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AUTHOR Shepardson, Daniel P.
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ABSTRACT

Eighth-grade students (n=42) were observed during five different life science problem-solving activities. Student interactions and thinking skills were recorded in relation to the problem-solving steps. A causal model was hypothesized and tested using path analysis procedures. The hypothesized causal model was adjusted based on path coefficients of p .1. The final causal model indicated that the problem solving steps had a greater influence on the use of thinking skills than student interactions, with data analysis influencing student interactions and thinking skills having the greatest. However, student interactions fostered the use of thinking skills to solve problems that otherwise may not have been used. Student interactions appeared not to enhance the variety of thinking skills that all students used during problem solving. Students used focusing, analyzing, and evaluating skills during problem identification/refinement. Students may have failed to plan sufficiently to solve their problems and to evaluate their thinking data collecting procedures by not using appropriate thinking skills. During data analysis students incorporated scientific knowledge into their explanations and evaluated their analysis process and conclusions. (KR)

Relationships Among Problem Solving, Student Interactions, and Thinking Skills

Daniel P. Shepardson

School Mathematics and Science Center
Department of Curriculum and Instruction
Purdue University
West Lafayette, IN 47907

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Introduction

The study of thinking has centered on specific tasks and not broader capabilities (thinking skills), and thus has not lead to significant advances in theoretical or empirical understanding of thinking skills (Greeno, 1989). Greeno (1989) further stressed that thinking research must expand to include "situated cognition"; that is, that thinking is situated in a physical and social context. While Resnick (1987) has stated the importance of student interactions in the development of thinking skills, research on the influence of student interactions on thinking skills is sparse. There is also a lack of practical "classroom" investigations of the relationship among problem solving, student interactions, and thinking skills. Thus, a major contribution of science educators would involve the study of students in their natural environments solving practical problems (Garrett, 1986).

Problem Statement

Because of the limited empirical data on the relationships among problem solving, student interactions, and thinking skills, a need exists to identify such relationships. Thus, the significance of this study lies in its investigation of students in their natural environment solving practical problems in a social context. The specific research question was:

> What relationships exist among problem solving, student interactions, and thinking skills.

Method

Students (N=42) in eigth-grade life science were observed in five different SSCS problem solving activities throughout the academic year. Students were observed for their interactions (student and teacher), thinking skills exhibited, and the problem solving phase. For a description of SSCS see Pizzini, Shepardson, and Abell (1989); and see Shepardson (1991) for a description of the variables. Data analysis utilized a multiple regression approach known as path analysis, which is a method for studying the direct and indirect effects of variables hypothesized as causes of variables treated as effects (Pedhazur, 1982). Figure 1 depicts the hypothesized causal model.

Results

The descriptive statistics are provide in Table 1. Table 2 provides a summary of the path coefficients and their level of significance. The final causal model, based on path coefficients of $p < .1$, is illustrated in Figure 2.

Discussion

The descriptive statistics imply that half of the students failed to actively engage in all aspects of problem solving or use a variety of thinking skills to solve problems. It appears that most students engaged in the data collecting phase and exhibited information gathering skills. Half of the students did not exhibit focusing, remembering, generating, integrating, or evaluating skills. The results suggest that most students did not exhibit higher order thinking. For the most part, those students who engaged in problem solving and used thinking skills did so in isolation of other students or the teacher.

For those students who engaged in problem solving and exhibited the use of thinking skills, the problem solving phase had a greater influence on their use of thinking skills than student-student interactions or teacher-student interactions. However, student-student interactions did foster the use of thinking skills that otherwise may not have been utilized. Yet, student-student or teacher-student interactions did not result in the use of a variety of thinking skills, and tended to emphasize lower level thinking skills (focusing and information gathering). There may also be a "mimic" relationship between student-student and teacher-student interactions in that both display a positive relationship with focusing and integrating skills. However, the evidence is inconclusive. These findings may suggest that if student interactions are to enhance the use of thinking skills by students, students must be exposed to the use of thinking skills during problem solving. That is, the use of thinking skills must be made explicit in the context of solving the problem. Students must be aware of and in control of their use of thinking skills (Jones, Palincsar, Ogle, & Carr, 1987).

