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AUTHOR Root, Jon R.; Gall, Meredith D.
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ABSTRACT

A study was conducted to determine whether conventional instruction and mastery-based auto-tutorial instruction interacted with learning characteristics that were found to be instruction-interactive in previous research. Conventional instruction consisted of lecture with discussion and laboratory periods. The mastery-based auto-tutorial instruction consisted of multi-media modules that the learner studied until mastery was attained, and student-teacher communication was minimal and occurred only in individual discussions. Undergraduates enrolled in an undergraduate course in wildlife recreational techniques were administered the following tests: the Ac (achievement via conformance) and Ai (achievement via independence) scales of the California Psychological Inventory, the internal-external locus of control scale (Rotter, 1966), a multiple-choice achievement test covering content from the experimental unit, a delayed achievement test developed and administered eight and one-half weeks after the experimental period, and semantic differential scales designed to measure student attitudes. The findings indicate that one can enhance learning by using Ac scores to match students with an instructional treatment. Students with low Ac scores achieved better when assigned to mastery instruction and students with high Ac scores achieved better when assigned to conventional instruction. (SW)

THE INTERACTION BETWEEN LEARNER CHARACTERISTICS AND TWO METHODS OF COLLEGE INSTRUCTION - CONVENTIONAL AND MASTERY LEARNING

Jon R. Root
Oregon State University

Meredith D. Gall
University of Oregon

In their review of research on college teaching, McKeachie and Kulik (1975) found that individualized instruction is the fastest spreading innovation in higher education. Individualized instruction is often supported by student-controlled audio and visual media, commonly referred to as auto-tutorial instruction.

Although reviews of the research literature on both individualized instruction (McKeachie and Kulik, 1975) and auto-tutorial instruction (Fisher and MacWhinney, 1976) report encouraging findings about their effectiveness in promoting student achievement, some researchers claim that there is no single instructional environment that is best suited for all students (e.g., Berliner and Cahen, 1973). The purpose of this study was designed to test whether conventional instruction and mastery based auto-tutorial instruction interacted with learning characteristics found to be instruction-interactive in previous research. This type of investigation is sometimes referred to as attribute-treatment interaction (ATI) research (Tobias, 1976).

Conventional instruction consisted of lecture with discussion and laboratory periods. In contrast, the mastery based auto-tutorial instruction consisted of multi-media (video-tape cassettes, slide-tape, and printed materials) modules that the learners studied until mastery was attained. The students were tested for mastery on each module. Student-teacher communication was minimal and occurred only in individual discussions.

Domino (1968) hypothesized that college students' achievement orientation, as measured by the achievement via independence (Ai) and achievement via conformance (Ac) scales developed by Gough (1957), would "...enhance or interfere with optimal functioning in settings where conformity or independence are differentially rewarded" (p. 256). His findings supported the hypothesis: high Ai students earned better grades in courses requiring

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independent learning behavior than in courses requiring conformity to the instructor's demands, whereas high Ac students performed in the opposite direction. In the present study, it was hypothesized that the high Ai student would do better under mastery learning conditions than under conventional instruction, whereas the high Ac student would do better under conventional instruction than under mastery learning conditions.

Another attribute that may interact with instructional variations is locus of control (Rotter, 1966). According to Rotter, when an individual perceives a reinforcement as following his or her action but not being completely dependent upon that action, the individual is likely to believe that the reinforcement was the result of chance, fate, or luck, and as being unpredictable. A person who interprets an event in this way is said to have a belief in external control. If an individual believes that the event is directly related to his or her own behavior or characteristics, this individual is said to believe in internal control. Daniels and Stevens (1976) found interactions between these variables and instructional method variations of traditional instruction and a contract for grade plan. In the present study, it was hypothesized that students high in internal control would do better under mastery learning than under conventional instruction, whereas students high in external control would do better under conventional than under mastery learning.

Prior achievement (knowledge of the curriculum content) was studied by Tobias and Ingber (1976), who obtained empirical support for their theory that the more prior achievement the student has in a subject area, the less the need for such instructional supports as instructional objectives, immediate feedback, and mastery-based learning environment. The present study hypothesized that students high in prior achievement would do equally well under conventional and mastery instruction, whereas students low in prior achievement would do better under mastery learning, which contains many elements of instructional support, than under conventional instruction.

METHOD

Treatments

The experiment occurred during the first three weeks of a state university undergraduate course entitled Wildlife Recreational Techniques. The course is open to any officially enrolled student and has no prerequisite.

