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ABSTRACT

Concept maps are visual representations of knowledge structure and thought. Not enough attention has been paid to the measurement and influence of preservice teachers' knowledge structure and its development over time. This study implemented instructional scaffolding interventions in order to determine the effect on preservice teachers' knowledge structure (i.e., concept maps) and short essay responses. The study was also designed to develop a reliable method of measuring knowledge structure and to describe the characteristics of knowledge structure over time and between groups. Twenty preservice teachers enrolled at a state-supported university in the Midwest participated in the study. Participants were enrolled in one of two "Introduction to Educational Psychology" courses during the spring of 1998. A two-group, multi-variate repeated measures design was employed. Concept maps and short essay responses were compared over time. The findings suggest that instructional scaffolding interventions have, over time, a positive effect on students' ability to: create broad categories with subsuming structures; apply key terminology; construe interpretable patterns; decipher the demands of the task; reference the content discussed; and ultimately, produce superior essays. (Contains 9 figures, 5 tables, and 3 appendices.) (SM)

MEASUREMENT AND INFLUENCE OF PRESERVICE TEACHERS' KNOWLEDGE STRUCTURE IN AN EDUCATIONAL PSYCHOLOGY COURSE

CLARE COCO

in collaboration with

LOYOLA UNIVERSITY CHICAGO

Paper presented at the meeting of the Mid-Western Educational Research Association, Chicago (October 15, 1999).

Clare Coco, Ph.D.

Measurement and Influence of Preservice Teachers' Knowledge Structure in an Educational Psychology Course

ABSTRACT

Concept maps are visual representations of knowledge structure and thought. While it is sensible to assume that structured schemata are related to skillful essay responses, not enough attention has been paid to the measurement and influence of preservice teachers' knowledge structure and its development over time. Instructional scaffolding interventions (ISI) were implemented in order to determine its effect on preservice teachers' knowledge structure (i.e., concept maps) and essay responses. Twenty preservice teachers enrolled at a state-supported university in the mid-west participated in the study. Participants were enrolled in one of two *Introduction to Educational Psychology* courses that were taught by the investigator during the spring term of 1998. A two-group, multivariate repeated measures design was employed. A univariate analysis revealed a significant different between groups in phase three F (1, 18) = 6.57, N = 20; power = .679, Sig. = .020. The findings suggest that instructional scaffolding interventions have, over time, a positive effect on students' ability to: create broad categories with subsuming structures, apply key terminology, construe interpretable patterns, decipher the demands of the task, and ultimately, produce superior essays.

Measurement and Influence of Preservice Teachers' Knowledge Structure in an Educational Psychology Course.

OBJECTIVES

The objectives of this study were: 1) to determine the effect of instructional scaffolding interventions (ISI) on students' knowledge structures and short essay responses; 2) to develop a reliable method to measure knowledge structure; and 3) to describe the characteristics of knowledge structure over time and between groups.

PERSPECTIVES and THEORETICAL FRAMEWORK

Teacher educators have realized that consideration of instructional methods should take into account the way in which knowledge is initially organized and represented in students and the ways in which their knowledge representations are modified by new information. If organization is the issue, then we need a way of measuring organization – and we need to influence it.

Measurement of Knowledge Structure

Several researchers have developed measures to infer students' knowledge structures and their development in college courses (e.g., Naveh-Benjamin, McKeachie, et. al., 1986; Winitzky, 1992; Winitzky, Kauchak & Kelly, 1994). Numerous studies to measure knowledge structure involve the use of Reitman and Rueter's (1980) *ordered tree technique* which involves transforming the data into distance matrices from a standard cognitive structure. For example, Strahan (1989) used the ordered tree technique to examine experienced and novice middle-school teachers' views of instruction. It was found that although the experienced and novice teachers selected many of the same terms, the experienced teachers: 1) used more terms in constructing their ordered trees; 2) organized them into more chunks; and 3) created more linkages between chunks (Strahan, 1989). Naveh-Benjamin, McKeachie, et. al., (1986) modified the ordered tree technique to generate four measures of cognitive structure – grouping, hierarchical structure, directionality of the structure, and similarity to the structure.

A problem with the research so far is that most of the studies use general distance from a standard structure (an ordered tree, or hierarchy) as the measure of structure development. The assumption that single concepts or sets of concepts are mentally organized into an ordered tree (i.e., hierarchy) impedes other patterns of knowledge structure. It is held that there is a need to develop a measurement of knowledge structure that accommodates other structural possibilities (e.g., sequence, cause-effect, cycle, descriptive, compare/contrast).

Scaffolding as Part of Classroom Instruction

Given that the studies previously mentioned add to our knowledge that structure changes as a result of learning, we also need to determine what instructional strategies can help to influence knowledge structure. *Scaffolding* is an instructional technique that provides assistance and allows students to complete tasks they are not able to complete independently (Wood, Bruner, & Ross, 1976). In *Becoming a Scaffolder of Students' Learning*, Hogan and Pressley (1997) suggest a number of demonstrative actions to support scaffolding efforts with students. Without in-depth description, they are as follows:

- Use a Socratic style of interaction
- Provide feedback, but avoid directly evaluating students' thinking
- Model thinking processes
- Provide explanation as necessary
- Provide tailored assistance
- Encourage and capitalize on students' comments and questions
- Respond flexibly to students' errors
- Maintain an atmosphere that supports intellectual risk

METHODOLOGY

Participants

Twenty preservice teachers enrolled at a public, state-supported university in the mid-west participated in the study. Participants attended one of two *Introduction to Educational Psychology* courses that were taught by the investigator during the spring term of 1998.

Design

A two-group, multivariate repeated measures design was employed. Concept maps and short essay responses were compared over time (i.e., three phases of the study) in intervention and non-intervention classroom settings. The independent variables were: phases of study (X1a-X3a); and groups (X1b-X2b). The dependent variables were quality of concept maps (Y1, Y3, Y5) and written expressions of conceptual understanding (Y2, Y4, Y6). The analytic paradigm is illustrated in **Figure 1**.

Independent Variables

a) Groups. Two groups were established: experimental and control.

b) Phases of Study. There were three phases of the investigation. Each phase consisted of 3 to 4 class sessions.

Dependent Variables

The following dependent measures were used:

a) *A concept map representation sheet* was used to assess the quality of students' knowledge structure of motivation. Concept map work sheets were administered to all participants in each phase of the study. Seven criteria were used to infer the characteristics of the knowledge structure: 1) *inclusiveness of content* – the degree to which motivational theories were included in the concept map; 2) *explanatory focus* – the degree to which the concept map explained student motivation; 3) *fluency* – the degree to which key terms were used in the concept map; 4) *breadth* – the degree to which broad categories were used in the concept map; 5) *depth of categorization* – the degree to which subsuming terms were used to describe each category; 6) *interpretability* – the degree to which the structure of the concept map is understood or brings about meaning; and 7) *originality* – the degree to which the structure or design was used by fewer than 20% of the participants. The investigator assigned a score on a five-point scale (1 – 5) to each of the criteria listed above. A score of five points on any criteria indicated excellence; three points – satisfactory work; one point – needs improvement. (Four points and two points were assigned for work that appeared to fall in between the extreme categories and the mid-point). A perfect map received thirty-five points.

b) A *short essay question sheet* was designed to assess the participants' written expressions of conceptual understanding of motivation theory. Only three criteria were used to judge the quality of essay responses in each phase of the study: 1) *inclusiveness of content;* 2) *explanatory focus;* and 3) *fluency*. A score on a five-point scale (1 – 5) was assigned to each of the criteria described above. A perfect essay received a fifteen point total score.

Most of the intercorrelations between the criteria to assess concept maps and essays were significant at the 0.01 level (2-tailed) (see **Tables 1 and 2**). In addition, a Pearson Product correlation coefficient revealed a positive relationship between the concept map and essay scores ($r = .599$, $p < .01$, $N = 20$, 2-tailed) (see **Table 3 and Figure 2**).