The dismal engagement of students in problem solving and the use of a variety of thinking skills, raises several important questions concerning the development of student thinking abilities through problem solving instruction in science. Specifically:

1. Why didn't students engage in problem solving?

2. What factors influenced the limited use of thinking skills by students?

4. Why didn't student-student interactions have a greater influence on the use of thinking skills?

4. How might teacher-student interactions influence the thinking skills used by students?

Answers to these questions, at this time, are pure speculation, but provide food for thought, and guidance for future research. The speculations presented below are not ranked in any specific order of significance:

1. The novelty and structure of the problems identified influenced student engagement and use of thinking skills;

2. Students lacked an interest and desire to engage in problem solving;

3. Lack of domain specific knowledge inhibited student engagement in problem solving and the use of thinking skills;

4. Student prior knowledge and ideas were insufficient or inappropriate to the problems, thus restricting their engagement and use of thinking skills;

5. Students lacked prior experience in solving problems, thus inhibiting their problem solving engagement and use of thinking skills;

6. Students lacked prior knowledge, experience, and awareness of thinking skills. Thus, lacked the ability to use thinking skills to solve problems;

7. Those students who failed to engage in problem solving and the use of thinking skills lacked the cognitive ability to do so; and

8. Those students who did not engage in problem solving did not find the problem to be a "problem".

References

Garrett, R.M. (1986). Problem-solving in science education. Studies in Science Education, 13, 70-95.

Greeno, J.G. (1989). A perspective on thinking. American Psychologist, 44, 134-141.

Jones, B., Palincsar, A., Ogle, D., & Carr, E. (1987). Strategic teaching and learning: Cognitive instruction in the content areas. Alexandria, VA: Association for Supervision and Curriculum Development.

Pedhazur, J.E. (1982). Multiple regression in behavioral research explanations and predictions. New York, NY: Holt, Rinehart, and Winston.

Pizzini, E.L., Shepardson, D.P., & Abell, S.K. (1989). A rationale for and the development of a problem solving model of instruction in science education. Science Education, 73, 523-534.

Resnick, L. (1987). Education and learning to think. Washington, DC: National Academy Press.

Shepardson, D.P. (1991). The relationships between problem-solving phase, student interactions, and thinking skills among middle school students taught within the SSCS problem-solving instructional model. Ann Arbor, MI: University Microfilms International.

Figure 1
The Hypothesized Causal Model
Depicting the Relationships Between
Problem Solving Phase, Student Interactions, and
Thinking Skills

