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ABSTRACT

This study examines the effect on learning of repeated plays of the simulation game "Trade and Develop" (T/D). It also examines the effects of students' ability, using a general measure (determined by school tracking procedures) and a specific measure (achievement test in the specific class). The results of the study indicate that, after playing the basic version of T/D twice, further playing of the basic game or the advanced game will not increase students' understanding of the mechanics of the game (perceptions), strategies of play, or analogies between the game model and the real situation. The effects of students' general ability on learning in the game were weaker for learning of strategies than for learning of perceptions of the game, or for understanding of the analogies between the game and real life. The learning of perceptions and of strategies was not related to the specific measure of achievement, but the correlation between learning of analogies and the achievement measure was significant. (Author)

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Center for Study of Social Organization of Schools

REPORT NO. 115
SEPTEMBER, 1971

THE EFFECT OF ABILITY, ACHIEVEMENT, AND NUMBER OF PLAYS ON LEARNING FROM A SIMULATION GAME

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INTRODUCTORY STATEMENT

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

The Center works through five programs to achieve its objectives. The Academic Games program has developed simulation games for use in the classroom. It is evaluating the effects of games on student learning and studying how games can improve interpersonal relations in the schools. The Social Accounts program is examining how a student's education affects his actual occupational attainment, and how education results in different vocational outcomes for blacks and whites. The Talents and Competencies program is studying the effects of educational experience on a wide range of human talents, competencies, and personal dispositions in order to formulate--and research--important educational goals other than traditional academic achievement. The School Organization program is currently concerned with the effects of student participation in social and educational decision-making, the structure of competition and cooperation, formal reward systems, effects of school quality, and the development of information systems for secondary schools. The Careers and Curricula program bases its work upon a theory of career development. It has developed a self-administered vocational guidance device to promote vocational development and to foster satisfying curricular decisions for high school, college, and adult populations.

This report, prepared by the Academic Games Program, investigates how learning from playing a simulation game (Trade and Develop) is affected by the number of plays of the game and the ability and achievement levels of the students involved.

ACKNOWLEDGMENTS

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ABSTRACT

This study examines the effect on learning of repeated plays of the simulation game Trade and Develop (T/D). It also examines the effects of students' ability, using a general measure (determined by school tracking procedures) and a specific measure (achievement test in the specific class).

The results of the study indicate that, after playing the basic version of T/D twice, further playing of the basic game or the advanced game will not increase students' understanding of the mechanics of the game (perceptions), strategies of play, or analogies between the game model and the real situation.

The effects of students' general ability on learning in the game were weaker for learning of strategies than for learning of perceptions of the game, or for understanding of the analogies between the game and real life. The learning of perceptions and of strategies was not related to the specific measure of achievement, but the correlation between learning of analogies and the achievement measure was significant. These results are discussed in terms of a learning model for games proposed by Coleman (1967, 1971).

INTRODUCTION

The number of simulation games available has been increasing exponentially over the past twenty years (Zuckerman and Horn, 1970). Classroom use of this new medium has become commonplace. While there is a growing body of knowledge concerning the types of learning fostered by simulations (Boocock and Schild, 1968; Livingston, 1970; Lee, 1971; Fletcher, 1971) much less is known about variables that mediate such learning. Inbar (1968) studied the effects of a number of student predispositions and variations in administration on learning in a simulation of a community disaster. He found that the major explanatory variable was the size of the playing group (p. 183). However, the game used by Inbar required the players to move one at a time, in sequence, and therefore the validity of his finding is restricted to this type of game. Fletcher (1971), in a study of the elementary social studies game Caribou Hunt, found that allowing students to examine the results of previous plays of the game increased the amount the students learned. Farran (1968) found that students who competed against one another as individuals learned more than students who worked as a group in competition with other groups. In a study using a business management game, McKenney and Dill (1968) found that grouping by ability was detrimental to low-ability students and that having faculty-advisors did not help increase group performance.