Procedures

Experimental Group. **ISI** *followed* individual mapping and writing activities (see **Appendix A** for examples of concept maps and short essay responses). **ISI** consisted as a series of guided information feedback sessions to support the learning of struggling students. Students volunteered to give knowledge to help other students develop an appropriate schematic representation of motivation theory. A six-page packet containing a prior selection of students' concept maps of motivation theory were handed-out to each member of the class. The packet contained a representative collection of low-quality to high-quality conceptualizations of human motivation. In small groups, students were instructed to provide written feedback regarding the quality of the map structures contained in the packet (see **Appendix B** for examples of students' concept maps with other students' feedback comments). Each group was then asked to create a "collaborative concept map" to form a new concept map (see **Appendix C** for examples

of collaborative concept maps). Each group presented their newly configured and collaboratively determined concept map to the whole class using an overhead projector. Ideally, through this collaborative activity, the "social" or "community" support in the class would lead to better patterns of text organization, and short essay responses. The investigator and voluntary class members took the role of scaffolds in providing guidance to other class members. The goal was to communicate to others the information that was relevant and/or irrelevant to the task. Concept map and short essay responses were collected within a 4-week period.

RESULTS AND CONCLUSIONS

As expected, group 1 mean score (map and essay combined) was greater than group 2, in each phase of the study **(see Table 4 and Figure 3).** A MANOVA on the dependent variables did not reveal an overall significant difference between groups (Wilks' Lambda value = .700, F = 2.29, N = 20; df = 16, p < .05). However, a univariate analysis revealed a significant different between groups in phase three F (1, 18) = 6.57, N = 20; power = .679, Sig. = .020 **(see Table 5).**

Concept Map Variable. Mean total concept map score during phase three was higher for group 1 = 27.30, than group 2 = 22.10. For group 1, the *originality* index decreased more, indicating that students' knowledge structures became more similar to that of the other students as a result of social learning.

For both groups, mean score for *inclusiveness of the content* and *fluency* was higher than *explanatory focus*, *breadth* and *depth of categorization* criteria (see **figures 4 and 5**). Furthermore, *breadth* and *depth of categorization* criteria showed the greatest improvement throughout the unit.

Essay Variable. Mean total essay score in phase three was higher for group 1 = 10.90, than group 2 = 4.90. For both groups, mean score for *inclusiveness of the content* was higher than *explanatory focus* and *fluency* criteria **(see figures 6 and 7).**

Two Extreme Cases

Two participants, one with a highly structured concept map and one with a low-structured concept map were selected for closer scrutiny to illustrate qualitatively the nature of the quantitative findings by comparing extreme cases.

The concept map in **Figure 8** shows how participant #1, conceived of the motivation theory, as presented from the text and classes. This participant earned a total map score of 11 (inclusiveness to the content, 0; depth of the categories, 0; explanatory focus, 0; fluency, 0; breadth, 4; depthness, 0; interpretability, 2; originality, 5. In this sequential pattern, events are arranged in a chronological order that has a specific beginning and end. Clearly this pattern has "big ideas" and does not focus attention on key elements of motivation theory.

On the other hand, participant #2's concept map **(refer to Figure 9)** earned a total map score of 29 (inclusiveness to the content, 5; explanatory focus, 5; fluency, 5; breadth, 5; depthness, 4; interpretability, 4; and originality, 1. This hierarchical pattern includes a main concept and the subconcepts under it. That is, the general idea of

"explaining motivation" and the four theories, or subcategories of it. Moreover, key terms are added under each theory to explain motivation.

EDUCATIONAL IMPORTANCE OF THE WORK

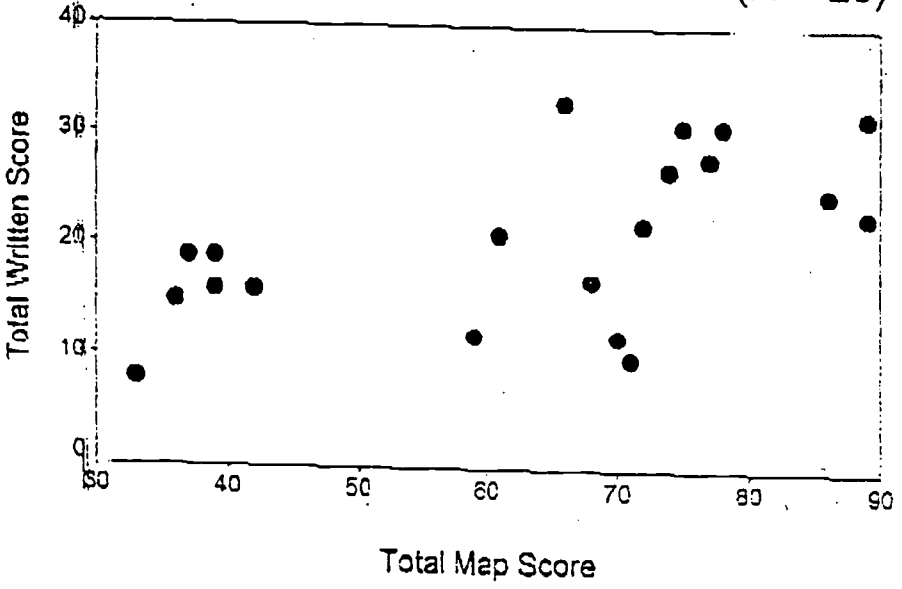
The present findings suggest that instructional scaffolding interventions increase students' ability to formulate broad categorizations, subsuming structures, key terminology, interpretable patterns, to reference the content discussed, and to remain on task (i.e., to answer the question). At the same time, scaffolding interventions tend to decrease original pattern structure as the struggling learner moves through the zone of proximal development to build better knowledge structures independently.

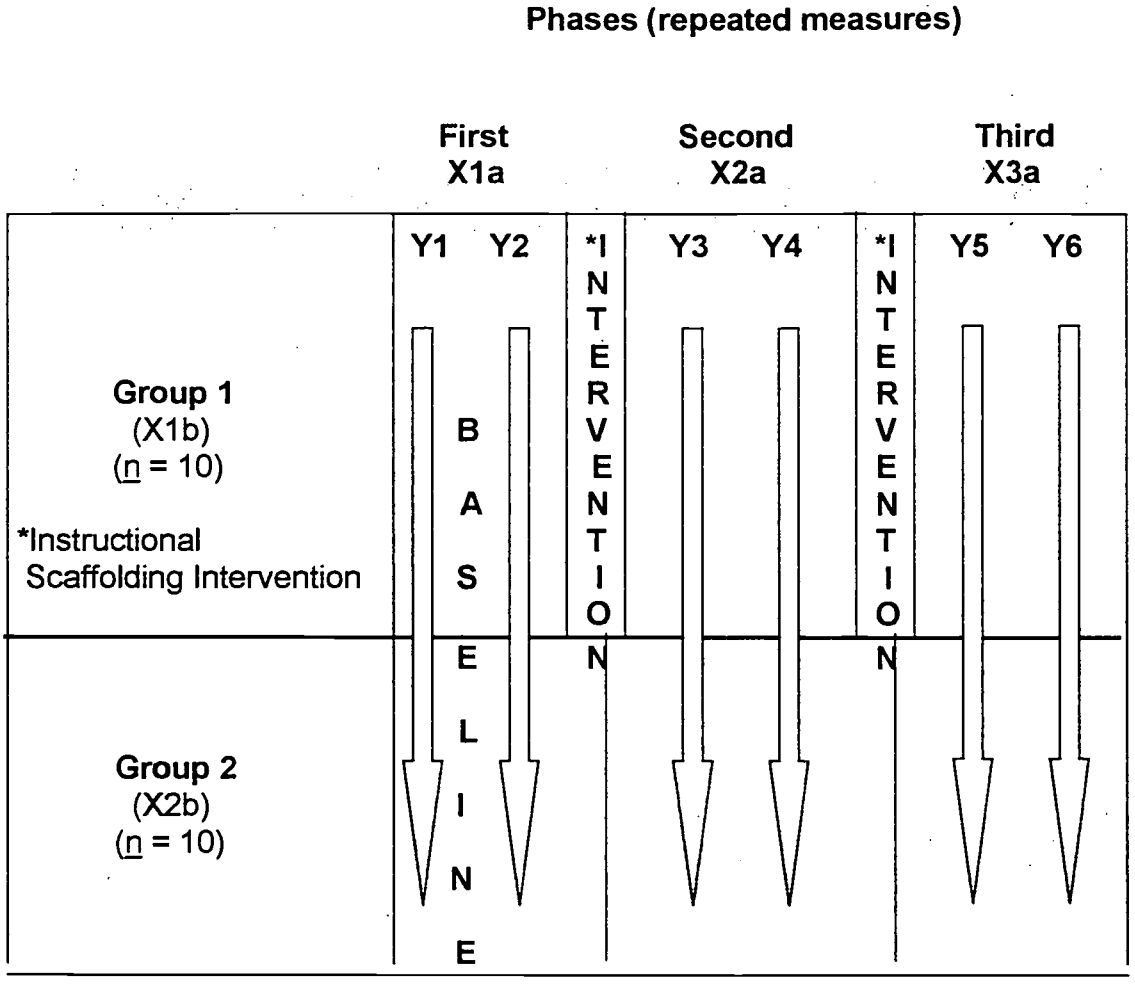
Given that knowledge structure and short essay responses were moderately correlated, these findings direct our attention to a major problem in writing activities. Namely, inappropriate development of overall relations and a general framework for the theoretical matter learned, which further prevents assimilation of new information (i.e., accretion), restructuring, and tuning. The use of ISI as an independent variable provides conclusive findings that the positive relationship between knowledge structure and written expressions of conceptual understanding is causal.