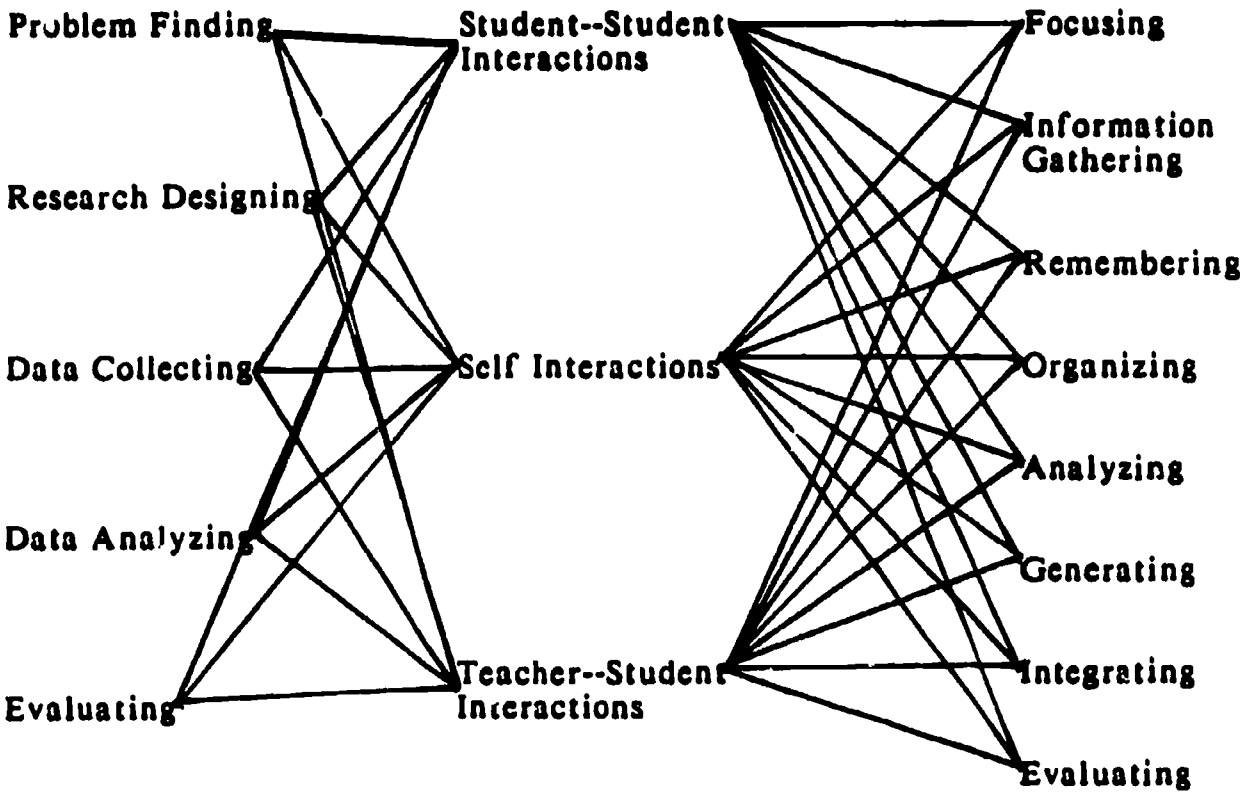


Table 1
Descriptive Statistics for Each Variable Based on Percentages Per-Student

Variable	Mean	SD	Median	Range
Problem Finding/Refining	0.04	0.11	0.00	0.00-0.50
Research Designing	0.06	0.11	0.00	0.00-0.50
Data Collecting	0.59	0.37	0.70	0.00-1.00
Data Analyzing	0.08	0.17	0.00	0.00-0.86
Evaluating	0.01	0.02	0.00	0.00-0.11
Student--Student Interactions	0.35	0.28	0.31	0.00-1.00
Teacher--Student Interactions	0.15	0.20	0.09	0.00-0.75
Self Interaction	0.58	0.21	0.63	0.12-0.98
Focusing Skills	0.04	0.06	0.00	0.00-0.21
Information Gathering Skills	0.33	0.21	0.34	0.01-0.79
Remembering Skills	0.01	0.01	0.00	0.00-0.04
Organizing Skills	0.07	0.10	0.02	0.00-0.44
Analyzing Skills	0.05	0.08	0.01	0.00-0.28
Generating Skills	0.01	0.01	0.00	0.00-0.07
Integrating Skills	0.03	0.07	0.00	0.00-0.27
Evaluating Skills	0.01	0.02	0.00	0.00-0.09