The content covered during the experimental period was a sequence on spinfishing that included instruction on fishing lines, fish hooks, knots used in angling, sinkers, floats, swivels, terminal tackle, use and care of spinning reels, rod and reel selection, and spin casting for accuracy.

Th[illegible] tional instruction treatment consisted of two one-hour lec[illegible] cussion periods and one two-hour laboratory period per w[illegible] three weeks. The lectures consisted primarily of cogni[illegible] /pe content. During the laboratory periods the students w[illegible] given training in certain skills and assignments in equipmen[illegible] tilization.

Students in the mastery learning treatment were given assignments covering the same content as the conventional group. The mastery learning instruction incorporated the basic characteristics of individualized instruction and auto-tutortial instruction. It was composed of six modules presented in study guides, slide-tapes, video cassette lessons, and printed materials. The course instructor was available during regular office hours and on request by students. The students did not attend class but had the opportunity to use the instructional materials at two learning centers on campus. An assistant was available to check out materials, assist the students with problems, administer the mastery quizes, and keep the necessary records.

Students in the mastery learning treatment were required to take mastery tests and "master" each module before continuing on to the next module. Students who failed a module were allowed to take alternate tests until they mastered it. They were allowed to proceed at their own rate within the time frame of the experimental period (three weeks). Recommended completion dates were included in the study guide, but students were not required to follow the schedule except to have all modules completed by the end of the experimental period. They could study the modules as often as they liked before taking a mastery quiz. If, after reading the objectives of a module, they felt they could attain mastery without studying the material, they were allowed to take the quiz.

The content for each treatment was closely monitored to insure that it was as identical as possible.

Subjects

The 62 students enrolled in the course represented the many different disciplines and backgrounds usually found at a technology-oriented state university. Students were stratified by sex and year in college, and then were randomly assigned by stratum to the conventional instruction and auto-tutorial treatments. Due to adds and drops during the first week of classes, the final auto-tutorial group totaled 28 students and the final conventional group totaled 33.

Measures

The Ac (achievement via conformance) and Ai (achievement via independence) scales of the California Psychological Inventory

(Gough, 1957) were administered during the first class meeting. Both test-retest and construct validity of the scales have been demonstrated to be consistently good across a variety of settings (Gough, 1957).

The internal-external (I-E) locus of control scale developed by Rotter (1966) also was administered during the first class meeting. A substantial amount of research has accumulated in support of the scale's reliability and validity (Joe, 1971).

A multiple-choice achievement test covering content from the experimental unit was developed by the course instructor and the investigators. A thorough, systematic check of the items was made for content validity. This test was administered on the second day that the class met (pretest) and on the final day of the experimental period (posttest). The pretest administration was used to measure prior knowledge of curriculum content. The Kudar-Richardson formula 20 estimate of reliability based on the pretest data was .75.

A delayed achievement test was developed and administered eight and one half weeks after the experimental period, during the students' regular final examination period. The twenty items in the test were chosen from the achievement test given immediately before and after the experimental period. They were selected from items analyzed as discriminating between better and poorer students at the .05 confidence level on the posttest data.

Semantic differential (SD) scales were developed to measure students' attitudes toward the following concepts: (1) "Mastery learning," (2) "Instruction taught by the lecture method," (3) "Individualized instruction," and (4) "Face to face interaction with the instructor." Each scale included eight bipolar sets of adjectives. The internal consistency of the scales, estimated by Cronbach's alpha coefficient, was .89 for the "mastery learning," and .93 for the other three scales. These scales were administered during the first class meeting and again at the conclusion of the experiment.

RESULTS

Table 1 indicates that the two treatment groups were very similar on the pretest administration of the achievement test and of two of the attitude scales. Significant pretest differences between the two groups were found on the scales measuring "mastery learning" and "face to face interaction with the instructor." Therefore, a residual gain score was obtained for each student and used in subsequent analyses. To find the residual gain score, the posttest scores were regressed on the pretest scores. The resulting regression line was used to predict a posttest score. The actual posttest (Y) score then was subtracted from the predicted score (Y') to form the residual gain score (Y-Y').

