The two general classes of activities are further distinguished by six dimensions. Using this model as a blueprint, individual items were constructed for each of the six dimensions creating six SAQ scales. These include:

1-Level of Cognitive Processing. This scale is designed to measure students' engagement in generative skills for transforming to-be-learned information. The construction of the scale delineates a cumulative ordering of complexity in information processing activities ranging from (a) initial encoding of course content, (b) to selecting important ideas, (c) to organizing concepts together, (d) to applying information to ideas outside the classroom.

2-Representation level. This scale is designed to measure the kind of content students focus on during studying. The scale delineates an ordered gradation from (a) lower-level details, (b) to mid-level concepts, (c) to higher-level principles.

3-Initiative. This scale is designed to measure the source of instigation of students' engagement in particular study activities. Students' engagement in particular activities may be assessed on a continuum ranging from (a) receptive (i.e., following an external directive), (b) to reactive (i.e., respond to an external cue), (c) to proactive (i.e., originating from internal, self-directed prompts).

4-Memory Augmentation. This scale is designed to measure the extent to which students' employ strategies for enhancing their memory of to-be-learned information. Such strategies may be assessed on a continuum of complexity ranging from (a) rote rehearsal of terms or words, (b) to more elaborative activities such as constructing charts, tables or graphs, or mnemonics.

5-Autonomous Management. This scale is designed to measure students' engagement in activities that demonstrate active, personal control and agency during learning episodes, such as constructing self-questions, or generating original written summaries of the content.

6-Effort Management. This scale is designed to measure students' disposition to engage in productive thoughts and behaviors to influence one's time, level of concentration, learning effectiveness, and distraction avoidance. Students' use of effort management activities may be assessed on a continuum ranging from (a) monitoring (on-line awareness), to (b) regulating (modifying one's actions), to (c) planning (developing goals and purposes prior to studying), to (d) evaluating (making a value judgement of how well one has done after studying).

Since students' study practices vary according to purpose and context, each item on the SAQ was presented in several different study contexts. Specifically, students were asked how they studied in three contexts: during "routine" studying (e.g., initial reading of the assignment), during in-class activities (e.g., teacher-led sessions), and during test preparation (e.g., out-of-class studying).

In addition, the SAQ was designed to collect students' self-reports interactively, that is, the computer administration allowed items to be skipped for example, if the student indicated not studying in a particular context. The computer controlled a sequential branching process and presented only those items and study contexts to students if they actually indicated engaging in that context. The presentation of items was thus tailored to each student's actual study practices. Also, sampling interactively within several contexts enhanced flexibility and variation in data collection which is a benefit over "linear" paper and pencil administration procedures.

Finally, students' study practices were expected to be affected by the nature of skills and knowledge to be learned during the instructional unit, the nature of task demands and learning requirements imposed on students, as well as teacher-provided supports offered to assist students in their learning during the particular unit of instruction. Therefore, students were told to restrict their self-reports to how they studied for this course and, in particular, the specific instructional unit and classroom test recently completed. Example items are presented in the appendix.

Items on the SAQ were scaled using the Item Response Theory measurement model and computer program called Partial Credit (Masters & Wilson, 1992). Using this measurement model, a student's responses to items are awarded full or partial credit according to a scoring scheme based on an underlying theory of the particular construct being measured. For example, according to our model of studying for the Representation scale, a student who reports focusing on higher-level content, such as principles, is given a higher score (more credit) than a student who reports focusing on lower-level facts and details. Thus, the underlying construct of each dimension (i.e., scale) of the SAQ is specified according to a hypothesis that indicates a cumulative ordering of the variable. Model fit parameters (generated by the Partial Credit algorithm) can be used to assess the degree of congruence between the theoretical specification and the actual responses of the students to the set of items. The overall fit statistic indicates how well the Partial Credit algorithm reproduces the group's actual pattern of responses. Thus, if the overall fit of the model is good, each student's total score on a scale provides a gobal summary of his/her pattern of responses on that scale and provides a criterion reference to the particular items that make up the scale.

Measurement quality is assessed at the individual item and person level also. Item fit statistics indicate how well each particular item functions along with all other items in measuring the same underlying construct. A poor item fit indicates that the item may be bias, vague or tapping a different construct. Person fit statistics indicate how well each person's pattern of response to the items is similar to the pattern derived from the entire group. Poor person fit indicates that the person's response pattern is very different from the group response pattern -perhaps that person misunderstood the items or possesses a different understanding than the group. Thus, the measurement model provides at least two useful functions: First, it supplies information regarding construct validity thus furthering efforts to construct a transparent, criterion referenced variable. Second, the measurement model serves to supervise item and person quality. Further information on the measurement features of the SAQ scales are provided in Warkentin (1994).