The criteria developed to measure knowledge structure and essay responses indicate satisfaction. However, further research is necessary to shed light on construct related evidence of validity, and issues of reliability. The initial reason for developing this measure was the feeling that conventional achievement tests measured bits of knowledge but were inadequate measures of the students' organization of knowledge. The addition of this method to the array of other methods for measuring structure and with other methods to analyze specific knowledge (e.g., essay) should provide us with a more meaningful assessment and representation of knowledge structure. This is a major aid toward an understanding of knowledge structure and development and a framework for designing strategies for teaching.

Finally, a critical gap in our understanding of the link between preservice teacher's knowledge structure and their actual behavior. If we can help teachers better organize what they know, will that enable them to better utilize that knowledge at the appropriate time and place?

Figure 2. Correlation Between Total Map and Essay Scores For All Phases (N = 20)





- **Independent Variables** = Phases of Study (X1a – X3a).
  = Group (X1b – X2b).
- **Dependent Variables** = Quality of Concept Map (Y1, Y3, Y5).
  = Written Expression of Conceptual Understanding (Y2, Y4, Y6).

Figure 1. Analytic Paradigm.

Figure 3. Mean total score for experimental and comparison group during each phase.

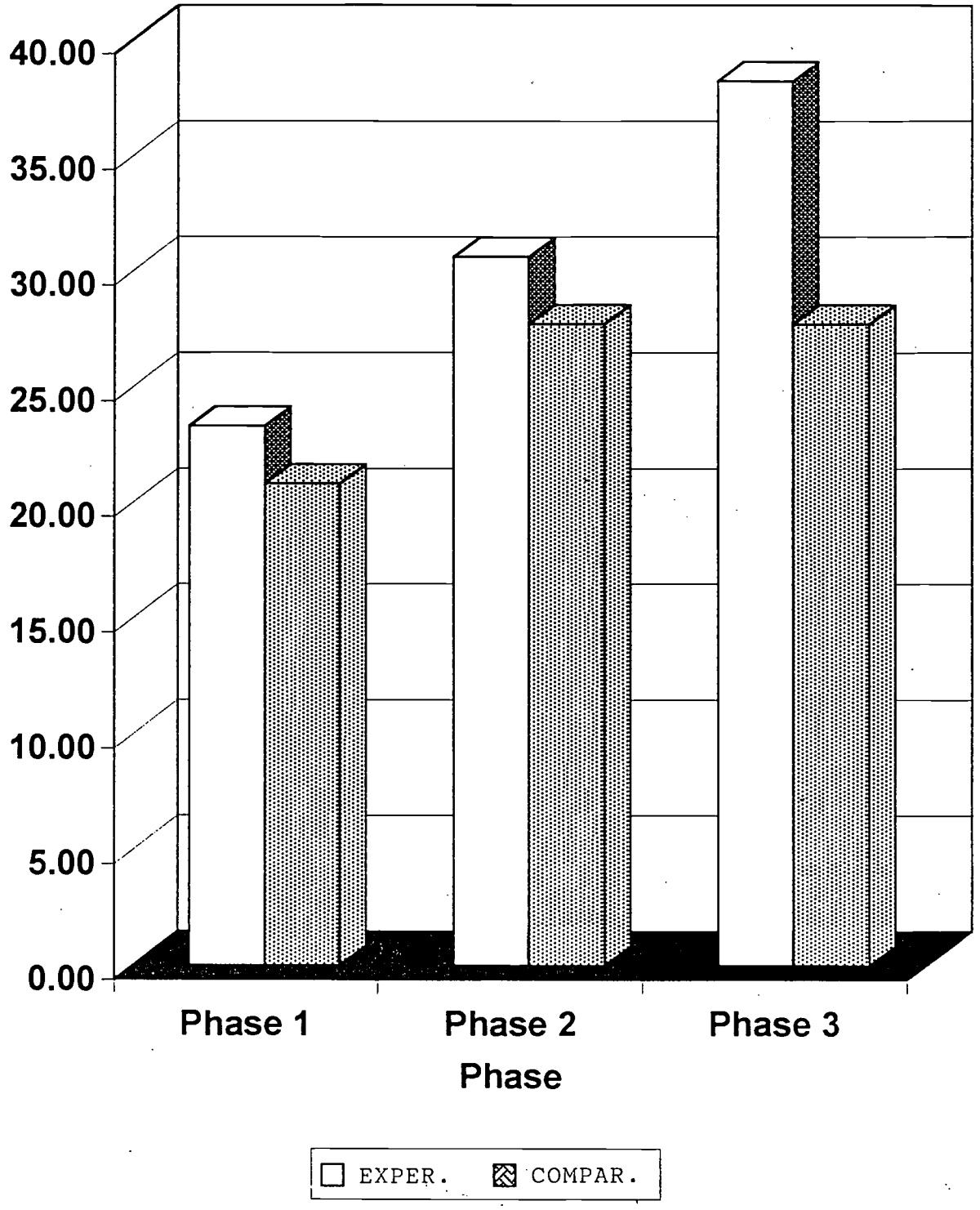


Figure 4. Group 1 Mean Criteria Scores (Map) in Phase 3 (N=10).