Table 1

Pretest Differences Between Treatment Groups

Variable	N	$\bar{X}$	SD	t	df	p
Achievement Pretest						
Mastery	28	22.25	5.61	.18	57	.85
Conventional	31	22.51	5.47			
Achievement Pretest						
Mastery (female)	6	17.83	1.83	.91	10	.39
Conventional (female)	6	16.00	4.60			
Attitude toward "mastery learning"						
Mastery	28	40.93	6.32	2.24	57	.03
Conventional	31	36.26	9.26			
Attitude toward "lecture method"						
Mastery	28	33.21	6.44	-.92	57	.36
Conventional	31	34.77	6.53			
Attitude toward "face to face interaction"						
Mastery	28	46.68	6.83	2.45	57	.02
Conventional	31	42.64	5.84			
Attitude toward "individualized instruction"						
Mastery	28	46.36	8.40	1.31	57	.20
Conventional	31	43.58	7.91			

A residual gain score for the achievement posttest score (regressed on pretest scores) and the delayed achievement test (regressed on posttest scores) was also calculated for each student.

The t test for independent means was used to determine whether the difference between mastery and conventional group on each dependent variable was statistically significant. The results of this analysis are reported in Table 2 (achievement variables) and Table 3 (attitude variables). There were no significant differences between the means of the two groups on the posttest and delayed administrations of the achievement test. One significant difference was found between the means of the two groups on the scale measuring attitude toward "mastery learning." This difference is probably due to pre-existing differences between the two groups on this variable.

The analysis of attribute-treatment interactions was made through the use of the test for homogeneity of group regressions. Regions of significance for significant interactions were also defined. The computed regions of significance describe a range of values of the attribute scale (e.g. Ac) for which there are statistically significant group differences on the dependent variables (e.g., achievement).

Table 4 lists F-values and probabilities for the test of homogeneity of group regressions involving, Ai, Ac, Locus of Control, and Prior Achievement as attribute variables, and conventional instruction and auto-tutorial instruction as treatment variables; achievement scores were the dependent variables. The strongest attribute-treatment interactions involved Achievement via Conformance (Ac). The group slopes differed significantly for the posttest scores, the post residual scores, and the delayed residual scores.

Scattergrams were plotted to further clarify these interactions. Figure 1 shows the regression of Ac on the post achievement scores. The two regions of significance include 33 of the 59 students, that is, 56 percent of the total sample. From this analysis it appears that students who have high scores on the CPI Achievement via Conformance scale and who are assigned to conventional instruction demonstrate better learning than students who have high scores on this scale and who are assigned to mastery learning. In contrast, students who have low scores on the Ac scale and who are assigned to mastery learning demonstrate better learning than students who have low scores on this scale and who are assigned to conventional instruction. In brief, high Ac scorers do best in conventional instruction; low Ac scorers do best in mastery learning.

The finding when the achievement post residual scores were regressed against Ac was similar. The left region of significance extends

Table 2

Performance of Mastery and Conventional Group on Achievement Variables

Variable	N	$\bar{X}$	SD	t	df	p
Posttest						
Mastery	28	34.39	4.26	1.24	57	.22
Conventional	31	33.03	4.19			
Post Residual Gain						
Mastery	28	.45	4.18	1.17	57	.24
Conventional	31	-.70	3.30			
Delayed						
Mastery	27	17.26	2.89	.53	56	.58
Conventional	31	16.90	2.13			
Delayed Residual Cain						
Mastery	27	-.11	1.90	-1.22	56	.23
Conventional	31	.46	1.67			

Table 5

Performance of Mastery and Conventional Groups on Attitude Variables

Concept Variable	N	$\bar{X}$	SD	t	df	p
Post "mastery learning"						
Mastery	27	40.59	7.55			
				2.87	56	.01
Conventional	31	35.74	5.23			
"Mastery learning" residual gain						
Mastery	27	1.86	7.43			
				1.43	56	.09
Conventional	31	-.93	4.80			
Post "lecture method"						
Mastery	26	35.92	6.36			
				-.25	55	.80
Conventional	31	36.32	5.91			
"Lecture method" residual gain						
Mastery	26	-.04	5.94			
				.02	55	.99
Conventional	31	-.06	5.53			
Post "face to face interaction"						
Mastery	20	44.85	7.41			
				.82	56	.42
Conventional	31	43.29	7.07			
"Face to face interaction" residual gain						
Mastery	27	-.29	5.92			
				-.34	56	.73
Conventional	31	.28	6.71			
Post "individualized instruction"						
Mastery	27	43.92	8.23			
				1.42	56	.16
Conventional	31	41.87	8.12			
"Individualized instruction" residual gain						
Mastery	27	.63	5.17			
				.73	56	.47
Conventional	31	-.50	6.58			

