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ABSTRACT

The purpose of the study was to investigate the relationship between selected student characteristics, student involvement in learning, and achievement. Both naturalistic (n = 28, 27) and experimental studies were conducted. In the experimental study, two classes (n = 29, 26) learned a sequence of matrix arithmetic by mastery learning strategies. The third class (n = 27) learned by more conventional strategies. A significant positive relationship was found to exist between student involvement and selected student and environmental characteristics in both studies. On the final unit, the mastery learning classes scored significantly higher than the conventional class on both student involvement in learning and achievement (p less than .001). (Author)

Student Involvement in Learning and School Achievement

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Student Involvement in Learning and School Achievement

Introduction

There is a theme which has been recurring consistently in educational writing during the past half century. This theme can be summarized in a single statement: learning is dependent on the behavior or involvement of the learner. This belief has been stated in various forms by Morrison (1926), Wheat (1931), Dewey (1938), Tyler (1950), and Rothkopf (1970). As popular as this belief has been there has been very little research which has been conducted to test the appropriateness of this belief, particularly in a school learning situation. Rather, most recent research in education has been concerned with investigating the relationship of teacher characteristics, teacher-student interactions, selected teaching methods and materials, and selected student characteristics (e.g., intelligence, school attitude, personality characteristics) directly to school learning or achievement. This study is an attempt to investigate this hypothesized relationship between student behaviors and learning.

In his paper "A Model of School Learning," Carroll (1963) quantified student involvement in learning with the use of a single variable, time. Time, according to Carroll, was not "elapsed time" (the time during which the student is in the presence of the instructor or instructional material): rather, time refers to the amount of time that the student is actively involved in learning. This latter amount of time is referred to in this paper as "time-on-task."

Carroll hypothesized several characteristics of the learner and the learning environment that affect the students' time-on-task. The learner characteristics are defined in terms of variables which are fairly stable (i.e., highly resistant to change). Examples of these characteristics are intelligence, aptitude, and motivation.

More recently Bloom (1971) hypothesized three sets of variables which affect both the level of achievement attained and achievement variation. These three sets of variables are cognitive entry behaviors (CEB), affective entry characteristics (AEC), and quality of instruction (QI). In contrast to Carroll's variables, Bloom operationally defined the two sets of student characteristics (CEB, AEC) in terms of more learnable or alterable characteristics.

Based on the writings of both Bloom and Carroll, time-on-task is hypothesized to be a mediating variable between the three classes of antecedent variables and achievement.

The Model

The purpose of this study is to investigate the following model.

Insert Figure 1 About Here

In words, the model states that student characteristics (CEB, AEC) in a given learning environment (QI) are related to, and affect, the amount of time that a student spends on-task (TOT) which, in turn, is related to, and affects, the student's achievement (ACH).

Specifically, the study was conducted to investigate the following three hypotheses:

1. There is a positive relationship between student time-on-task and student achievement.
2. There is a positive relationship between selected student and environmental characteristics and student time-on-task.
3. Students possessing more positive entering characteristics in a more adaptive learning environment will spend more of their time on-task and will show greater achievement than students possessing less positive entering characteristics in a less adaptive learning environment.

Before moving to the actual experiment itself one important point must be made. The change from the operational definition of student characteristics in stable terms to the operational definition of the characteristics in more learnable terms has great implications for education. If the model holds only when stable student characteristics are used as the antecedent variables, it has little relevance for educational practice. Since there is relatively little hope of altering stable characteristics in a single course or even a series of courses (especially at later years in the student's school life), there is also little hope of altering the amount of time the student spends on-task, and hence, the amount he learns. This leads us to the gloomy picture of the non-effects of school and schooling which seems to be somewhat prevalent in much of educational thinking today.

If, on the other hand, the student's entering characteristics can be defined in terms of specific cognitive pre-requisites and task or course-specific affect, the model holds great promise for explaining <u>and controlling</u> school learning.

Naturalistic and Experimental Studies

Two separate studies were undertaken to investigate the model. The first study was conducted in two naturally occurring classrooms. The second study was an experimental study.