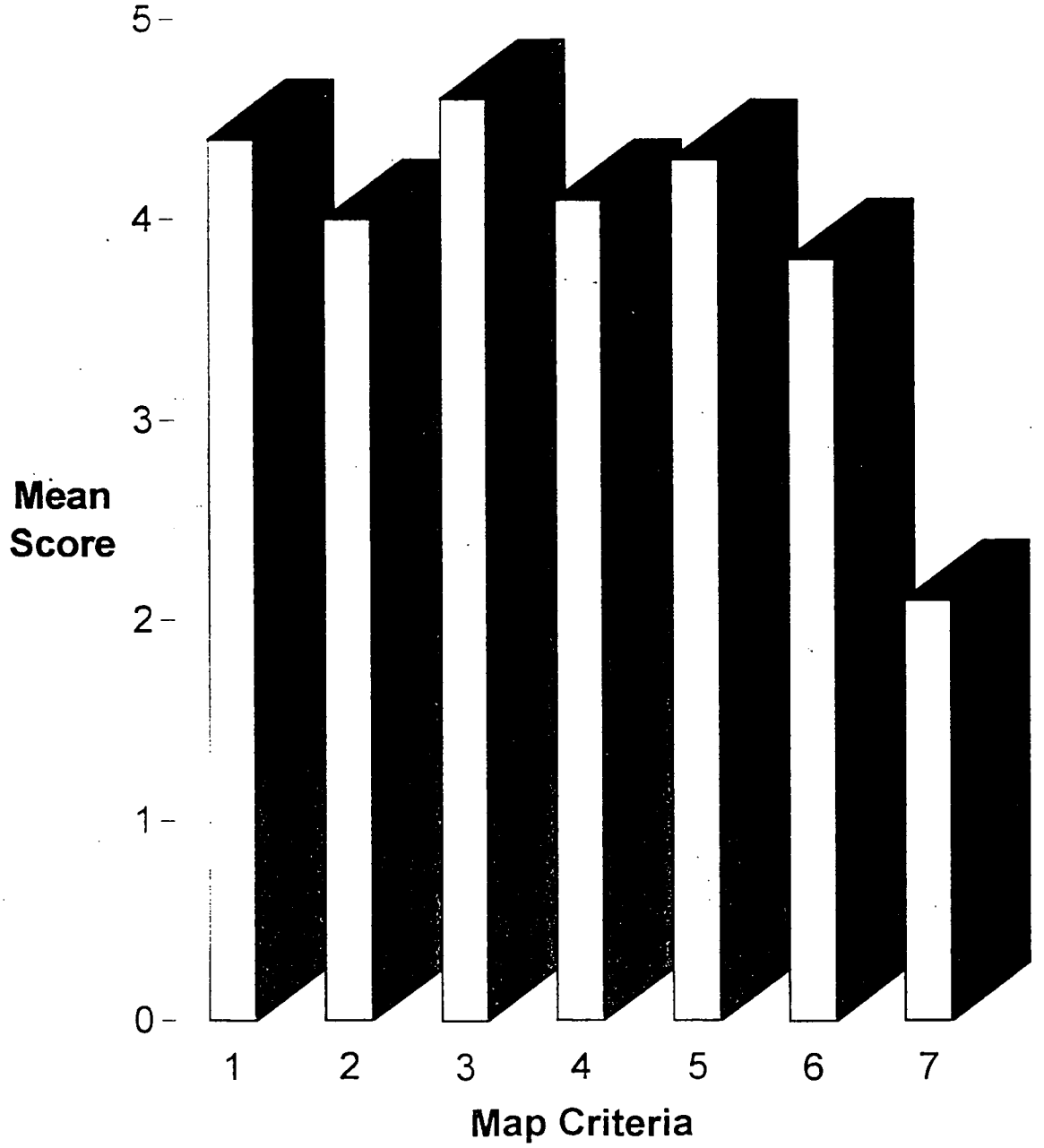


Figure 5. Group 1 Mean Criteria Scores (Essay) in Phase 3 (N=10).

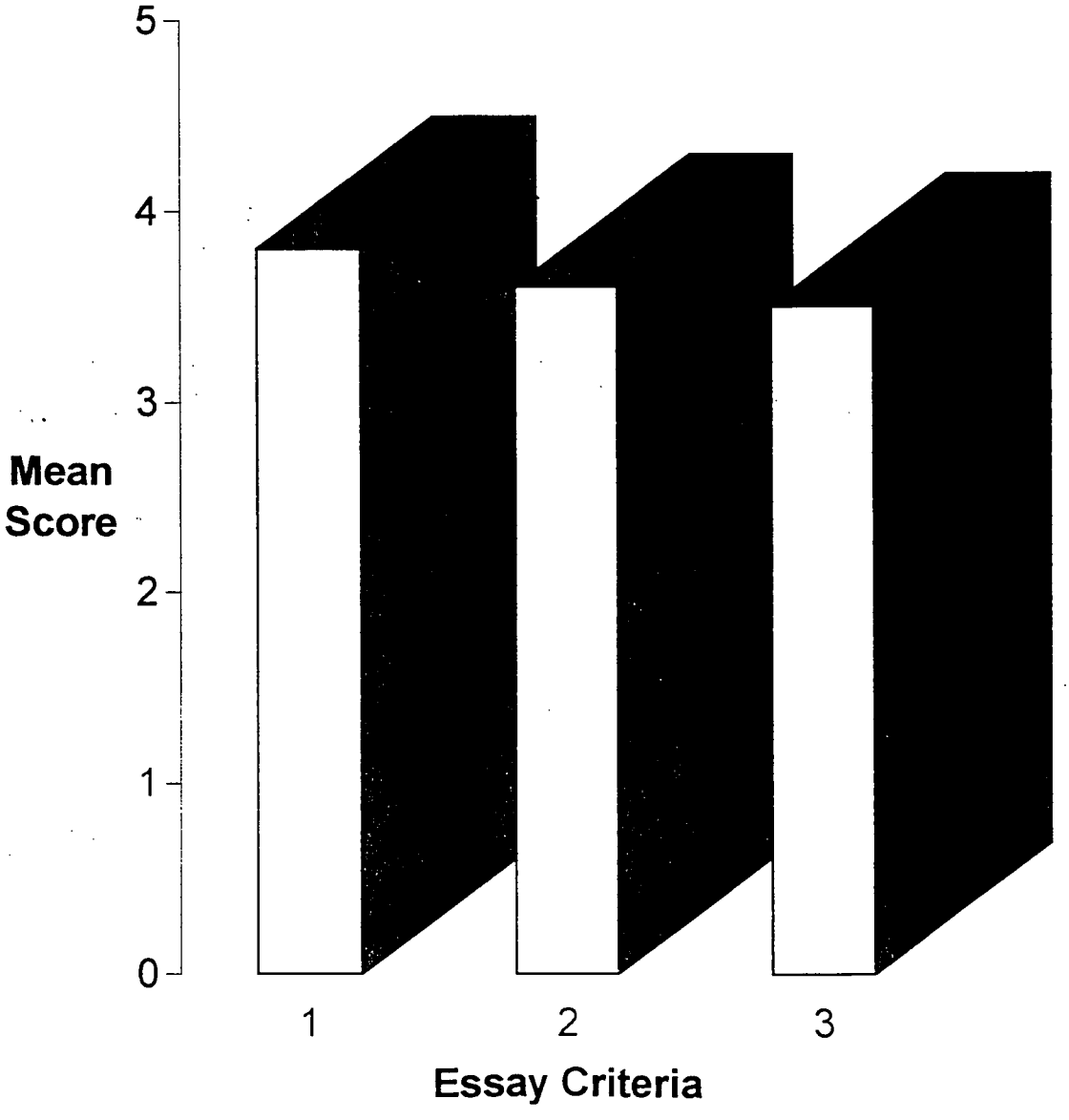


Figure 6. Group 2 Mean Criteria Scores (Map) in Phase 3 (N=10).