Table 4

The Effects of Attribute by Treatment Interactions on Student Achievement

Achievement Test		Homogeneity of Group Regressions			
	N	A_i F-Value	A_C F-Value	Locus of Control F-Value	Pretest F-Value
Post	59	.06	12.87**	.87	.40
Post Residual	59	1.22	9.12**	.14	.25
Delayed	58	.30	2.65	1.11	.66
Delayed Residual	58	2.65	5.08*	.32	3.25

*p < .05

**p < .01

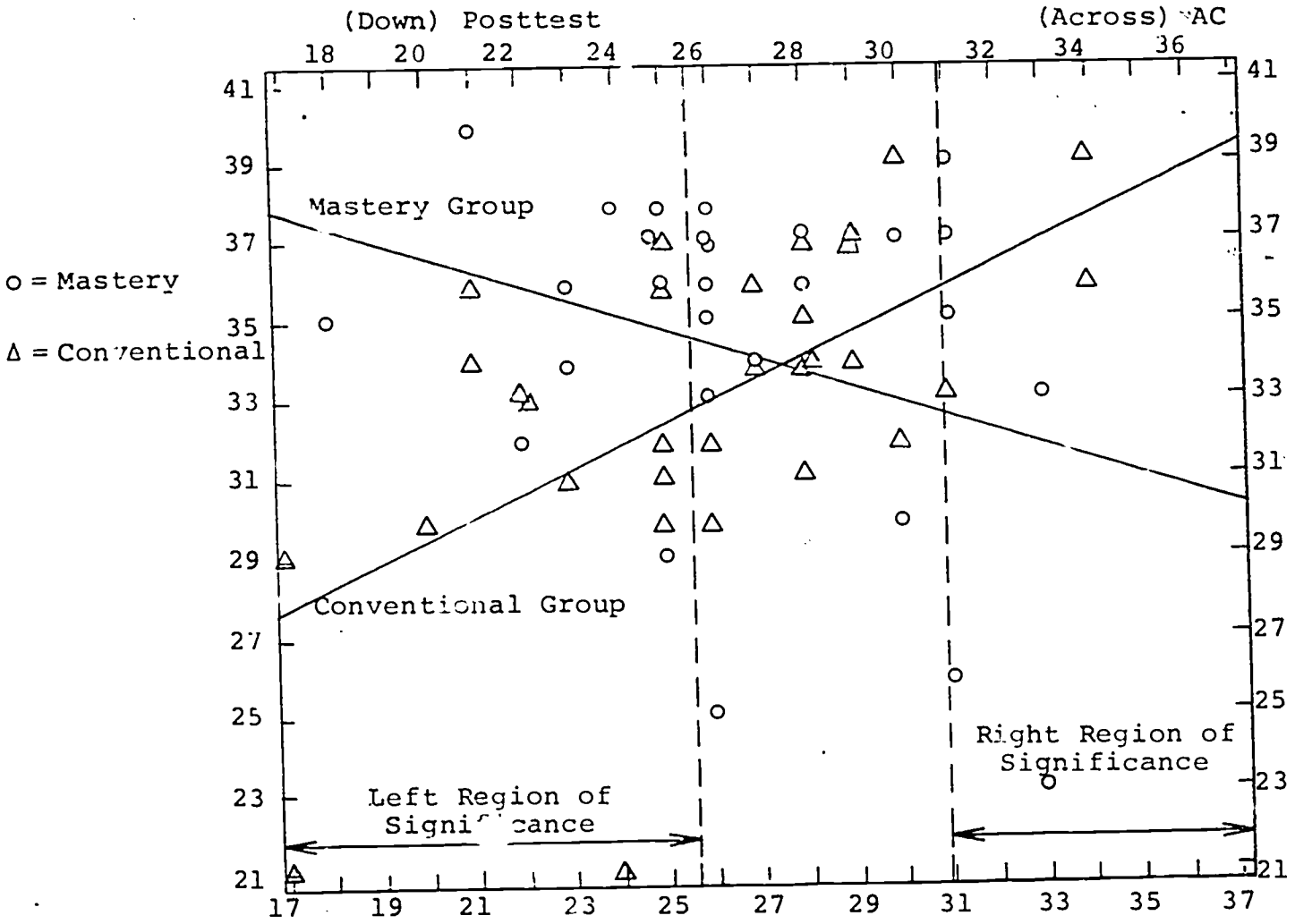


Figure 1

Ac by Treatment Interaction on Achievement Posttest

from the Ac value of 25.2. The right region of significance begins at the Ac value of 32.7. The left region of significance includes 44 percent of the students in the study.