There were two main purposes of the naturalistic study: to examine the associational relationships among the variables which, if present, would provide a basis for an experimental study; and, to facilitate the generalization of the results of the experimental study to naturally occurring classrooms.

Subject Matter and Samples

The samples used in the study were taken from a junior high school in a middle class suburb of a Midwestern metropolitan area. Mathematics was chosen as the subject matter for both sub-studies.

The naturalistic study was conducted at two grade levels. One sample consisted of twenty-seven seventh grade arithmetic students. The second sample consisted of twenty-eight ninth grade algebra students. The two classrooms were chosen at random from all of the seventh and ninth grade classrooms in one junior high school. The arithmetic class was taught a one-week unit on division and divisibility. The algebra class was taught a one-week unit on simplication of algebraic expressions.

In the experimental study, thirty students were randomly selected from each of three time blocks during which eighth grade students were assigned to mathematics classes. One of the three treatment conditions was randomly assigned to each experimental class. The students were taught a three unit sequence of programmed material in matrix arithmetic developed by Block (1970). Because of student absences during the duration of the study the three classes contained 29, 26, and 28 students who completed the entire experiment.

Operationalizing the Model

There are five variables in the model that need to be operationally defined: time-on-task, achievement, cognitive entry behaviors, affective entry characteristics, and quality of instruction.

The major variable in the model is time-on-task. Time-on-task refers to the time during which the student is actively involved in learning. There are two sets of behaviors which are relevant to the active involvement of the students: an overt set and a covert set. In other words, there are on-task behaviors (e.g., writing) that are, in fact, observable, and on-task behaviors (e.g., thinking) that are unobservable. Ideally, the time-on-task measure should include two components: an overt component and a covert component.[1]

The first component of the time-on-task measure is a classroom observation instrument. An observer watches each student for a period of six seconds and codes his behavior as being on-task or off-task. On-task behaviors include physically attending to the task, writing (taking notes or working on an assignment), or talking to a significant other about the task. The per cent of overt time-on-task was estimated by dividing the number of observations that the student was coded "on-task" by the total number of observations of that student.[2]

The second component of the time-on-task measure is based on a stimulated recall technique developed by Bloom (1953). This technique involves having a tape recording made of a teacher presentation or classroom discussion. After the class period is over the tape is played for the students. The tape is stopped at various points and the students are asked to write what they had been thinking at that point in time in the actual classroom situation. In a seatwork situation the procedure was modified since no verbal stimulus was present in the classroom. Periodically, the students were asked to stop working and write in a sentence or two what they were thinking just prior to being told to stop. The students' thoughts were then classified by judges as being relevant or irrelevant to the task.

The per cent of covert time-on-task was estimated by dividing the number of thoughts that were classified as task relevant by the total number of thoughts classified.[3]

Finally, the variable "time-on-task" is defined as the arithmetic average of the per cent of covert time-on-task and the per cent of overt time-on-task. Internal consistency reliabilities for this variable ranged from .71 to .86.

The remaining four variables in the model are defined in slightly different ways in the two studies. In the naturalistic study the following operational definitions apply.

Achievement is defined by the scores on a unit achievement test. The test was constructed to measure unit objectives at the knowledge, comprehension, and application levels of the cognitive taxonomy (Bloom _et al_., 1956), (r_{tt} = .85, .86).

Cognitive entry behaviors (CEB) were measured by the scores on the prior chapter achievement test (r_{tt} = .86, .84). Affective entry characteristics (AEC) were measured by scores on the National Longitudinal Study of Mathematics Ability Math Self-Concept Inventory (r_{tt} = .80. .66). Quality of instruction

(QI) was measured by the students' responses to two questions concerning their perceptions of two aspects of instructional quality: the comprehensability of the instructor's explanations, and the amount of reward or reinforcement received from the instructor.

In the experimental study, achievement was measured by the scores on each unit's achievement test. Reliabilities ranged from .62 to .82.