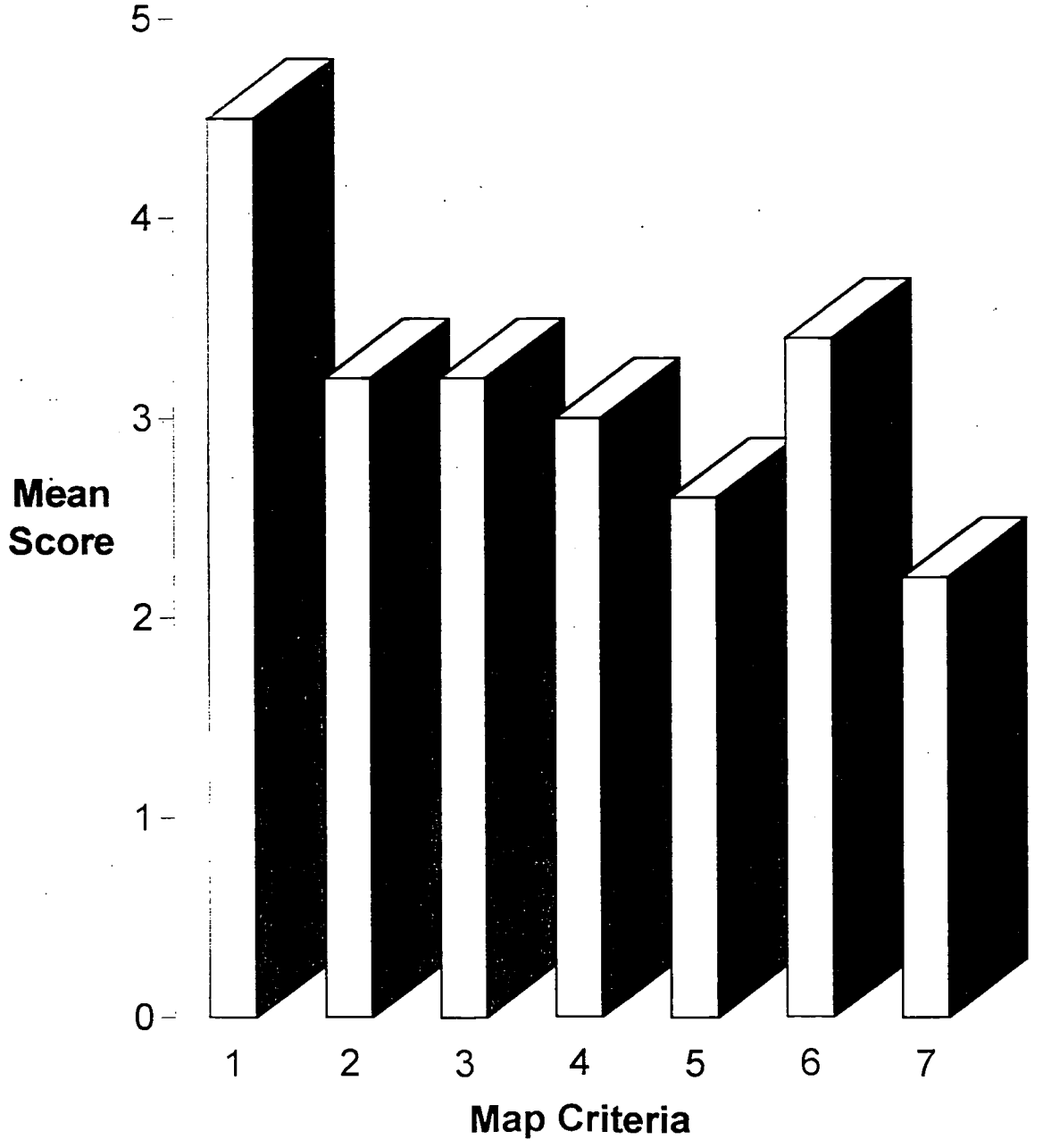
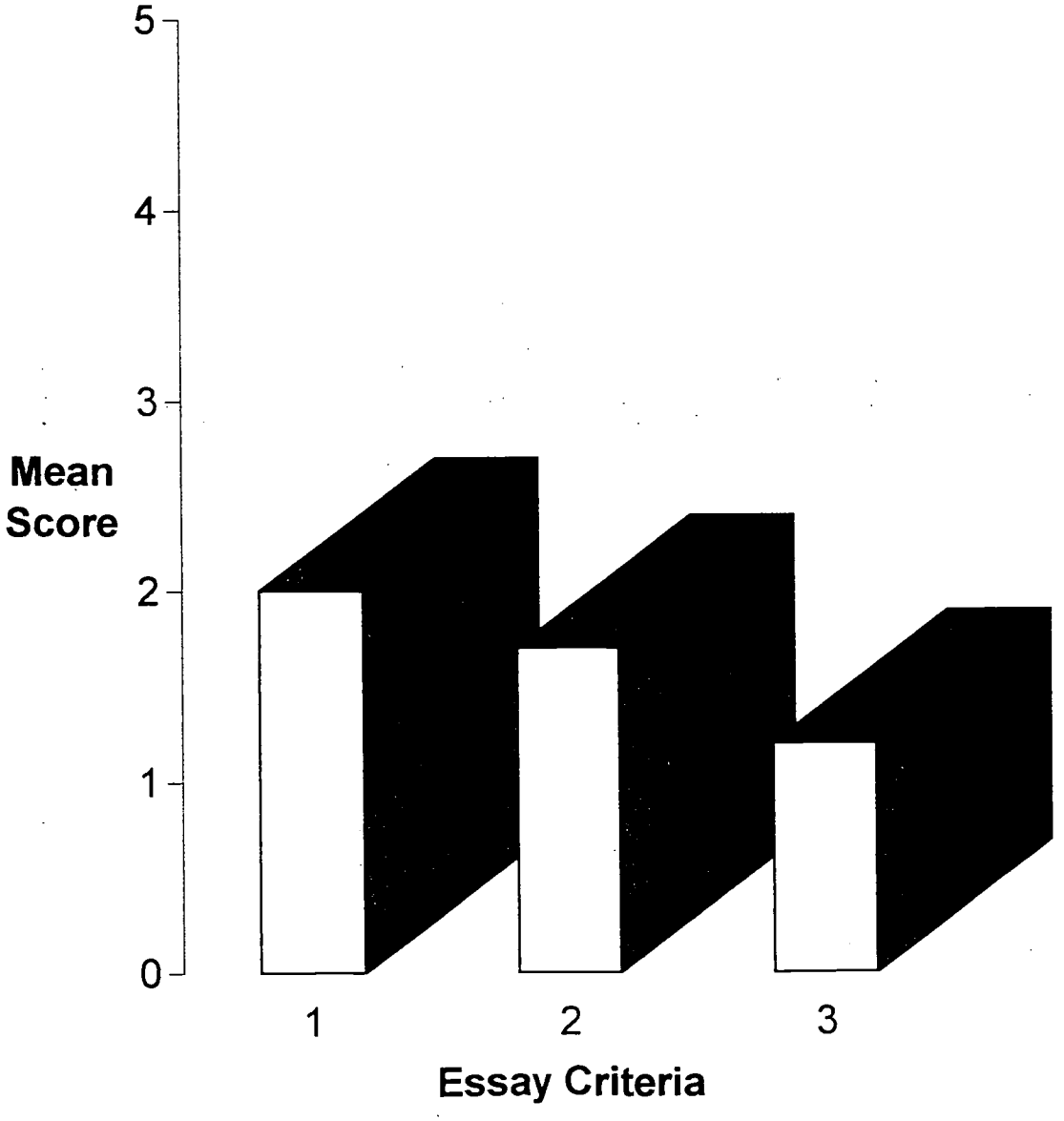


Figure 7. Group 2 Mean Criteria Scores (Essay) in Phase 3 (N=10).