Academic Self-Efficacy This scale is intended to measure students' self-perceptions of their academic ability and expectations of classroom success. Students' academic self-efficacy was assessed using items such as "How do you rate yourself in academic ability compared with others in this course?" (Brookover, Erickson, & Joiner, 1967; Covington & Omelich, 1984).

Concept Similarity Rating Task Three current educational psychology textbooks were examined to compile a list of thirty-five concepts from two major domains of learning, Behaviorism and Cognitivism. Five educational psychology professors then rated each concept for importance to the field of educational psychology. Based on these ratings a final set of twelve core concepts were identified to be used in the study. These concepts were: transfer of learning, advance organizers, declarative memory, procedural memory, rehearsal, positive reinforcement, negative reinforcement, punishment, time out, ...

The 12 core concepts were combined to form all possible 66 pairs of concepts to be used by students in the rating task. Students' knowledge structure for these course-specific concepts was elicited by having them rate the similarity of each of the 66 pairs of concepts on a 4-point Likert scale according to degree of similarity, with 1 indicating unrelated or slightly related, to 2 indicating that the concepts share a few characteristics or are somewhat similar in their meanings, to 3 indicating the concepts are moderately to strongly related sharing several important characteristics or being involved directly in the same applications, to 4 indicating that the concepts were synonymous, or that one was a component of the other. The students' professor of the course also completed the same concept rating task.

The ratings were entered in to the Pathfinder scaling algorithm (Schvaneveldt, 1990). Pathfinder provides a graphic representation of the semantic network implied by the subject's ratings of concept interrelatedness, as well as an assessment of the internal stability of the network and its structural similarity to other networks containing the same concepts. Using Pathfinder, each student's semantic network representation of these core concepts was compared to an expert's network representation -their professor's. The graphic similarity between networks, together with the degree of coherence of their structure, was used to index the quality of each student's knowledge of course-specific subject matter content. Structure similarity and structure coherence assume that the ability to perceive the underlying relatedness of concepts is a measure of competence in that domain (Chi, Glaser, & Rees, 1982). Research has shown that a student's network representation of course concepts tends to become more like their teacher's representation after a period of instruction. Additional research has shown that a high degree of correspondence between network representations (i.e., structural similarity) is highly correlated with achievement and that greater coherence of this knowledge structure predicts degree of learning (Goldsmith & Johnson, 1990; Schvaneveldt, 1990). See appendix for an example semantic network.

Prior academic ability: Students' current GPA (not including their grade in the present course) was used.

Achievement Criterion Test: All students completed a criterion test designed to assess factual recall as well as conceptual understanding of the core concepts and application of knowledge to solve relevant problems covered in the target unit. All items were multiple choice format and assessed both Behavioral and Cognitive concepts equally. Students understood that their score on this test was to be counted as part of their overall course grade. Students scores on the criterion test were standardized by transforming them to T-scores.

Procedure:

The data was collected following an instructional unit on the theories of learning (Behavioral and Cognitive views). After completing the unit (approximately 4 weeks) students were administered the criterion test, the computerized SAQ, and the academic self-efficacy questionnaires. Students were told to answer the items with reference to the test they just taken in class. Students were then given the concept similarity rating task. Information on student's GPA was provided by the registrar's office.

Results

Descriptive statistics on the variables is presented in Table 1. Two of the study activities were dropped from the analysis due to low alpha (internal consistency) coefficients.

Influences on study activity engagement

The first research question concerned how student characteristics affect engagement in particular study activities. For this analysis four multiple regressions were performed using students' academic self-efficacy, prior academic achievement (GPA) and knowledge similarity and coherence to predict engagement in each of the four study activities. The results, presented in Table 2, show the standardized coefficients which represent the unique, independent contribution of each factor to engagement.