Cognitive entry behaviors (CEB) for each unit were measured by the achievement test scores on the prior unit. Affective entry characteristics (AEC) were measured by a single question asking the student how interesting he thought the next unit would be. The students responded on a five point scale from 1 (very boring) to 5 (very interesting). Quality of instruction (QI) was determined by the learning strategy to which the students were assigned. Mastery learning strategies were termed high quality of instruction while the more conventional strategy was termed low quality of instruction.

The Design of the Studies

The naturalistic study lasted five days. The procedure was the same in both the algebra and the arithmetic classes. On the first day the students were administered the AEC and QI measures. The observer assumed his place on one side of the front of the classroom. No coding of behaviors was done the first day. The major purpose was to have the students become accustomed to having another adult in the room. On the second day the observation procedure was begun. Each class period consisted of approximately twenty minutes of teacher presentation followed by thirty minutes of seatwork. In the presentation portion the teacher presented new material, worked examples, and answered questions. This same procedure was continued for the next two days. The students were instructed not to do any of their work at home. On the fifth day the achievement test was administered.

In the experimental study the three classes learned under two different strategies. The first class learned by a mastery learning strategy (Block, 1970) in which the students were provided with immediate feedback of results, corrective procedures, and additional time and help, if needed. All students in this class were helped to attain an 85 per cent level of mastery on each unit (85ML).

The second class received the same learning strategy as the first except all students were helped to attain a 75 per cent mastery level on each unit (75ML).

The third class received a more conventional learning strategy in which the students read the programmed text on each unit, were administered the test on that unit upon completion, and moved on to the next unit (CONV).

All three classes read the first unit of the programmed texts. After each student had completed the reading he took the unit test. After the test was corrected, those students in the 75ML and 85ML classes who did not attain their appropriate per cent correct were given additional time and student tutorial help in order to correct their mistakes. After the students in the two mastery classes corrected their mistakes, they were given a parallel review test containing the number of problems they had had incorrect initially which, when completed correctly, would bring them up to the criterion level. For example, suppose a student in the 75ML class initially had 13 of the 20 items correct, i.e., 65 per cent. For his review test he would be given two more problems. These two problems done correctly would bring him to the necessary 75 per cent mastery level. The CONV class was finished with the unit after the test was completed. The learning proceeded in the same manner for all three units. Each day one learning unit was given to the students.

The major purpose of the experimental study was to investigate the third hypothesis. Since this is the case it is necessary to indicate the differences between the mastery learning and conventional classes on the relevant antecedent variables.

The two classes differ in quality of instruction since the mastery learning class is provided with immediate feedback and corrective procedures. Also the mastery learning classes are provided with additional time in the classroom so that the mistakes can be corrected. The conventional class has neither of the above characteristics.

The cognitive entry behaviors of the students in the two groups differ because the mastery learning classes are required to attain a pre-set criterion level on each prior task before going on to the next task in the sequence. This pre-set criterion level provides all students with a high level of the necessary cognitive pre-requisites for each successive task. The conventional class moves to the next task after a test over the previous task has been administered. Thus the conventional class is likely to have a lower mean score as well as greater variability on the measure of cognitive entry behaviors.

Finally, Block (1970) concluded that the 85 per cent level of mastery maximized the affective outcomes of the total unit. The implication is that in a sequence of learning tasks or units, the affective entry characteristics for each successive task or unit are higher for a relatively high criterion mastery group than for a conventional group. The conclusion is that after a series of tasks the two groups which were quite similar at the beginning of the sequence will be quite different in both cognitive and affective pre-requisites for subsequent tasks.

Results

Because of the problems involved in using per cents in formal statistical analysis, a logistic transformation was performed on the data before the analyses were computed.

The first hypothesis was to determine if there exists a high associational relationship between time-on-task and achievement. The findings with regard to this hypothesis are presented in Table 1.

Insert Table 1 About Here

The results indicate that this relationship does exist. The zero-order correlations between the two variables were highly significant in the three samples ($p < .01$). It is of interest to note the similarity in the degree of the relationship in both the naturalistic samples and the control class of the experimental study. Further, a variance interpretation of the corrected[4] coefficients yields the finding that time-on-task accounts for between one-half to two-thirds of the variation in achievement.