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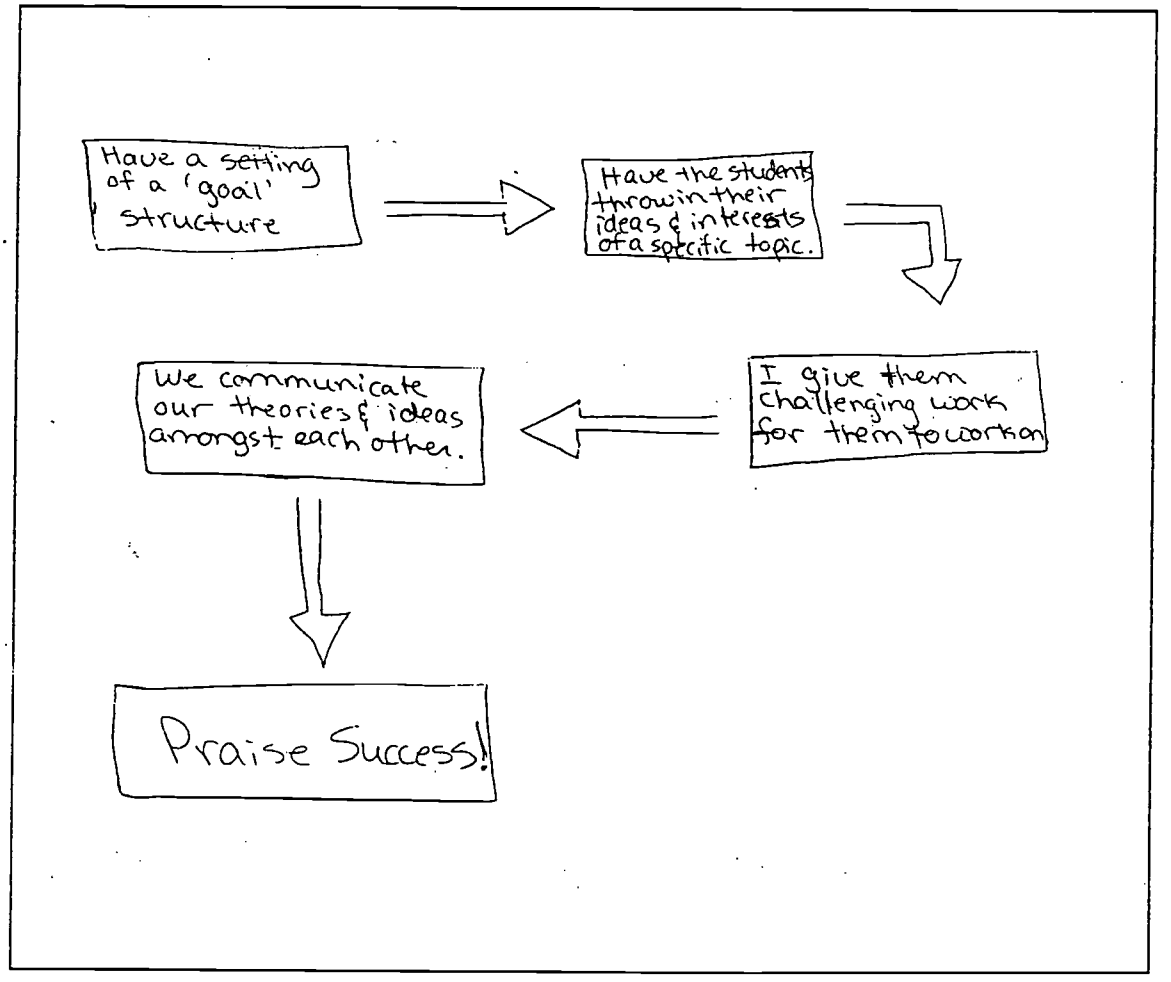

Figure 8.

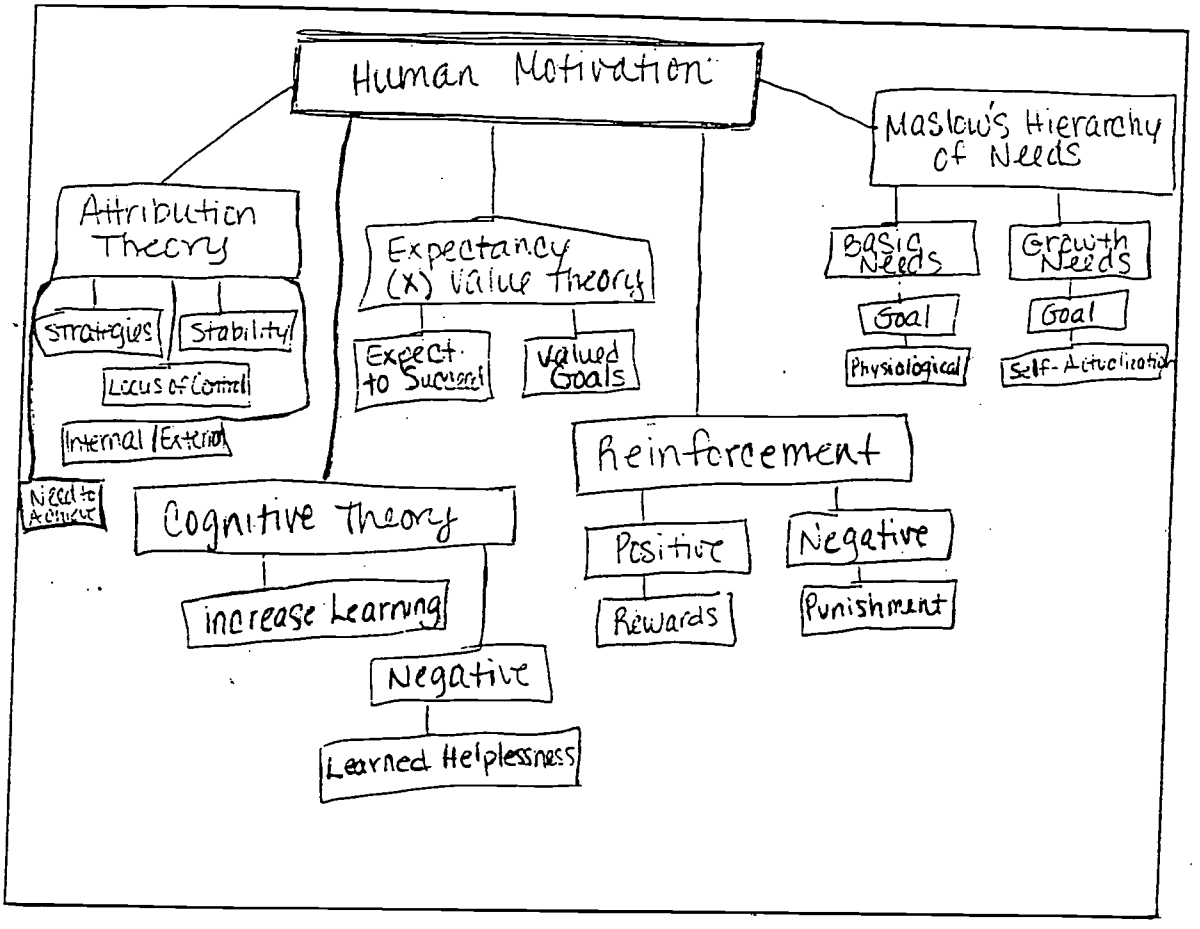

Figure 9.

Table 1

Intercorrelations Between Criteria Used to Evaluate Concept Maps (N = 20)

Correlations

		m.breadth	m.depthn	m.explan	m.fluen	m.inclus	m.interpr	m.origin
Pearson Correlation	m.breadth	1.000	.079	.482*	.508*	.482*	.463*	.014
	m.depthn	.079	1.000	.723**	.757**	.605**	.535*	-.539*
	m.explan	.482*	.723**	1.000	.885**	.806**	.552*	-.286
	m.fluen	.508*	.757**	.885**	1.000	.888**	.572**	-.371
	m.inclus	.482*	.605**	.806**	.888**	1.000	.545*	-.112
	m.interpr	.463*	.535*	.552*	.572**	.545*	1.000	.067
	m.origin	.014	-.539*	-.286	-.371	-.112	.067	1.000
Sig. (2-tailed)	m.breadth	.	.739	.032	.022	.031	.040	.955
	m.depthn	.739	.	.000	.000	.005	.015	.014
	m.explan	.032	.000	.	.000	.000	.012	.222
	m.fluen	.022	.000	.000	.	.000	.008	.108
	m.inclus	.031	.005	.000	.000	.	.013	.639
	m.interpr	.040	.015	.012	.008	.013	.	.780
	m.origin	.955	.014	.222	.108	.639	.780	.
N	m.breadth	20	20	20	20	20	20	20
	m.depthn	20	20	20	20	20	20	20
	m.explan	20	20	20	20	20	20	20
	m.fluen	20	20	20	20	20	20	20
	m.inclus	20	20	20	20	20	20	20
	m.interpr	20	20	20	20	20	20	20
	m.origin	20	20	20	20	20	20	20

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2

Intercorrelations Between Criteria to Evaluate Written Essays (N = 20)

Correlations

		w.explan	w.fluen	w.inclus
Pearson Correlation	w.explan	1.000	.553*	.481*
	w.fluen	.553*	1.000	.918**
	w.inclus	.481*	.918**	1.000
Sig. (2-tailed)	w.explan	.	.011	.032
	w.fluen	.011	.	.000
	w.inclus	.032	.000	.
N	w.explan	20	20	20
	w.fluen	20	20	20
	w.inclus	20	20	20

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3

Correlation Between Total Concept Map and Total Written Essay Scores.