No studies to date have examined the effects of repeated plays of the game on learning. One purpose of the present study was to test the hypothesized advantage of multiple plays of a simulation game. It seems reasonable to expect that playing a simulation game several times would be more effective than playing it only once, for two reasons. The first involves the constraints imposed on a player when he commits himself to a certain strategy. In many games, the most important decisions are made at the beginning of the game and cannot be changed. In other games, although decisions are made at regular intervals throughout play, each decision is constrained by the results of previous decisions. Thus the player can vary his basic strategy only by playing the game several times. The second reason involves the problem of learning to play the game. During the first play of a game the players are often confused and uncertain about the rules and mechanics of play. Only after they have mastered the rules can they experiment seriously with different strategies.

A second purpose of the present study was to determine the effects of the players' academic ability on their learning in the game. In summarizing some of the gaming folklore and research on student ability, Boocock and Schild state, "Consistent empirical evidence shows that the relationship between learning in a game situation and performance in the conventional school setting is very weak." (1968: 256) In other words, poor students learn about as much from games as good students do. On the other hand, Fletcher (1971) found that student academic ability was

related to certain types of learning in games (i.e., the learning of the analogies between the game model and the real life situations). Thus, while the advantage of games claimed by Boocock and Schild for the low ability students is an important one, Fletcher's results indicate that it may not exist for some types of learning. Also, the measure of ability used may determine to some extent the results obtained. In the present study both a general measure of ability (as determined by the school tracking procedure) and a specific measure of ability (achievement test in the specific class) are included for study.

METHOD

The Simulation Game

The simulation game used in the present study was Trade and Develop (Livingston, 1969), a game designed to teach certain basic economic principles that affect the development of a nation. It is a highly simplified, abstract representation of an international economy. The major principles embodied in the rules and payoff structure of the game are the productivity of labor, the productivity of capital, and their interdependence.

One play of Trade and Develop (T/D) consists of six rounds with four separate phases per round: production, trade, investment, and consumption. Each player has his own playing board, which depicts three sectors of the economy: basic industry, consumer industry, and agriculture. Decisions are indicated on these individual boards, so the players can make simul-

taneous decisions. Each player's goal is to maximize his country's satisfaction points, which are gained during the consumption phase of each round. At the end of the game, each player also receives bonus points based on the development of his country's productive capability. Differences between countries in the productive capability of the three sectors encourage trade and interdependence. Role playing is unimportant in T/D; players are simply told that they represent the economic decision makers of their country.

The advanced version of T/D, which was also used in this study, introduces a fourth sector into the economy--extractive industry. A country has the capability of extracting either iron ore or petroleum but not both. Thus the interdependence among the two types of countries is increased. In both levels of the game players compete against other countries with the same capability. Thus, there are two winners in each play of the game; one for each group of countries with the same development potential.

Sample

The subjects who participated in this study were 111 eighth grade students at a semi-rural junior high school in Carroll County, Maryland. They were members of four social studies classes taught by the same teacher. Two of these classes consisted of high-ability students and two of low-ability students.

Measures of Game Impact

The measures of game impact (i.e., learning) consisted of categories of test items on the students' understanding of the game. The test items were divided into three categories: perceptions of the game, strategies, and analogies (Fletcher, 1971). Questions in the first category (perceptions) were designed to test knowledge of the mechanics of the game.

Example: In the Trade and Develop game, you get points for

a) producing b) trading c) consuming d) all of these

The items in the second category (strategies) test the student's knowledge of the game strategies that will yield the most points.

Example: If you are going to get one tractor fleet, one factory, and one steel mill, which one should you get first?

a) the tractor fleet
b) the factory
c) the steel mill
d) it doesn't matter

The third category (analogies) contained the items designed to determine whether the students understood the analogies between the elements of the game and those of real life.

Example: The tokens with a picture of a man stand for what kind of people?

a) all the people
b) all the men
c) all the people who work
d) all the people in the army

(The full test of understanding of the game is given in Appendix A.) The total score on all items as well as a score for each category were used as the dependent variables.

Design of the Study. The major variable of interest in this study was the number of plays of the simulation game Trade and Develop. Three levels

of this treatment variable were included for investigation: playing the basic game twice (T_1), playing the basic game four times (T_2), and playing the basic game twice and the advanced version twice (T_3). (Students in T_1 worked on a map exercise while the others played the additional rounds of the game.) All activities were conducted as part of the students' regular social studies classes and administered by the regular social studies teacher.