The second hypothesis was to determine whether there exists a high associational relationship between relevant antecedent variable classes and time-on-task. The results pertaining to this hypothesis are presented in Table 2.

Insert Table 2 About Here

In terms of the zero-order correlations between each of the antecedent variables and time-on-task, there was a significant correlation between cognitive entry behaviors and time-on-task in two of the three samples. The lack of a significant relationship in the arithmetic sample was believed to be a function of the apparent non-sequential nature of the subject matter which questioned the appropriateness of the measure of cognitive entry behaviors selected. In two of the three samples there was a significant correlation between the affective entry characteristics measure and time-on-task.

Finally, in only one of the samples was the correlation between quality of instruction and time-on-task significant. This, however, was the only sample in which quality of instruction was defined in terms of the instructional strategy to which the student was assigned. In both of the other samples the measure of quality of instruction was based on the students' perceptions of the instructional quality.

When corrected multiple correlations were used to investigate the relationship of the composite of the antecedent variables and time-on-task, the antecedent variables account for between 25 per cent and 67 per cent of the variation in time-on-task. Since, however, only one, or at most two, of the three antecedent variables could be corrected for attenuation before being placed in the multiple regression analysis it is believed that the findings represent an underestimate of the relationship between the antecedent variables and time-on-task.

The third hypothesis was to determine the effect of high cognitive entry behaviors, positive affective entry characteristics, and a high level of quality of instruction as compared to low cognitive entry behaviors, less positive affective entry characteristics, and lower quality of instruction on both time-on-task and achievement.

In order to investigate the final hypothesis the three classes were compared on the two criteria on the third unit. As a check on the initial similarities of the classes, however, the classes were compared on the criteria on the initial unit. All three classes were subjected to exactly the same treatment up to the administration of the initial test in unit one. All students had read the programmed text on their own and taken the unit test. This initial comparison was a means of examining how similarly the classes functioned in the same treatment situation.

Table 3 presents the means, standard deviations, and F-ratios for per cent of time-on-task and original per cent correct for the three classes in both units one and three.

Insert Table 3 About Here

There is not a significant difference in either per cent of time-on-task or original per cent correct after the original amount of learning time in unit one. After the same initial learning experience the classes were approximately equal on the two criteria.

Before the univariate F-tests shown in Table 3 were calculated, a multivariate analysis of variance was performed with both per cent of time-on-task and original per cent correct as the criteria. The F-ratio for unit three (using Wilks lambda criterion) was 10.35 ($p < .001$). Following the multivariate analysis of variance, the univariate F-tests were computed. Significant differences were found among the classes on both time-on-task and achievement.

Insert Table 4 About Here

The orthogonal contrasts in Table 4 help to better understand the nature of these differences. The differences of interest were the difference between the two mastery learning classes (85ML - 75ML) and the difference between the combined mastery learning group and the conventional class ((85ML + 75ML)/2 - CONV). In considering the contrasts, the same finding occurs whether time-on-task or achievement in the criterion. The contrast between the two mastery learning classes was not significant. However, the contrast between the combined mastery learning group and conventional class was highly significant ($p < .001$).

The nonsignificant difference of the two mastery learning classes requires further investigation. The two mastery classes differed from the conventional class on all of the antecedent variables for unit three. They differed in quality of instruction by definition. There was a significant difference ($p < .001$) on the measure of cognitive entry behaviors. Finally, there was also a significant difference ($p < .01$) on the measure of affective entry characteristics.

The two mastery classes themselves were not significantly different on any of the antecedent variables. The quality of instruction was the same, again by definition. There was no significant difference on the measure of affective entry characteristics. Finally, since some members of the 75ML class attained scores higher than the required 75 per cent on the original unit two test the mean scores on the cognitive entry behavior measure were not significantly different. Thus, this nonsignificant result lends additional support to the hypothesized model.

Perhaps a graphic representation of the data will make the findings concerning the third hypothesis more clear. The trend over the entire three task sequence is seen in Figure 2.