Three noteworthy findings from these analyses are revealed. First, self-efficacy is significantly related to strategy use -Cognitive Processing (.35) and Initiative (.43). Specifically, students who scored higher on self-efficacy also tended to report engaging in higher levels of processing such as selection, integration and application and to be more self-initiators of these activities compared to students who scored lower on the self-efficacy measure. Second, this relationship is significant even when the effect of students' prior academic achievement and subject matter knowledge (similarity and coherence) is partialed out or accounted for. Third, subject matter knowledge -structure similarity and structure coherence- was not significantly related to students' engagement in particular study activities.

Influences on classroom achievement

The second research question concerned how student characteristics and study activities relate to performance on the criterion test. First, we were interested in how particular study activities relate to classroom achievement. A multiple regression analysis was performed using the four study activity scales as predictors of classroom achievement. The results are presented in Table 3. Standardized coefficients reveal that only the Cognitive Processing scale is significantly related to achievement (.29) although the other coefficients are descriptively in the positive direction.

A second multiple regression was performed to assess the effects of students' subject matter knowledge and prior achievement on criterion test performance. Table 4 presents the results of this analysis. As shown, knowledge coherence -the internal consistency or stability of relationships between concepts- significantly predicts classroom test performance (.30). In addition, a significant and relatively larger relationship is revealed for prior achievement (.39).

A third multiple regression analysis was performed to evaluate the effect of self-efficacy on test performance. Table 5 indicates a relatively strong effect showing that students who reported higher academic self-efficacy scores also demonstrated higher performance on the classroom achievement test (.53). In addition, the magnitude of this relationship is relatively larger than prior academic achievement (.45).

The relationship of all variables to criterion test performance was evaluated in one final multiple regression analysis. The results are presented in Table 6. Once again standardized coefficients are presented indicating the unique effect of each variable on classroom achievement, independent of all other effects. The results reveal that self-efficacy is the best predictor of criterion test performance (.39), followed closely by prior academic achievement (.35), and finally knowledge coherence (.22). Apparently, the effect of study activity engagement is overwhelmed by the magnitude of relationship of these statistically significant variables. In this more comprehensive analysis, which includes all variables, an interesting pattern is revealed. Students' perceptions of their self-efficacy (which includes their expectations for success, self-evaluations to succeed in class) produces a greater effect on achievement than students' subject matter knowledge, prior achievement and study activity engagement.

Structural Equation Modeling Analysis

A structural equation modeling technique was used to test all of the hypothesized relationships between variables in the study as specified in Figure 2. This analysis is similar to the stage-wise presentation of multiple regression just given, but is able to evaluate all of the hypothesized relationships simultaneously as well as provide indicators of model fit. According to this model four major predictions can be made. First, it is expected that prior academic achievement, a student background variable, will affect students' subject matter knowledge, self-efficacy, study activity engagement and achievement. Second, it is expected that students' self-efficacy will affect students' study activity engagement as well as subsequent achievement. Third, students' subject matter knowledge is expected to affect study activity engagement as well as achievement. Finally, it is expected that study activity engagement will affect achievement.

Figure 3 displays the overall results of this analysis. First, the goodness of fit indices indicate that the proposed model (i.e., the set of interrelationships) has acceptable fit. The Chi-square statistic is not significant and the fit indices are close to 1.00. Overall, the model accounts for 64% of the variance in students' achievement test performance (R2 = .64). The relationships that are significant are displayed with solid lines. Standardized coefficients are presented and indicate the relative magnitude of each effect. As can be seen, prior achievement has a significant effect on knowledge similarity and coherence. Self-efficacy has a significant effect on Cognitive Processing and Initiative. Finally, there are three direct effects on achievement, in order of magnitude they are self-efficacy, prior academic achievement, and knowledge coherence.

Conclusion

Self-efficacy has been defined as one's self-perception of academic competence, one's expectation to succeed, or one's perception of progress on an academic task or situation (Stipek, 1988). According to the results presented here, this motivation variable had two significant effects on study activity engagement and achievement. First, students with a higher sense of self-competence in their academic ability tended to report more engagement in higher-level cognitive strategies (Cognitive Processing) such as selecting main ideas, integrating information together and applying information to out-of-class experiences than students with lower ability expectations and self-perceptions. In addition, more efficacious students tended to perceive the source of engagement in these generative processing activities as stemming from their own thoughts (proactive initiative) rather than from an external prompt or cue (reactive or receptive). Both of these findings support prior research at the high-school level (Thomas, Bol, Warkentin, Wilson, Strage, & Rohwer, 1993), and middle school level (Pintrich & De Groot, 1990). Such evidence is consistent with the notion that higher expectations of success lead to higher-level cognitions and more internal self-attributions of agency. The finding is dramatic in that even when other influential factors were held constant, such as prior academic achievement and knowledge structure, self-efficacy had a significant impact on study activity engagement.