The second variable investigated was the ability level of the classes involved. Two of the classes were classified as high ability and the other two as low ability, on the basis of the school's tracking procedure, which uses homogeneous grouping.

Students were assigned randomly to the three treatment groups within each of the four classes. Thus, the experimental design was a three-factor hierarchical analysis of variance: treatments by classrooms within ability levels.[1] The ANOVA Layout showing the sources of variance, degrees of freedom, and the appropriate F-ratios is given in Table 1 (Myers, 1966; 223). Table 1 also shows the specific null hypotheses tested by each F-ratio.

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[1]The major advantage of this design is that the variability between classrooms at each level of ability can be extracted as a source of variance and analyzed. The major disadvantage of this design is that the degrees of freedom for the F-ratios of primary interest are small, and therefore the significance tests lack statistical power. However, if the observed effects for classrooms and classrooms-by-treatments are sufficiently small, then the variance and the degrees of freedom associated with these effects may be pooled with the within-cell variance and degrees of freedom, to increase the statistical power of the significance test.

The students had taken a mid-term exam on economic geography just prior to playing the game. The relationships between this measure of achievement and the game impact measures were also investigated. This test was considered a specific measure of ability as opposed to the general ability levels determined by the school tracking procedures.

The data were analyzed using Finn's (1968) MULTIVARIANCE program on the University of Maryland's Univac 1108 computer.

RESULTS

There were no significant differences between the treatment groups (T_1, T_2, and T_3) on any of the game impact measures. For the total on the test of understanding the game and for its analogies subtest there was a significant treatment-by-class interaction effect. However, the differences that produced this effect were closely matched by differences in student achievement on a test taken before the students played the game. Figure 1 illustrates this relationship. There was also a significant effect for ability on all the measures, with high-ability students outperforming low-ability students on the total test and each subtest. Table 2 presents the means for each treatment group in each class (the cell means) on the game impact measures and on achievement.

Tables 3 and 4 present the results of the analysis of variance for each of the game impact measures. For the purpose of pooling variances, a C/A or TC/A effect was assumed not to exist when its associated F-ratio would occur under the null hypothesis with probability of .40 or greater.

When the associated p-value was less than .40, no such assumption was made, and the variances were not pooled.[1] While the effect of ability was significant in all the subtests for understanding of the game, this effect was smallest in the strategies subtest, accounting for only 11 percent of the total variance, as compared with 22 percent and 27 percent in the other two subtests (as determined by the correlation ratio eta squared).

The relationships between classroom achievement and the game impact measures were studied by means of a correlational analysis. Table 5 shows the average within-cell correlation of achievement with each of the measures. Of these correlations only the one between achievement and the analogies subtest was significant ($p < .05$; two-tailed test).

Two other variables of interest on which information was available were sex of student and whether or not the student had acted as a scorer in at least one game. The correlations of these dichotomous variables with understanding of the game are shown in Table 6. The only correlation that reached significance was between sex of student and the analogies subtest; the girls outperformed the boys. However, even this relationship becomes non-significant when achievement is taken into account; the partial correlation between sex of student and analogies score, controlling for achievement, was .19.

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[1]For a discussion of this technique, see Myers (1966, pp. 283-288), Kirk (1968, pp. 214-217), or Winer (1962, pp. 202-207).

DISCUSSION

The results of this experiment indicate that, for students who have played the simulation game Trade and Develop twice in its basic version, further playings of either the basic game or the advanced game will not enhance their understanding of the mechanics of the game (perceptions), strategies of play, or analogies between the game model and the real situation. It is evident from the group means given in Table 2 that after playing the game four times even the high ability students scored low in terms of their understanding of the game. On the average, students were able to answer correctly only half of the perceptions and strategy questions. High ability students, on average, answered three-fourths of the analogies questions correctly and the low ability students answered half of them correctly.

These results are consistent with the answers students gave to the question "How many more times would you like to play Trade and Develop?", which was asked at the end of the last game. A number of students in each of the groups indicated that they were just beginning to understand the game. Furthermore, these students indicated that they wanted to continue playing the game once or twice for the rest of the semester. It may be that such periodic use of games in the classroom would provide for more effective learning. The game period could function in a manner analogous to the laboratory period in the physical sciences (as suggested by Lee, 1971 and others).