Insert Figure 2 About Here

In the conventional class both per cent time-on-task and per cent achievement decrease over the entire sequence of units. The time-on-task line and the achievement line are very close to parallel for the conventional class. In the mastery group we see that both the per cent of time-on-task and the per cent achievement increase over the sequence of units.[5] While the increase in achievement from unit one to unit two appears quite small, the increase in time-on-task for these two units is more sizeable. This might indicate that unit two was more difficult than unit one, i.e., the students have to maintain a greater percentage of on-task time merely to attain the same level of achievement on the second unit as they did on the first. The third unit, by this reasoning, seems to be easier since the achievement line shows a sharper rise than does the time-on-task line. In general, however, it can be seen that as we move from unit to unit time-on-task and achievement do, in fact, covary in both groups. Further, and equally important, as we move from unit to unit, groups of students who were very similar in their learning on the comparable learning task (task one) become increasingly dissimilar as they progress toward the end of the sequence.

Conclusions and Implications

Most of the conclusions and implications of the study are derived from the results of the experimental study. An attempt was made to relate the findings to the naturalistic study when possible. However, the strength of the model on which this study is based lies in the results of the experimental study.

Since this is the case it is important to enumerate some important limitations of this study. First, the experimental study was of very short duration and was an extremely controlled, structured situation. The entire study lasted approximately five hours over a one week period. The possibility of generalizing to less structured classroom situations extending over much longer periods of time must be carefully examined.

The experimental study consisted of sequential learning units. In the one situation (the arithmetic sample in the naturalistic study) in which the sequential quality of the course was uncertain, the model did not hold as well. Thus the generalizability of the results to non-sequential learning situations must be made with caution.

Despite these limitations the following conclusions and implications are offered. The model hypothesized in this study was supported by the data in both naturally occurring classrooms and in an experimental study. The results of this study lend support to the importance of student involvement in learning as a central variable in the learning process. The model on which this study is based uses achievement as an indicator of the learning which has occurred, time-on-task as an indicator of the students' involvement in learning, affective and cognitive entry behaviors as indicators of the characteristics and/or skills which the students bring to the learning situation, and quality of instruction as an indicator of the learning environment. The emphasis in education, accordingly, should be on helping the student become involved in the learning process (on-task) and maintaining this active involvement (time-on-task) by providing him with the necessary cognitive pre-requisites, helping him to maintain a high affective entry level, and providing a learning environment which allows for initial variation in student characteristics by offering varying amounts of elapsed time and help. Once this involvement in learning occurs and is maintained, learning follows. It is important to note that the antecedent variables which are related to, and affect, time-on-task can be reasonably defined in terms of learnable, alterable characteristics of the student.

A major conclusion which follows from the experimental study is that, contrary to the results of studies such as the Coleman report (1966) which studied the state of schools as they currently exist, school learning situations can be set up that can either create or destroy talent. In one of the experimental learning situations students were helped to spend increasingly more of their time on-task and achieve higher test scores on subsequent units. In another of the experimental learning situations student spent increasingly less of their time on-task and achieved lower test scores on subsequent units. In similar learning conditions, the two groups of students were quite similar in both per cent of time-on-task and achievement.

With the above discussion in mind, one major implication that follows from the study concerns the importance of time-on-task as a critical and alterable variable in school learning, and the parallelism which exists between time-on-task and achievement. Put simply, as students spend more of their time on-task they learn more. Since this is the case, time-on-task can be viewed as a criterion variable in its own right. Teaching effectiveness can be evaluated while learning is occurring and not after it has already occurred.

This study puts the effects of schooling in a quite different perspective from that of Coleman and, more recently, Jencks (1972). However, it must be noted that these previous studies were reports of the way schools and school learning currently are. The present study, on the other hand, is a study of what schools can do. The emphasis is totally different. While prior studies have tended to look at and possibly explain the present, the present experimental study has attempted to speculate on what might be possible.

Footnotes

[1] Those interested in a more complete description of the time-on-task instrument are referred to Anderson (1973).

[2] For the purposes of objectivity a second observer was brought into the classroom periodically. The per cent of observer agreement in both studies ranged from 79 to 89 per cent.