However, as shown in the structural equation model analysis, the effect of self-efficacy on Cognitive Processing and Initiative did not realize into an effect on classroom achievement. Instead, self-efficacy contributed a direct effect on achievement and the effect of study activities was diminished to non-significance. Thus, the effect of cognitive strategies on achievement (as shown in the multiple regression analysis) drops out when self-efficacy is included. This puzzling finding indicates that cognitive strategies by themselves do not add sufficiently to test performance for students already possessing strong self-efficacy perceptions.

Second, academic self-efficacy was the overall best predictor of classroom achievement even more so than prior achievement and knowledge coherence. This finding underscores the importance of self-efficacy on achievement. One might speculate why self-efficacy might have such a dramatic relationship to achievement and to study activities. One likely reason is the fact that academic studying is ill-defined (Thomas & Rohwer, 1986). Ill-defined problems by their very nature require individuals to create and clarify their own goals, to monitor their progress more extensively, to check their progress and regulate their efforts, etc. In addition, academic studying is complex, requiring students to carefully orchestrate many aspects of their behavior, thinking and emotions. Academic studying not only requires knowledge and cognitive ability, but the skill to use that knowledge and ability within stressful, taxing situations. Students with high self-efficacy are more likely to successfully cope with these task demands better than less self-efficacious students. Further intervention research might explore methods for improving students' self-efficacy while assessing changes in the quality of student thinking (strategy engagement) and overall classroom performance on achievement tests.

Another significant predictor of classroom achievement was the internal consistency of students' knowledge structure. Those students who rated the core concepts more consistently, tended to answer more test questions correctly. Surprisingly, knowledge similarity was not significantly related to test achievement. The knowledge coherence index is different from the knowledge similarity in the following way. Whereas, similarity is based on configural (graphic) similarity between the students' semantic network and the expert's (i.e., the professor) semantic network of the concepts, coherence is based solely on the each student's own ratings of the set of concepts. Coherence is an index of the degree to which pairs of concepts that are strongly related, and therefore share close configural proximity to each other in the graphic representation, also tend to be more related to adjacent surrounding concepts more than distant, non-adjacent concepts within the students' own structure. Thus students with a high coherence index are non-random in their ratings of the set of concepts -their knowledge of the interrelationships between all concepts tends to from a consistent and reliable organization.

This finding indicates that achievement performance on the present classroom test may have depended not so much on what particular concepts were connected, as it did on attaining a coherent understanding that enabled consistency in thinking and reasoning. Given that all of the concepts were "core," course-relevant ones, and the test specifically assessed knowledge of these specific concepts, this result is understandable. Nevertheless, these results highlight the importance of consistency in knowledge representation. Practically then, instruction that focuses on students' ability to use concepts in a consistent manner, for example, to explain a number of real world phenomena, may be particularly relevant to achievement. For example, recent evidence from science education research has shown the importance of the internal consistency in students' use of explanatory concepts (Roth, 1990).

It should also be noted that typically, explicit measures of students' knowledge organization are not obtained in studies of self-regulated learning even though researchers have commonly acknowledged its importance to achievement, its potential interaction with strategy use, and have recommended including it in investigations (Alexander & Judy, 1988). This investigation attempted to tie specific content knowledge learned and study activities used during a specific unit of instruction, to performance on an achievement test covering that specific content.

The present findings tentatively suggest an important influence of knowledge coherence on test performance that is over and above strategy use. Further research is needed to explore this relationship, perhaps by looking at changes in knowledge structure and strategy use over a more protracted period of time.

Finally, the results indicate that none of the variables other than self-efficacy, produced an effect on study activity engagement. One possible explanation for this is that there was not sufficient variation in students' self-reports on the study activity scales. A close inspection of the scatter plots of student responses on the four study activity scales revealed a possible ceiling effect. Further research, both qualitative and quantitative, must be performed to document the validity of these study activities. Plans to obtain students' self-reports and think-alouds to validate these scales are currently being planned.

Other limitations were also noted. For example, whereas we used 12 core concepts to assess students' knowledge structure, other researchers who found stronger results (Goldsmith & Johnson, 1990) used 30 concepts. In addition, we noticed that many of our students possessed some practical (prior) experience with the behavioral concepts (e.g., positive reinforcement, punishment) from their own experiences as well as from other education and psychology courses (e.g., behavioral management).