In addition to providing the benefits of multiple play mentioned in the introduction, such periodic play would allow time for the student to reflect upon his previous performance, discuss his experience with others, and plan new strategies.

The effects of student ability on learning in the game are basically in agreement with those found by Fletcher (1971), in that the effect of ability was weaker for learning of strategies than for perceptions of the game or for understanding of the analogies between the game and real life. This association is at odds with the assertion of Boocock and Schild (1968) mentioned in the introduction.

The association between student achievement and understanding of the game is more in line with the Boocock and Schild claim in that two of the subtests were not related to achievement. However, the correlation between analogies and achievement is significant. In addition, this relationship was observed within treatment groups and across treatment groups within classes where the restriction in the variation of achievement would tend to restrict the size of a correlation coefficient.

To understand better the results for achievement and ability it may be useful to discuss a model for learning from games presented by Coleman (1971). Coleman divides learning situations into two categories, real-life and classroom. Within this framework, simulation games fall under the category of real-life learning. The three major stages within real-life learning are:

Stage 1 - Actions in the particular situation
Stage 2 - Understanding the particular situation
Stage 3 - Understanding the general case

In terms of the understanding-the-game test, strategies measure learning at Stage 1. That is, a person may know the optimum strategy without understanding why it is best. Similarly, the perception items measure learning between Stages 1 and 2, while the measure of analogies involves making generalizations between Stages 2 and 3, from the game to the real situation. Coleman argues that intellectual ability is least important for learning at stage one and most important for learning at Stage 3. The squared correlation ratios (η^2) in Table 4, showing the percent of variance in each of the three subtests accounted for by ability level of the class, order the stages in accord with Coleman's contention:

Stage 1	Strategies	$\eta^2 = .108$
Stage 2	Perceptions	$\eta^2 = .217$
Stage 3	Analogies	$\eta^2 = .269$

Essentially the same is true for the correlations of the subtests with achievement, except that perceptions and strategies change order (Table 5). Coleman suggests that in order for students of lower ability to achieve learning at Stages 2 and 3 additional activities such as post-game discussions are necessary.

The initial optimism expressed by Boocock and Schild (1968) for simulation games and academically unsuccessful students must necessarily be qualified by the measure of academic success being used. Further studies

paying more attention to the way such variables are defined are needed if we are to understand what specific advantage games hold, if any, for the academically unsuccessful student.

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Table 1

ANOVA TABLE FOR THE TREATMENTS
BY ABILITY WITHIN CLASSROOMS ANALYSIS OF
VARIANCE

SOURCE OF VARIANCE	DEGREES OF FREEDOM	F RATIO	NULL HYPOTHESES
Between Classes			
Ability (A)	1	$\frac{MS_A}{MS_{C/A}} = F_1$	No significant differences between low and high ability students.
Classes/Ability (C/A)	2	$\frac{MS_{C/A}}{MS_{S/TC/A}} = F_2$	No significant differences between classes within each ability level.
Within Classes			
Treatments (T)	2	$\frac{MS_T}{MS_{TC/A}} = F_3$	No significant differences between the three treatment groups.
T x A (interaction)	2	$\frac{MS_{TA}}{MS_{TC/A}} = F_4$	The three treatments are not differentially effective at the two levels of student ability.
T x C/A (interaction)	4	$\frac{MS_{TC/A}}{MS_{S/TC/A}} = F_5$	The three treatments are not differentially effective between classrooms within ability levels.
Subjects/T x C / A (within cells)	$\sum_{ijk}^{N} (n_{ijk} - 1)$		

TABLE 2

Group Means on Game Impact Variables and Achievement

			Achievement	Understanding of Game			
				Total	Perceptions	Strategies	Analogies
Low Ability	Class 1	T1	6.57	4.22	1.00	.89	2.33
		T2	7.25	5.38	1.25	1.25	2.88
		T3	5.00	3.88	.38	.88	2.63
	Class 2	T1	4.50	2.86	.67	.86	1.43
		T2	5.00	3.67	1.00	1.33	1.33
		T3	6.17	4.57	.57	1.29	2.71
High Ability	Class 1	T1	9.17	7.67	2.11	2.11	3.44
		T2	6.82	6.58	1.75	1.67	3.17
		T3	7.92	6.53	1.38	1.62	3.54
	Class 2	T1	8.25	5.78	1.33	1.33	3.11
		T2	10.00	6.75	1.58	1.58	3.58
		T3	9.50	6.82	1.82	1.82	3.18
Maximum Possible Score			12.00	10.00	3.00	3.00	4.00