[3] Again for the purposes of objectivity a complete set of the papers was given to the second judge. The per cent of inter-judge agreement was approximately 89 per cent.

[4] The correlations were corrected for attenuation. Since the purpose of examining the correlations is to test a model, both observed correlations and correlations corrected for attenuation are given. O'Connor (1972) and others recommend the practice of correcting for attenuation when one "is interested in the relationship between the true scores of the variables" (p. 76).

[5] The significance of the increase and decrease in both time-on-task and achievement from unit one to unit three was tested by a correlated t-test. Both the increase and decrease were significant ($p < .005$).

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TABLE 1

Zero Order Correlations (Observed and Corrected) Between Time-on-Task and Achievement

Sample	N	Observed r	Corrected r
Naturalistic Study			
Arithmetic	27	.59**	.76
Algebra	28	.62**	.73
Experimental Study			
Conventional Group	27	.66**	.82

Note.--The following convention for level of significance is used throughout this paper: .05 level = *; .01 level = **; and .001 level = ***. Also, ns is used to indicate that the finding is not significant at the .01 level or above.

TABLE 2

Correlations Between Antecedent Variables and Time-on-Task

Variable	Sample: Naturalistic Study Arithmetic (n=27)	Naturalistic Study Algebra (n = 28)	Experimental Study Matrix Arithmetic (n = 82)
CEB	.26	.58**	.52**
AEC	.32	.45*	.35**
QI	.14	.30	.50**
Multiple R	.38	.68	.57
Corrected R	.49	.82	.66

Note. -- The zero order correlations were corrected for attenuation before the multiple correlation was computed.

TABLE 3

Means, Standard Deviations, and F-Ratios for Per cent Time-on-Task and Original Per cent Correct for the CONV, 75ML, and 85ML Groups in Units 1 and 3

Group	Per Cent Time-on-Task Mean	Per Cent Time-on-Task Stand. Dev.	Original Per Cent Correct Mean	Original Per Cent Correct Stand. Dev.	F - Ratio TOT	F - Ratio ACH
			Unit 1			
CONV	76.6	17.1	65.3	13.6	0.25ns	0.79ns
75ML	73.6	16.4	69.0	12.9		
85ML	73.7	12.2	64.8	12.0		
			Unit 3			
CONV	62.3	18.6	49.1	18.3	13.56***	19.41***
75ML	75.8	12.5	74.2	18.9		
85ML	82.4	11.6	75.5	13.9		

Note. -- The per cent of time-on-task reported in this table is the per cent of time that the students were on-task in the original learning situation, i.e., before the mastery classes received extra time and help.

TABLE 4

Orthogonal Contrasts Among 85ML, 75ML, and Conventional Groups

Contrast	Value [Standard Error] of the Contrast	P less than
	Time-on-Task in Unit 3	
85ML - 75ML	0.092[0.063]	ns
(85ML + 75ML)/2 - CONV	0.274[0.055]	.001
	Original Achievement in Unit 3	
85ML - 75ML	0.018[0.088]	ns
(85ML + 75ML)/2 -CONV	0.476[0.076]	.001