Correlations

		TotalMap	totalW
Pearson Correlation	TotalMap	1.000	.599**
	totalW	.599**	1.000
Sig. (2-tailed)	TotalMap	.	.005
	totalW	.005	.
N	TotalMap	20	20
	totalW	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

Figure 2. Correlation Between Total Map and Essay Scores For All Phases (N = 20).

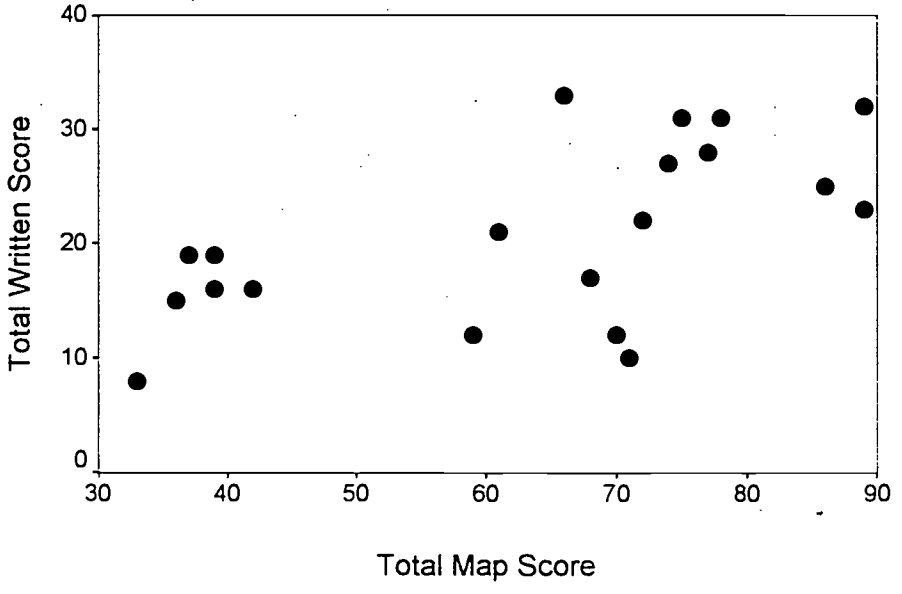

Table 4

Mean Total Scores For Experimental and Comparison Groups for All Phases

Report

Group		Y1Total Points	Y2 Total Points	TOT Y1Y2	Y3 Total	Y4 Total	TOT Y3Y4	Y5TOTAL	Y6Total	TotY5Y6
Group 1	Mean	17.30	6.00	23.30	24.00	6.70	30.6	27.30	11	38.20
	N	10	10	10	10	10	10	10	10	10
	Std. Deviation	6.36	2.94	8.18	8.21	2.67	10.1	5.85	4.46	9.03
Group 2	Mean	15.30	5.50	20.80	20.00	7.70	27.7	22.10	4.90	27.00
	N	10	10	10	10	10	10	10	10	10
	Std. Deviation	5.03	2.01	5.07	10.89	3.13	11.8	5.67	5.69	10.47
Total	Mean	16.30	5.75	22.05	22.00	7.20	29.2	24.70	7.90	32.60
	N	20	20	20	20	20	20	20	20	20
	Std. Deviation	5.68	2.47	6.75	9.61	2.88	10.8	6.21	5.85	11.11

Table 5

MANOVA Between Groups for Each Phase

Between-Subjects Factors

		Value Label	N
Group	1	Group 1	10
	2	Group 2	10

Multivariate Tests[c]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[a]
Intercept	Pillai's Trace	.940	83.903[b]	3.000	16.000	.000	251.709	1.000
	Wilks' Lambda	.060	83.903[b]	3.000	16.000	.000	251.709	1.000
	Hotelling's Trace	15.732	83.903[b]	3.000	16.000	.000	251.709	1.000
	Roy's Largest Root	15.732	83.903[b]	3.000	16.000	.000	251.709	1.000
GROUP	Pillai's Trace	.300	2.290[b]	3.000	16.000	.117	6.871	.472
	Wilks' Lambda	.700	2.290[b]	3.000	16.000	.117	6.871	.472
	Hotelling's Trace	.429	2.290[b]	3.000	16.000	.117	6.871	.472
	Roy's Largest Root	.429	2.290[b]	3.000	16.000	.117	6.871	.472

a. Computed using alpha = .05

b. Exact statistic

c. Design: Intercept+GROUP

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	TOTY1Y2	31.250[b]	1	31.250	.675	.422	.675	.122
	TOTY3Y4	42.050[c]	1	42.050	.347	.563	.347	.086
	TotY5Y6	627.200[d]	1	627.200	6.565	.020	6.565	.679
Intercept	TOTY1Y2	9724.050	1	9724.050	209.95	.000	209.947	1.000
	TOTY3Y4	16994.45	1	16994.45	140.29	.000	140.289	1.000
	TotY5Y6	21255.20	1	21255.20	222.49	.000	222.490	1.000
GROUP	TOTY1Y2	31.250	1	31.250	.675	.422	.675	.122
	TOTY3Y4	42.050	1	42.050	.347	.563	.347	.086
	TotY5Y6	627.200	1	627.200	6.565	.020	6.565	.679
Error	TOTY1Y2	833.700	18	46.317				
	TOTY3Y4	2180.500	18	121.139				
	TotY5Y6	1719.600	18	95.533				
Total	TOTY1Y2	10589.00	20					
	TOTY3Y4	19217.00	20					
	TotY5Y6	23602.00	20					
Corrected Total	TOTY1Y2	864.950	19					
	TOTY3Y4	2222.550	19					
	TotY5Y6	2346.800	19					

a. Computed using alpha = .05

b. R Squared = .036 (Adjusted R Squared = -.017)

c. R Squared = .019 (Adjusted R Squared = -.036)

d. R Squared = .267 (Adjusted R Squared = .227)

APPENDIX A

Scenario: Other teachers marvel at how adept you are in motivating students to learn in your 11th grade English class. As such, you have been asked by your Principal to present an all-day workshop on *Student Motivation* for parents, teachers and administrators within your school district. As part of the workshop, you would like to present an advance organizer to introduce different theoretical explanations of motivation.

Based on Motivation theories discussed in class,
create a concept map to explain human motivation according to different theoretical points of view.

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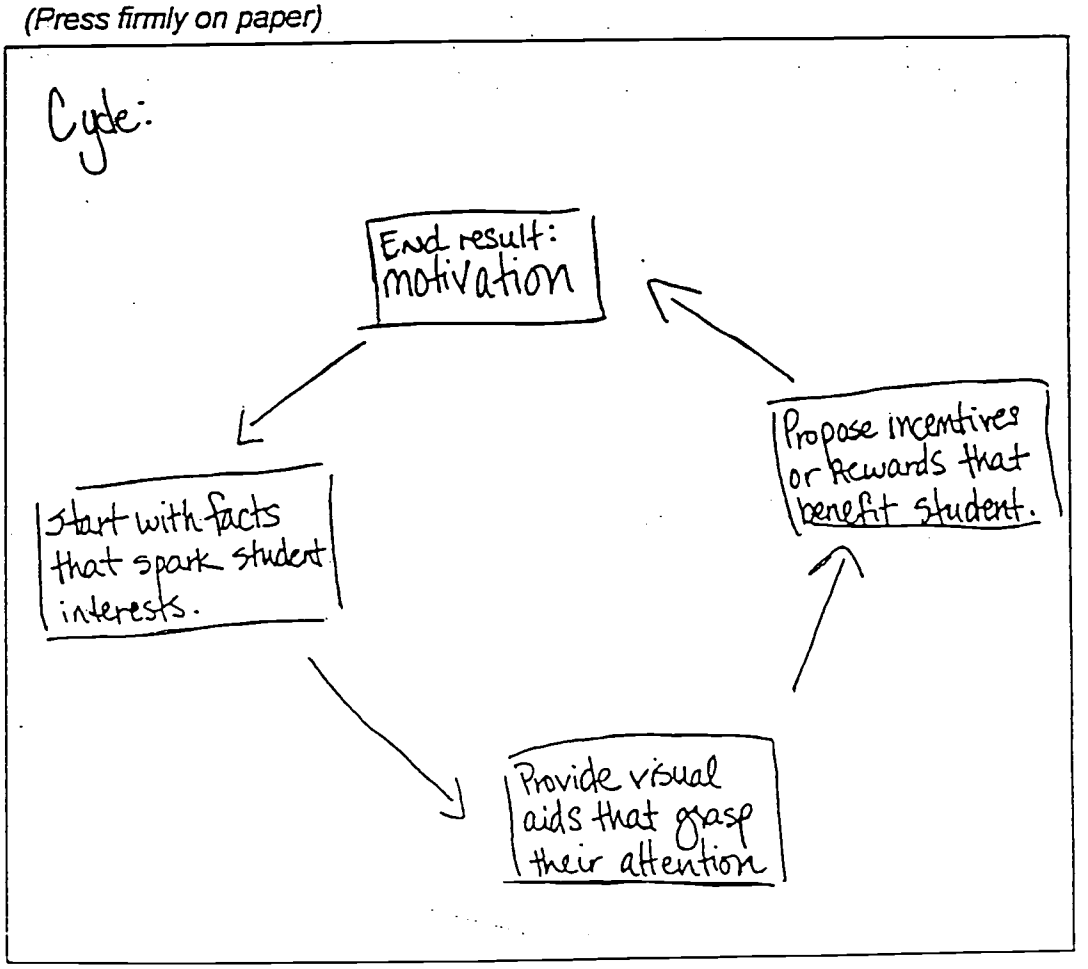