Figure 2 shows the regression lines for Ac scores and achievement delayed residual scores. The left region of significance extends from the Ac value of 24.8 and accounts for approximately 15 of the 58 students, or 26 percent of the total sample. The right region of significance is not definable within the range of the data.

This finding is the opposite of the Ac interactions found for the achievement posttest and achievement post residual score. It appears that students who have low scores on the Ac scale and who are assigned to conventional instruction demonstrate better learning than students who have low scores on this scale and are assigned to mastery learning.

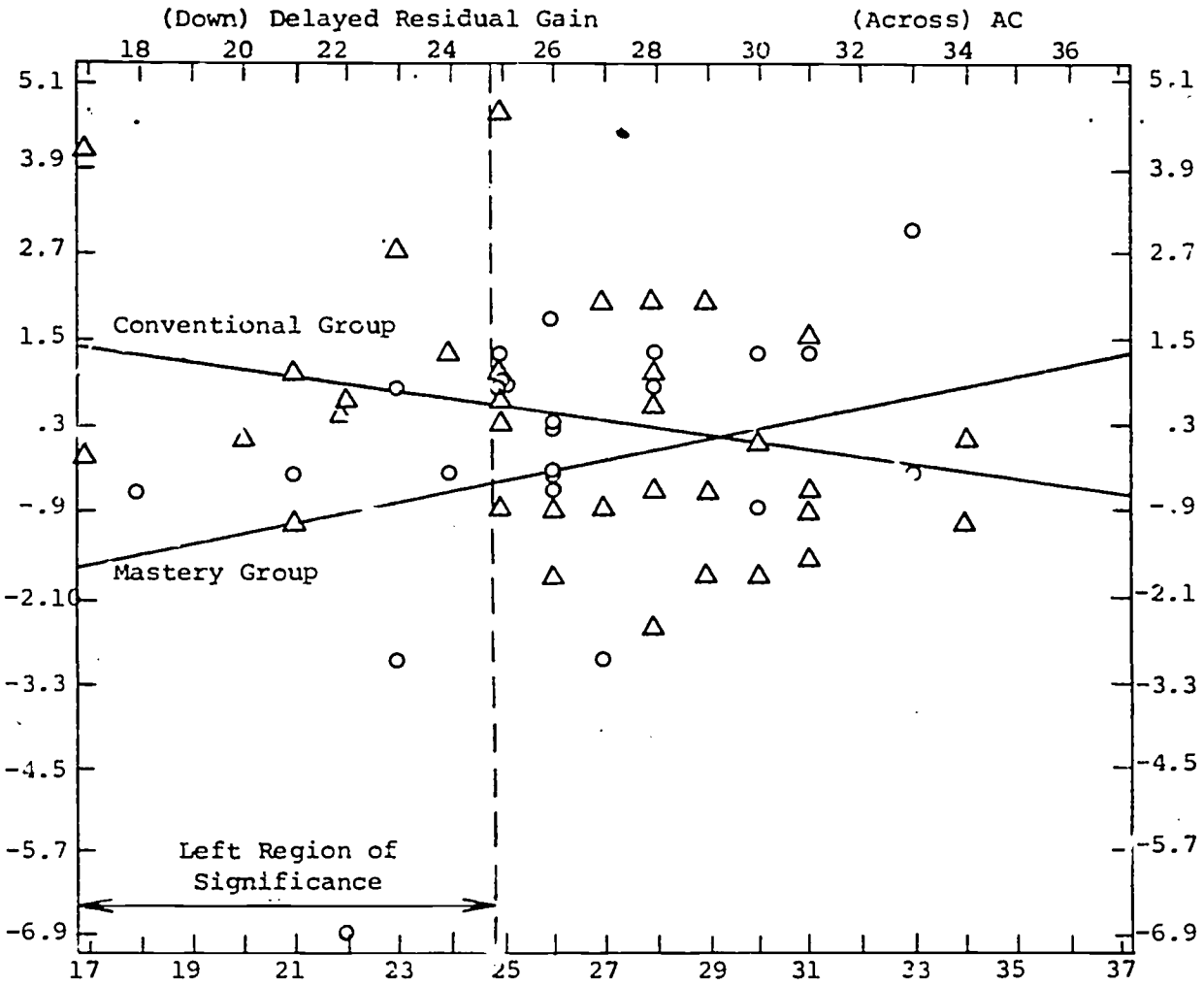
The results of the regression between the attribute variables of Ai, Ac, and Locus of Control, and the four attitude scales (post-test) are presented in Table 5. Ai by treatment interactions involving two attitude measures were found. A significant interaction involving Ai scores and attitude toward the lecture method (residual scores) was found. However, this finding is unremarkable because the regions of significance are not definable within the range of the data.