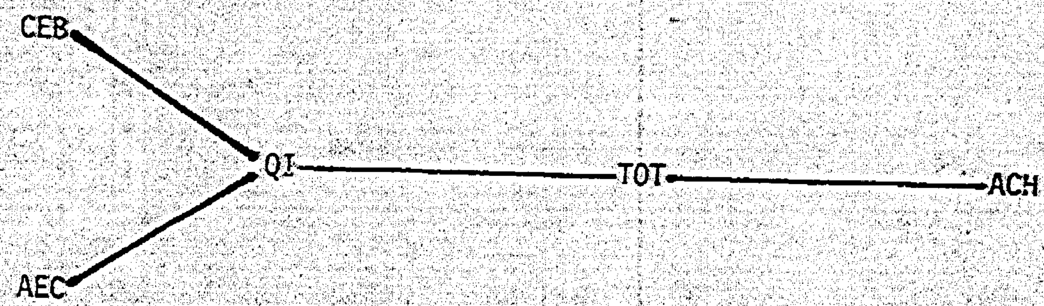

Fig. 1. -- A Schematic Form of the Model

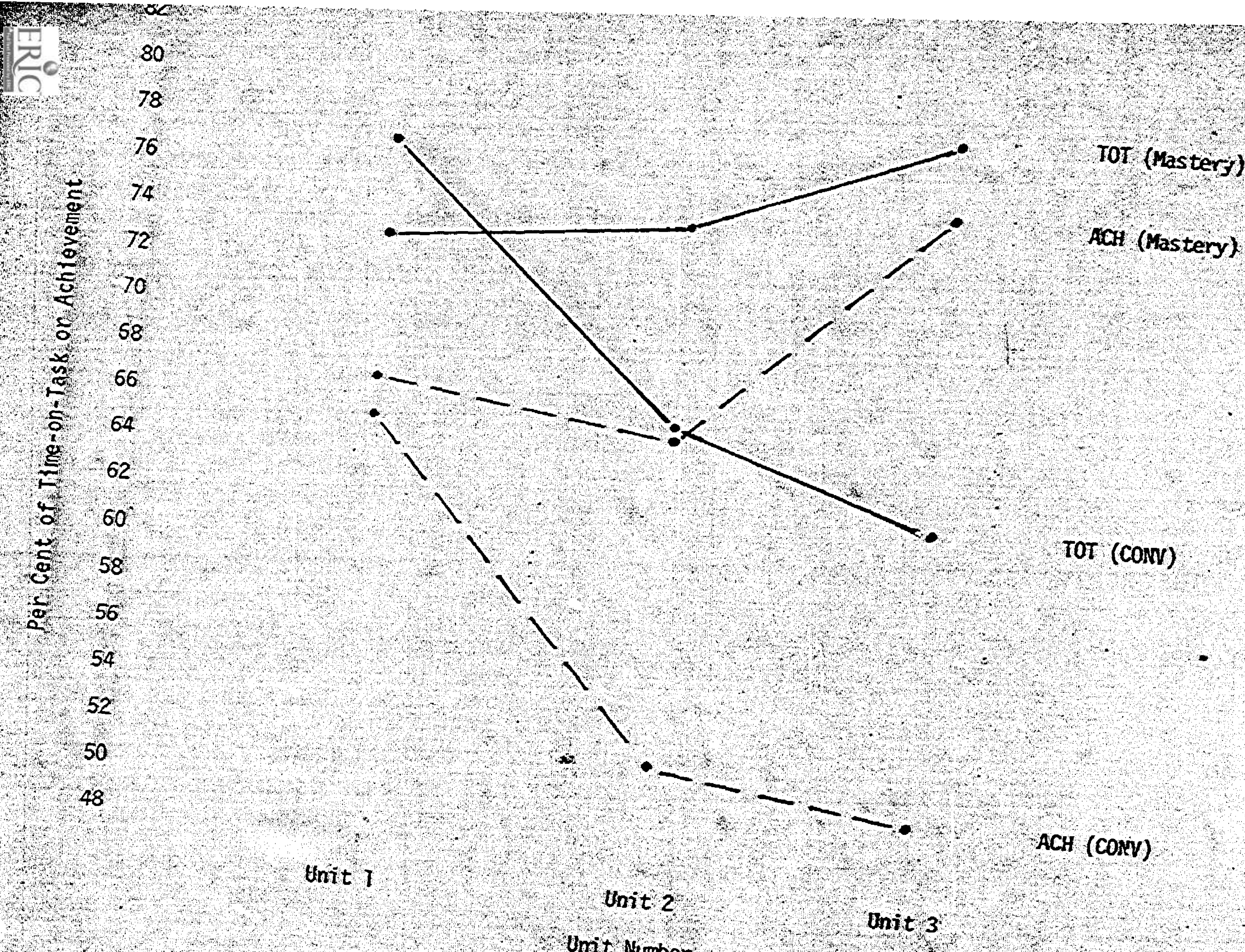

Fig. 2.—Per cent Time-on-Task and Per cent Achievement Over Three Consecutive Units: Mastery and Conventional Groups