Finally, the present study is correlational and the specification of relationships and pathways is largely exploratory. Many of the variables discussed are likely to occur simultaneously, in a reciprocal manner, or interactively within students' thoughts and actions. For example, strategy use may affect learning which in turn can affect students' perceptions or expectations of their competence (self-efficacy) which in turn may lead to greater/lesser strategy engagement. Also, strategies may be employed more or less skillfully depending on general academic knowledge or the nature of the context or content and this in turn may affect student's self-perceptions of ability. In addition, many other factors that affect study activity engagement and achievement (course features, teacher practices) are certainly important. Our main goal here was to assess a set of particular relationships within an ecologically realistic situation. Thus, the main contribution of this study may be to add to our growing knowledge about students' study behavior within natural academic contexts.

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Table 1. Descriptive statistics on the variables.

	Alpha	Mean	SD	Minimum	Maximum
1. Cognitive Processing	.88	.43	1.43	-2.15	3.4
2. Initiative	.82	.67	1.13	-1.47	2.48
3. Representation	.74	.88	1.35	-1.68	3.00
4. Effort Management	.67	.70	1.11	-2.70	2.74
5. Academic Self-efficacy	.62	.93	2.63	-5.89	5.05
6. Knowledge similarity		.30	.10	.10	.50
7. Knowledge coherence		.70	.12	.40	.89
8. Prior acdmc achievement		2.64	.48	1.8	3.79
9. Classroom criterion test		50.00	10.00	30.00	66.00
*10. Autonomous Management	.51				
*11. Memory Augmentation	.52				

*Study activities dropped from analysis:

Table. 2 Multiple regression results using Self-efficacy, Knowledge similarity, Knowledge coherence and Prior academic achievement to predict engagement in study activities. (Standardized coefficients given.)

	Predictors Variables				
Dependent Variables	Self Efficacy	Knowledge Similarity	Knowledge Coherence	Prior academic achievement	R2
Cognitive processing	.33*	.06	.10	.12	.19
Initiative	.41*	.12	.03	-.01	.20
Representation	.29	-.18	-.02	.22	.03
Effort Management	-.12	.24	.14	-.07	-.02

* $p < .05$

Table 3. Multiple regression analysis using the four study activity scales to predict classroom achievement performance.

Predictor Variables	Classroom achievement Standardized Coefficient
Cognitive processing	.29*
Initiative	.30
Representation	.16
Effort Management	.14
$R2 = .58$*	

*$p < .05$

Table 4. Multiple regression analysis using the subject matter knowledge and prior academic achievement to predict classroom achievement performance.

Predictor Variables	Classroom achievement Standardized Coefficient
Knowledge Similarity	.14
Knowledge Coherence	.30*
Prior academic achievement (GPA)	.39*
$R2 = .40*$	

Table 5. Multiple regression analysis using the subject matter knowledge and prior academic a-hievement to predict classroom achievement performance.

Predictor Variables	Classroom achievement Standardized Coefficient
Self Efficacy	.53*
Prior academic achievement (GPA)	.45*
$R2 = .56*$	

Table 6. Multiple regression analyses using Study activities scales, Knowledge similarity, Knowledge coherence, Self-efficacy, and Prior academic achievement to predict Classroom achievement.

Predictor Variables	Classroom achievement Standardized Coefficient	t	p
Cognitive processing	.06	.52	.60
Initiative	.16	1.32	.19
Representation	.06	.59	.55
Effort Management	.06	.63	.53
Self Efficacy	.38*	3.18	.003
Knowledge Similarity	.04	.37	.70
Knowledge Coherence	.22*	1.96	.05
Prior academic achievement (GPA)	.34*	2.82	.008