TABLE 3

Analysis of Variance for Game Impact Variable

Understanding of Game

Source of Variation	df	SS	MS	F
A	1	173.78	173.78	73.60**(a)
C/A	2	8.82	4.41	1.97
T	2	2.84	1.42	1
TA	2	5.02	2.51	1
TC/A	4	27.04	6.76	2.91*
Error	99	229.68	2.32 2.36(b)	
Total	110	447.18		

$\eta^2_A = .389$

$\eta^2_{TC/A} = .061$

*p < .05

**p < .01

a F-ratio calculated using pooled error mean square

b Value of pooled error mean square

Table 4. Analysis of variance for subtest scores for understanding of game

Source of Variation	df	Perceptions SS	Perceptions MS	Perceptions F	Strategies SS	Strategies MS	Strategies F	Analogies SS	Analogies MS	Analogies F
A	1	19.40	19.40	31.63** (a)	10.12	10.12	12.95** (a)	31.31	31.31	9.90**
C/A	2	.56	.28	<1	.72	.36	<1	6.32	3.16	4.62*
T	2	1.90	.95	1.48 (a)	.24	.12	<1 (a)	2.50	1.25	<1
TA	2	1.56	.78	1.22 (a)	1.14	.57	<1 (a)	2.08	1.04	<1
TC/A	4	4.56	1.14	1.83	2.92	.73	.93	7.08	1.77	2.59*
Error	99	61.38	.62		78.21	.79		67.32	.68	
			.61 (b)			.78 (b)				
Total	110	89.36			93.95			116.61		
		$\eta^2_A = .217$			$\eta^2_A = .108$			$\eta^2_A = .269$		
								$\eta^2_{TC/A} = .061$		

*p <.05

**p <.01

a F-ratio calculated using pooled error mean square

b Value of pooled error mean square

TABLE 5

Pooled Within-Cell Correlations

Type of Learning	Achievement
T/D - Total	.12
Perceptions	-.11
Strategies	-.02
Analogies	.33*

*$p < .05$; df = 83

TABLE 6

Correlation of Sex and Scorer With Understanding of the Game

Understanding of the Games	Sex[1]	Scorer[2]
Total	.10	.02
Perceptions	.09	.12
Strategies	-.15	-.09
Analogies	.25*	.01
	(n = 105)	(n = 107)

[1]Code: 1 = male; 2 = female

[2]Code: 1 = no; 2 = yes

*$p < .05$ (two-tailed test)