DISCUSSION

The interactions involving achievement via conformance on achievement posttest scores and achievement post residual scores were as predicted. The findings indicate that one can enhance learning by using Ac scores to match students with an instructional treatment. Those students with low Ac scores achieved better when assigned to mastery instruction and those students with high Ac scores achieved better when assigned to conventional instruction.

The interaction found between the Ac scores and the treatment variations on the achievement delayed residual scores is confusing because the regression lines are opposite to those found on the interactions on posttest scores and post residual scores. That is, students who scored low on the Ac scale were found to achieve better when assigned to conventional instruction instead of to mastery instruction.

A possible explanation of this result is that during the experimental period the students' acquisition of knowledge was from within the two distinct instructional treatments. However, between the time of the posttest and the delayed test there were no longer two treatments. The student in the mastery treatment finished the remainder of the course in a conventional instructional mode. It is possible that the low Ac students who were



o = Mastery

Δ = Conventional

Figure 2

A_C by Treatment Interaction on Achievement Delayed Residual

Table 5

The Effects of Attribute by Treatment Interactions on Student Attitudes

Dependent Variables		Homogeneity of Group Regressions			
	N	A_i F-Value	A_C F-Value	Locus of Control F-Value	Pretest F-Value
Mastery Learning	58	2.59	.52	.15	1.0
Mastery Learning Residual Gain	58	.08	1.47	.01	.68
Lecture	57	4.29*	.37	.53	.09
Lecture Residual Gain	57	2.79	.07	.78	.04
Face to Face Interaction	58	1.69	.45	.03	.61
Face to Face Interaction Residual Gain	58	3.95*	.45	.37	.70
Individualized Instruction	58	.41	.17	.08	.15
Individualized Instruction Residual Gain	58	.01	.01	1.25	.30

*$p < .05$

assigned to the mastery treatment gave less importance to the content covered in the modules presented during the experimental period than to the content covered during the remainder of the course, since they participated in the conventional mode for the remainder of the term. The students who were assigned to the conventional mode remained in that setting for the remainder of the term. During their preparation for the final examination they would have likely placed the same amount of importance on the content covered during the experimental period as on the remainder of the course content. Therefore, the interactions involving the achievement delayed test scores and achievement delayed residual scores are a function of the post-experiment instructional conditions rather than of the variations in instruction during the period of the experiment.

Although previous researchers have found interaction effects involving achievement via independence and locus of control, the present findings failed to replicate these effects. It may be that the type of content used in the study does not engage differences in learning style that distinguish between high and low independent learners, or students with internal and external locus of control. The independent learner and learner with internal locus of control may feel restricted and not challenged by subject matter content that deals primarily with knowledge of facts and terminology, and that has objective-type examinations. Possibly, achievement via independence and locus of control only interact with treatment variations based on instructional content that requires the student to use higher cognitive processes such as application, analysis, synthesis, and evaluation.

The prior knowledge hypothesis developed by Tobias (1976) states that students with low prior knowledge of the curriculum will achieve better in a learning environment that has high instructional support, such as in the mastery learning treatment utilized in this study. However, in this study prior knowledge did not interact with the instructional treatment variations.

A possible explanation of this result is that the achievement pretest means were higher than expected (22 points from a possible 41 points), indicating that the students had considerable knowledge before entering the course. It may be that the additional instructional support offered in the mastery learning treatment was not as necessary as in courses where students have little or no prior knowledge upon entry into the course.

The significant, but negligible interactive effects involving Ai and the attitude concepts may have resulted from the students in the conventional instruction treatment not having a clear understanding of the concepts "mastery learning" and "individualized instruction." A survey at the beginning of the study indicated that only approximately one-half of the students in

the conventional instruction treatment had previous experience in some form of mastery learning or individualized instruction. This means the remaining one-half had nothing from which to form their perception of these concepts, whereas all of the students in the mastery instruction treatment had experiences from which to form their perceptions.

This study indicates that achievement via conformance may serve as a useful differentiating variable to predict optimal instructional strategy for students. Additional studies using this scale with a variety of other instructional strategies should be made in order to determine more definitely the settings where it can be used to assign students to different forms of instruction.

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