R2 = .66*
* $p < .05$

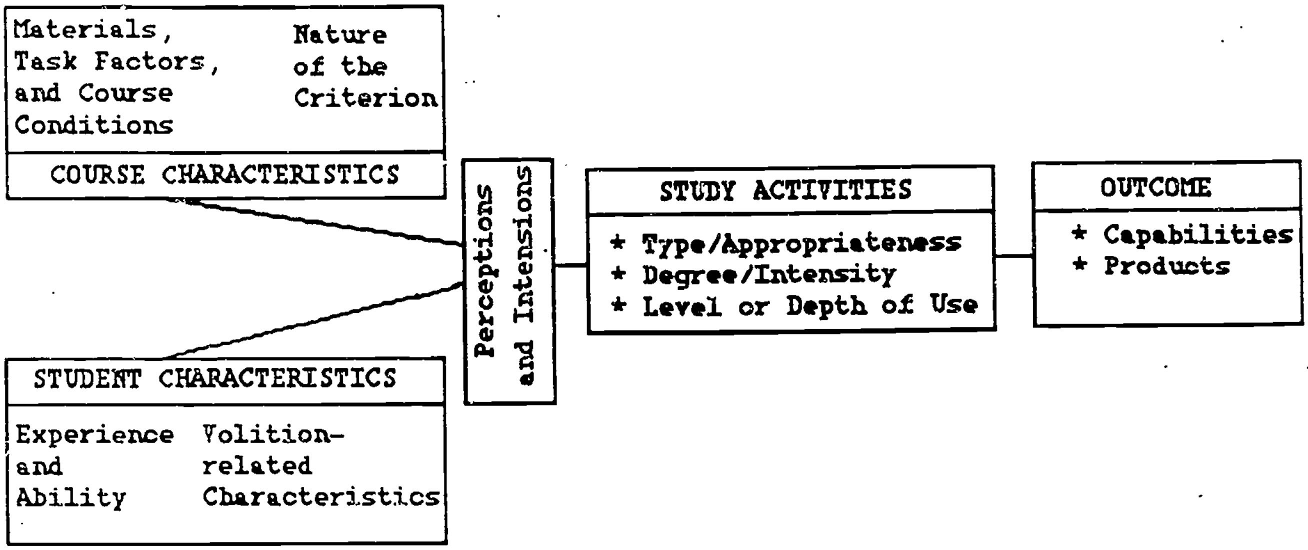


Figure 1. A model of the relationships among components of studying.