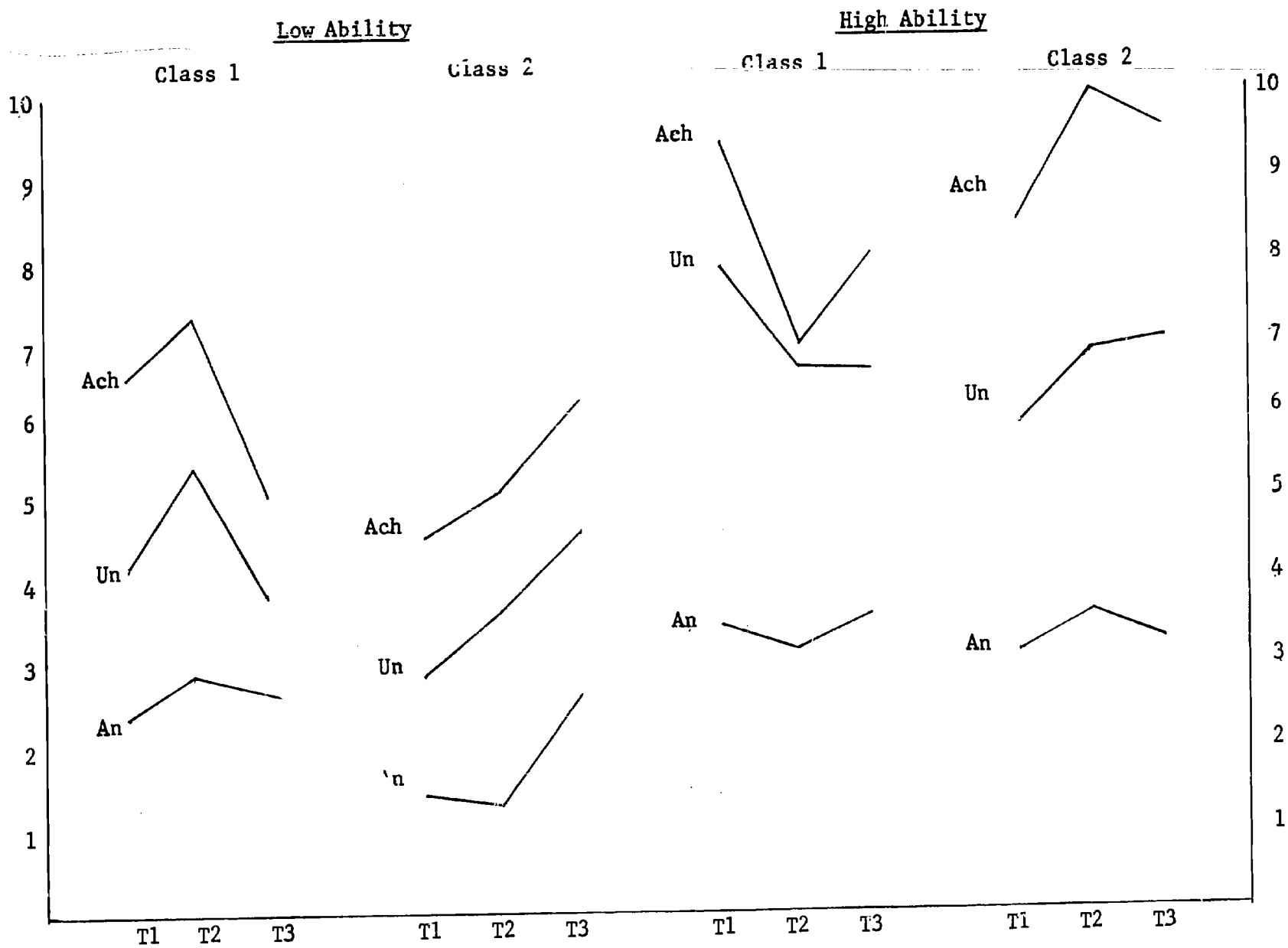

Figure 1. Mean scores of treatment groups in each class showing the treatment by class interaction for total understanding of the game and analogies.

Ach = achievement; Un = understanding of game (total); An = analogies between game and real life.

APPENDIX A.

UNDERSTANDING THE GAME TEST

Name: _____

These questions are all about the game TRADE AND DEVELOP. Write the letter of the best answer.

Perceptions

C 1. In the TRADE AND DEVELOP game, you get points for
A) producing B) trading C) consuming D) all of these

C 2. Which of these will give you the most points?
A) one loaf and five boxes
B) five loaves and one box
C) three loaves and three boxes
D) all of these will give you the same number of points

A 3. Having a green chart (instead of a blue chart) lets you produce more in
A) agriculture
B) basic industry
C) consumer industry
D) none of these

Strategies

A 4. If you are only going to get one factory, the best time to get it is in
A) the first round
B) the last round
C) any round except the first
D) it doesn't matter

C 5. If you are going to get one tractor fleet, one factory, and one steel mill, which one should you get first?
A) the tractor fleet
B) the factory
C) the steel mill
D) it doesn't matter

A 6. In which game should a player with a blue chart try to get tractors?
A) a game with five blue charts and one green chart
B) a game with one blue chart and five green charts
C) a game with three blue charts and three green charts
D) none of these games

Analogies

B 7. The tokens with a picture of a loaf of bread stand for
A) bread only
B) all food
C) all food except meat
D) food and clothing

D 8. Which of these things could a "box" token stand for?
A) clothing
B) furniture
C) toys
D) all of these

A 9. Which of these things could a "steel beam" token stand for?
A) tools and machines
B) cars and bicycles
C) TV sets and radios
D) all of these

D 10. Each player in the game makes decisions for
A) a family
B) a company
C) a city
D) a country