Table 2
Summary of Path Coefficients (Betas)
and Level of Significance

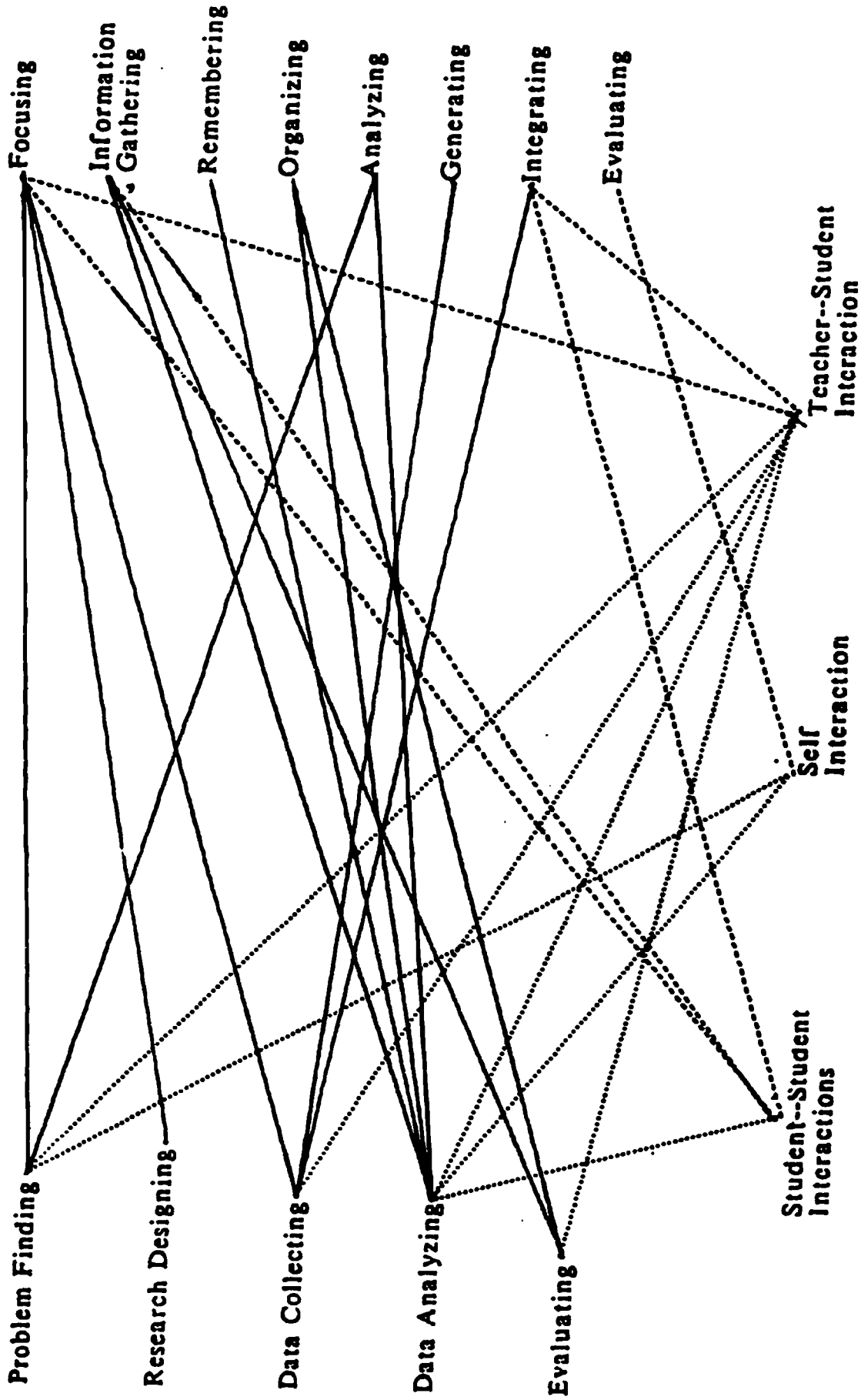
Path To	Path From	Initial Beta	P Value	Final Beta
ST--ST Interactions	Problem Finding	.022	.440	NA
	Research Designing	-.085	.280	NA
	Data Collecting	-.014	.464	NA
	Data Analyzing	.414	.002	.427***
	Evaluating	.102	.203	NA
TH--ST Interactions	Problem Finding	.218	.089	.299*
	Research Designing	.169	.147	NA
	Data Collecting	-.332	.025	-.370**
	Data Analyzing	-.241	.050	-.273**
	Evaluating	-.181	.090	-.206*
Self Interaction	Problem Finding	-.223	.073	-.298*
	Research Designing	-.021	.444	NA
	Data Collecting	.186	.118	NA
	Data Analyzing	-.209	.065	-.259*
	Evaluating	.051	.343	NA
Focusing Skills	Problem Finding	-.215	.098	-.234*
	Research Designing	.285	.043	.301**
	Data Collecting	.348	.028	.297**
	Data Analyzing	-.058	.363	NA
	Evaluating	.094	.247	NA
	ST--ST Interactions	.807	.031	.418**
	TH--ST Interactions	.888	.018	.544**
	Self Interaction	.488	.184	NA
Information Gathering Skills	Problem Finding	-.101	.247	NA
	Research Designing	.032	.409	NA
	Data Collecting	-.176	.124	NA
	Data Analyzing	-.217	.066	-.169*
	Evaluating	-.204	.043	-.180**
	ST--ST Interactions	-.609	.049	-.399**
	TH--ST Interactions	-.005	.494	NA
	Self Interaction	-.395	.176	NA
Remembering Skills	Problem Finding	-.095	.248	NA
	Research Designing	.164	.119	NA
	Data Collecting	.193	.101	NA
	Data Analyzing	.251	.040	.096**
	Evaluating	.053	.322	NA
	ST--ST Interactions	.035	.461	NA
	TH--ST Interactions	.251	.235	NA
	Self Interaction	.223	.298	NA