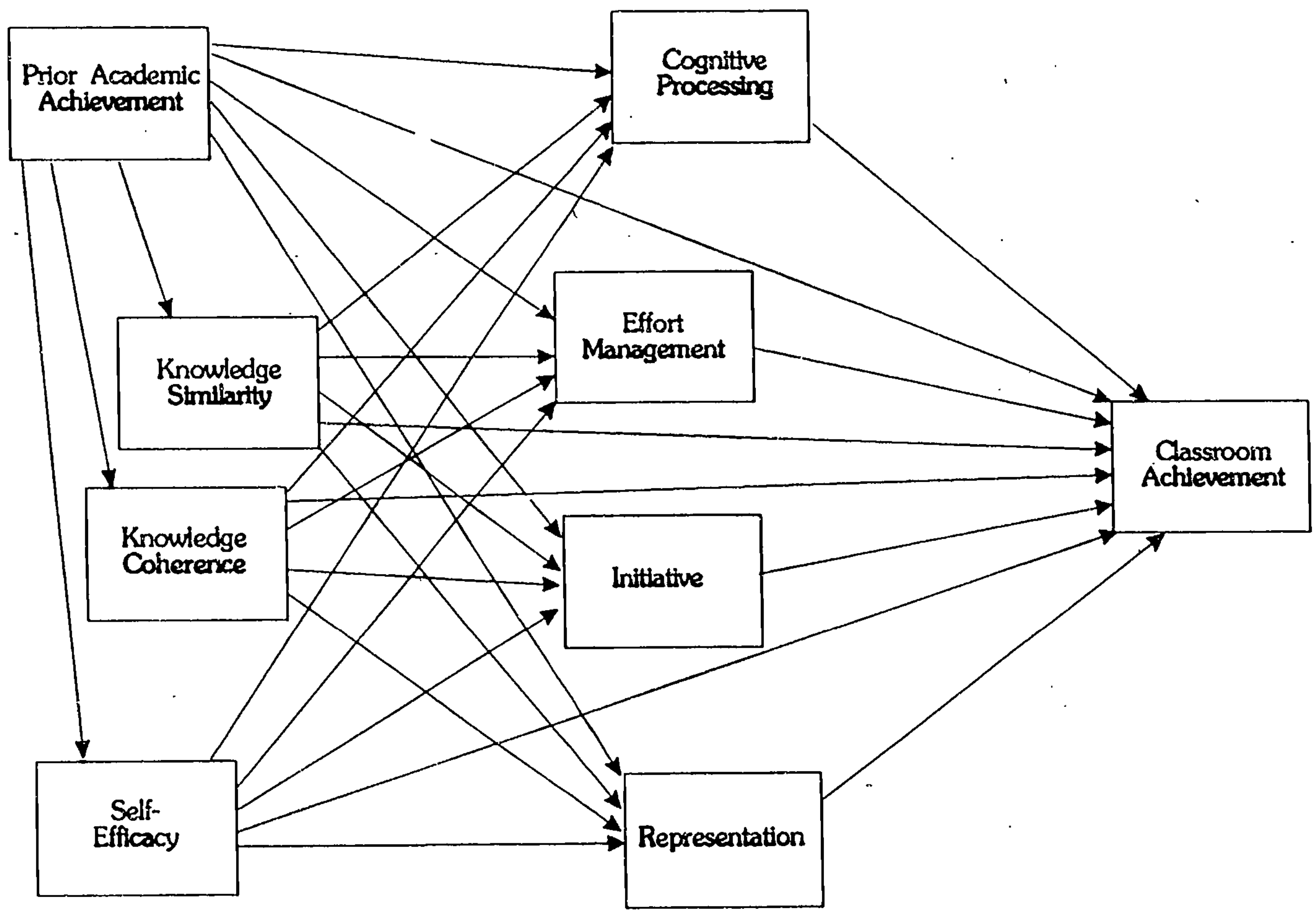
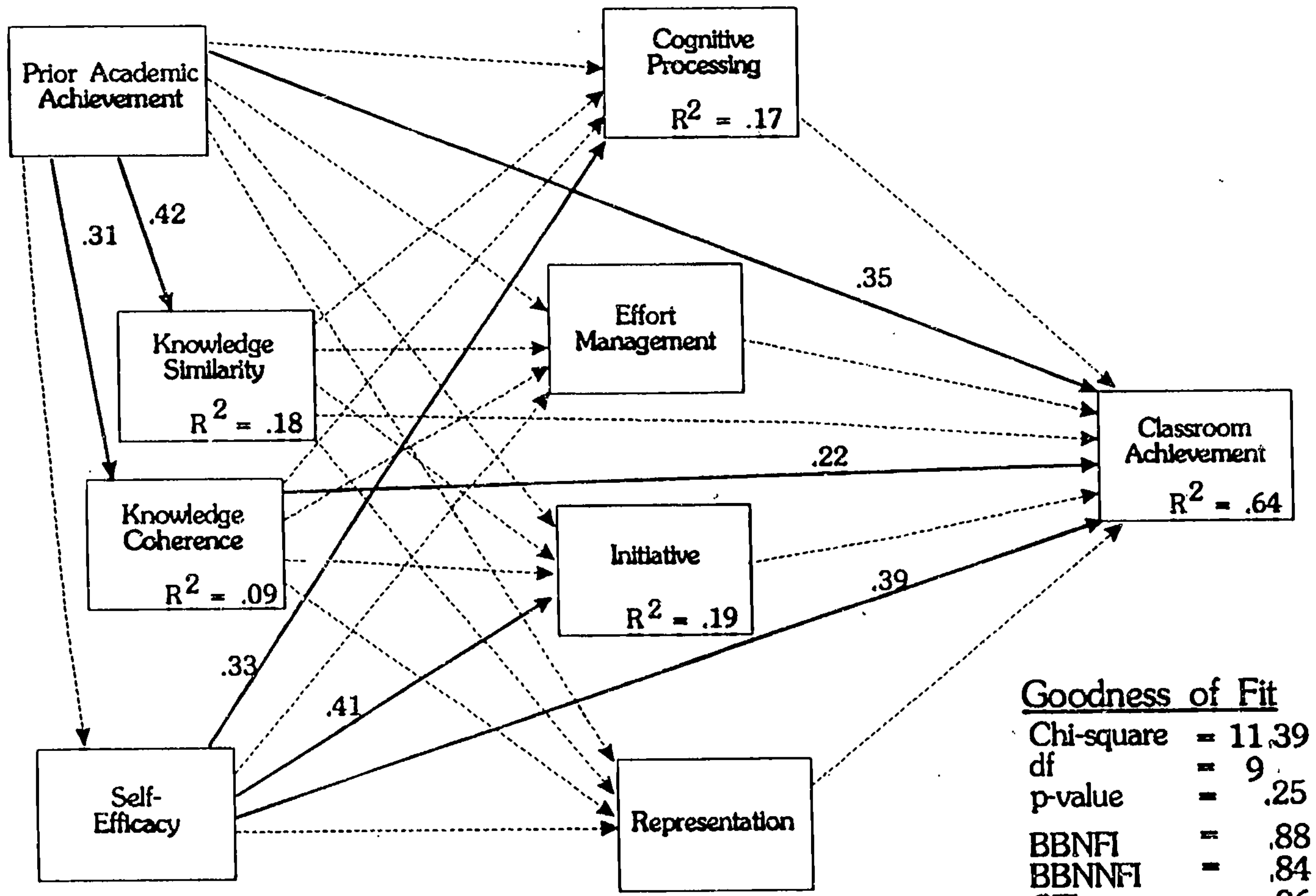