Although Bill and Elliot are fairly similar in ability, they are as different as night and day in their approaches to school. **Elliot** seems to care only about how he looks to others. For the school science fair, for example, he selected an extremely easy project on ants that looked fancy and impressive but, actually, have very little substance. He continually makes excuses before taking tests, such as "I'm taking this without any studying." Or he might say, "I'll be happy with a C." After the test, however, he is quick to promote his own good performances when they occur. **Bill** is quite the opposite. He loves challenges and becomes totally immersed in books and projects. He says that when he gets interested in something, he wants to learn all that he can. He usually earns good grades in his courses, but he seems basically unconcerned about his tests.

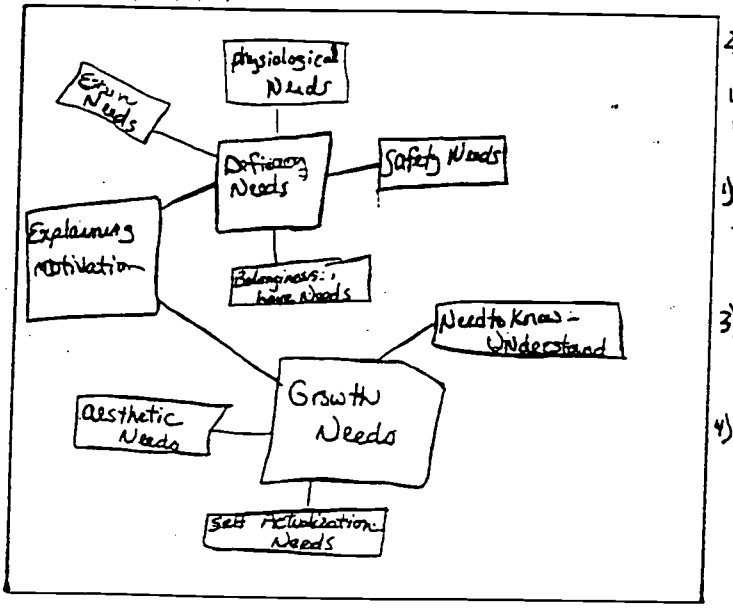
Based on Motivation theories discussed in class, explain the behaviors of the two boys according to different theoretical points of view.

Elliot seems to need more motivation in just the basics. He may not be aware of his capabilities because he is not interested thus accepting less of himself. Although he does like to flaunt a job well done.

Bill needs no motivation for his interests but rather for their importance. He needs to understand that his interests can be put to good use through his test taking.

APPENDIX B

(Press firmly on paper)



2) doesn't explain motivation it tells you what you need to provide motivation.

1) Has some flexibility but it is a little confusing

3) contains linking words, unsure if they are really linking though

4) It is original.

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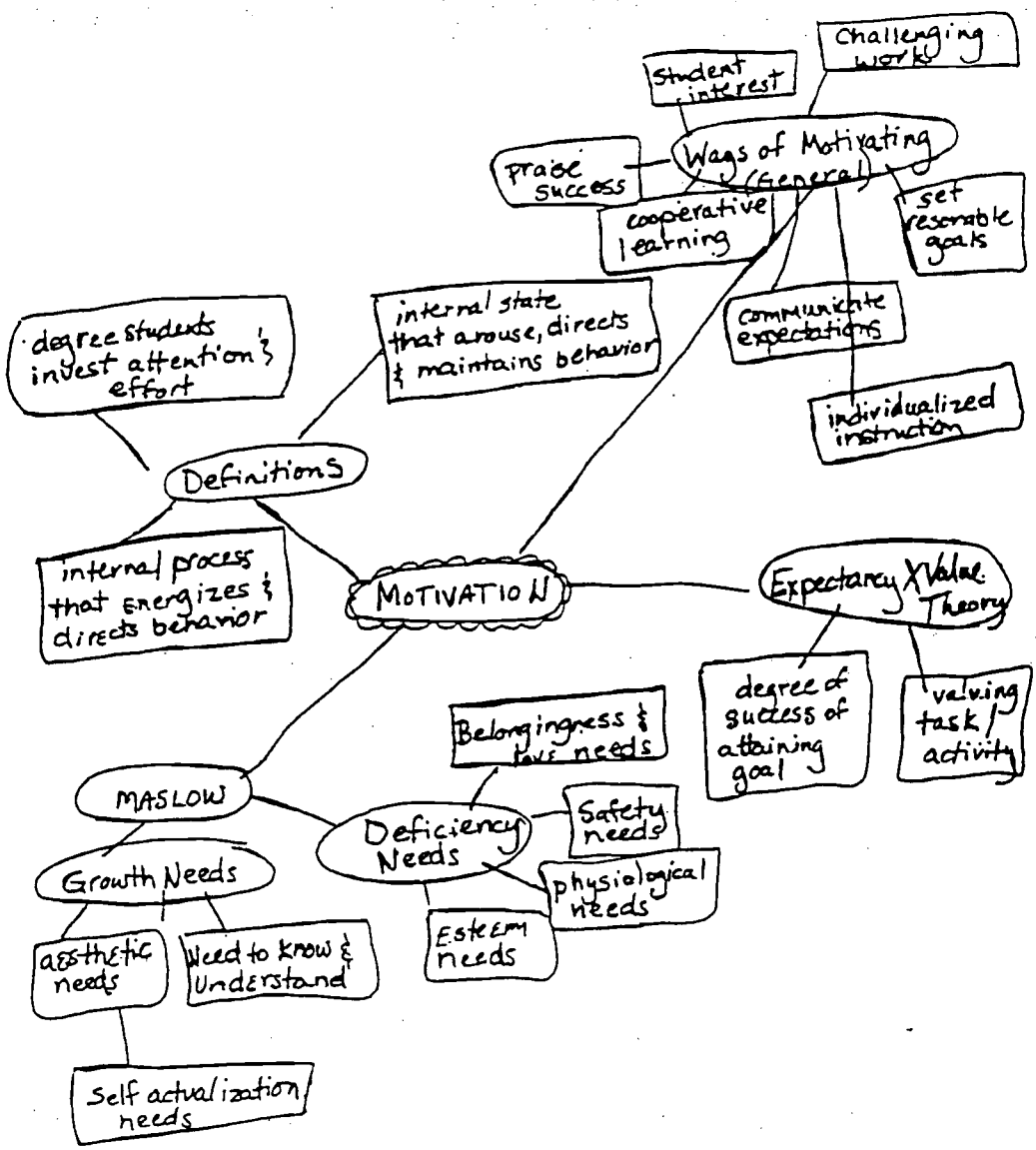
APPENDIX C



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