Table Continued

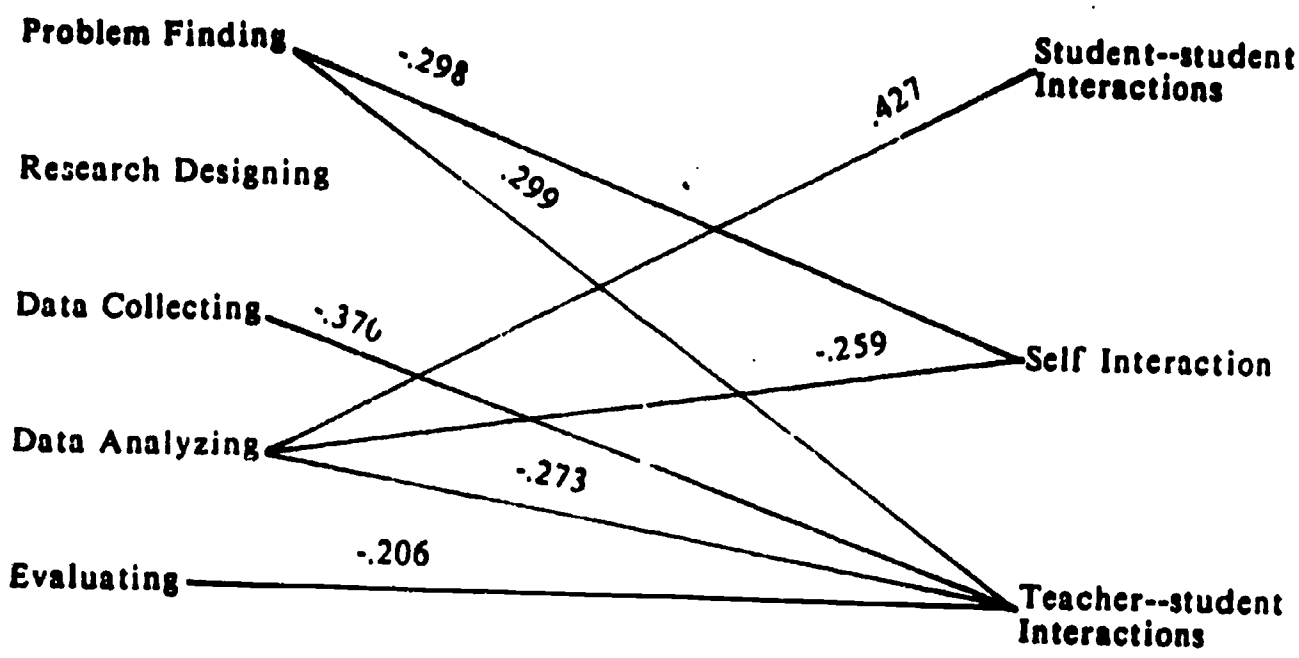
Organizing Skills	Problem Finding	.086	.313	NA
	Research Designing	-.166	.170	NA
	Data Collecting	.192	.156	NA
	Data Analyzing	.274	.064	.221*
	Evaluating	.280	.031	.236**
	ST--ST Interactions	.245	.293	NA
	TH--ST Interactions	.281	.259	NA
	Self Interaction	.324	.271	NA
Analyzing Skills	Problem Finding	-.235	.062	-.177*
	Research Designing	.160	.142	NA
	Data Collecting	.087	.296	NA
	Data Analyzing	-.225	.072	-.160*
	Evaluating	.100	.211	NA
	ST--ST Interactions	.358	.178	NA
	TH--ST Interactions	.092	.402	NA
	Self Interactions	.087	.424	NA
Generating Skills	Problem Finding	-.234	.129	NA
	Research Designing	.229	.132	NA
	Data Collecting	.321	.077	.237*
	Data Analyzing	-.073	.363	NA
	Evaluating	.051	.384	NA
	ST--ST Interactions	.126	.406	NA
	TH--ST Interactions	.154	.381	NA
	Self Interaction	-.097	.438	NA
Integrating Skills	Problem Finding	.011	.478	NA
	Research Designing	-.029	.443	NA
	Data Collecting	.344	.059	.317*
	Data Analyzing	-.091	.327	NA
	Evaluating	.049	.384	NA
	ST--ST Interactions	.871	.049	.368**
	TH--ST Interactions	.729	.074	.302*
	Self Interaction	.572	.174	NA
Evaluating Skills	Problem Finding	-.105	.305	NA
	Research Designing	.064	.376	NA
	Data Collecting	.256	.124	NA
	Data Analyzing	-.005	.490	NA
	Evaluating	.003	.494	NA
	ST--ST Interactions	-.402	.223	NA
	TH--ST Interactions	-.640	.106	NA
	Self Interaction	-.937	.030	-.421**