Prior Academic Achievement
Knowledge Similarity
Knowledge Coherence
Self-Efficacy
Cognitive Processing
Effort Management
Initiative
Representation
Classroom Achievement

Fig 2



Goodness of Fit

Chi-square	=	11.39
df	=	9
p-value	=	.25
BBNFI	=	.88
BBNNFI	=	.84
CFI	=	.96

Note: Standardized coefficients presented. A dashed line indicates nonsignificant effects.

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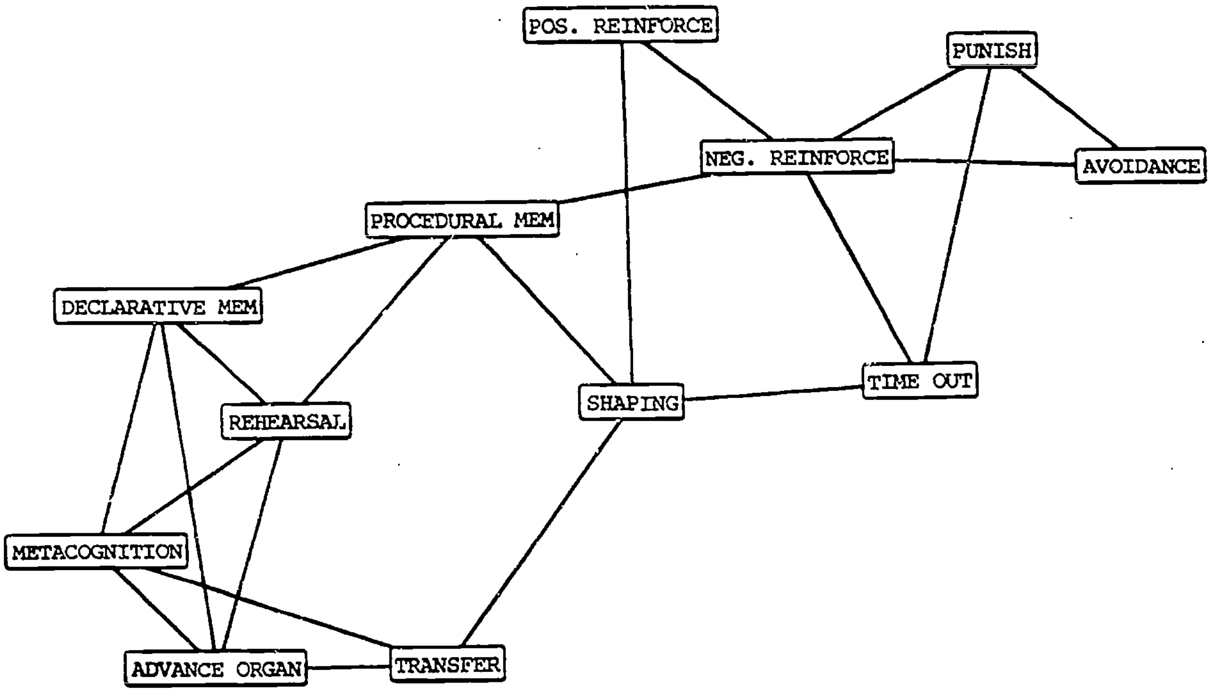
Fig 2

An example of the Pathfinder output for one semantic network representation of the twelve core concepts.



The twelve core concepts used in the concept rating task.

Transfer	Positive Reinforcement
Metacognition	Negative Reinforcement
Procedural Memory	Punishment
Declarative Memory	Avoidance
Rehearsal	Shaping
Advance Organizer	Time Out