NA=not applicable as initial path coefficient not significant
*P<0.1, **P<0.05, ***P<0.01

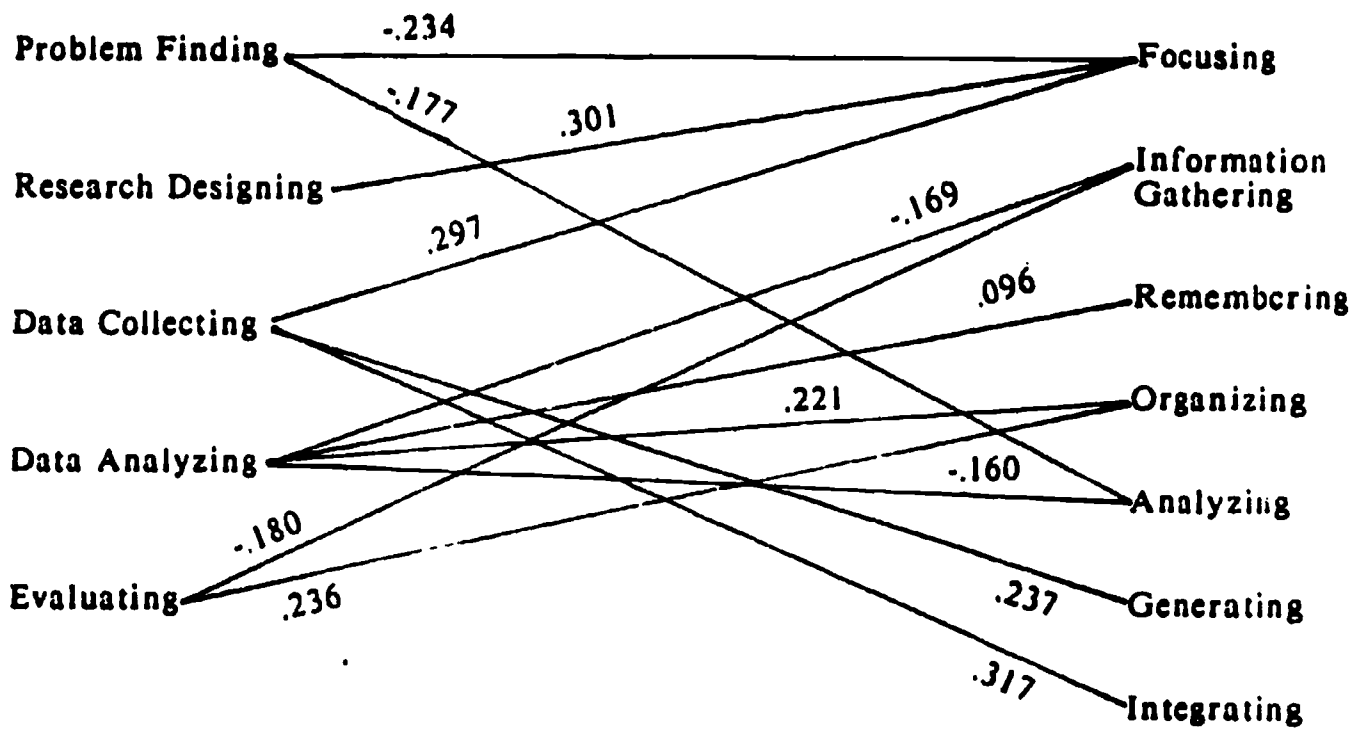
Figure 2
The Final Causal Model
Path Coefficients of p<.1



Significant Paths from Problem Solving Phase to Student Interactions



Significant Paths from Problem Solving Phase to Thinking Skills



Significant Paths from Student Interactions to Thinking Skills