Relationship of Student Characteristics and Achievement in a Self-Paced CMI Application

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Learner control of CBE applications has been an enticing topic of research. Reviews by Steinberg (1977) and Taylor (1976) indicate that effects upon achievement are equivocal when learner control has been compared with program or instructor control. The mixed results suggest the possibility of an interaction between certain aspects of instruction and characteristics of the learner, when the learner is permitted to control the program.

Current theory and data suggest that an important variable related to academic success is the student's perceived locus of control. Internal/external orientations have been shown to have a significant relationship to academic success (Coleman, et. al., 1966; deCharms, 1976). Behaviors exhibited by those having high internal or high external orientations (Crandall, et. al., 1965; Seeman, 1963; Seeman & Evans, 1962) appear to be closely related to successful use of opportunities that permit one to control the conditions of learning. It was hypothesized in this study that high internals would be more likely to explore and profit from learner control opportunities than would high externals. The I-E Scale developed by Rotter (1966) was considered to be an appropriate measure of this characteriatic for college students.

A more direct measure of achievement-stricing behavior is the SSHA (Survey of Study Habits and Attitudes, Brown & Holtzman, 1967). This assesses the tendency of students to be prompt, to employ effective work methods, and to possess positive attitudes towards teachers and schooling. SSHA has been shown to be related to grade point average of college students (Brown & Holtzman, 1967; Desiderato & Koskinen, 1969) and to exam scores (Wen & Liu, 1976). It has also been shown that the SSHA and the I-E are related (Ramanaian et al., 1975).

It was hypothesized for the studies reported here that effective study habits would facilitate one's efforts to learn, and that this variable should interact with I-E when students are given an opportunity to excercise control. It was also hypothesized that these variables would be particularly salient in a self-paced CMI application where the instructor controlled the operating parameters during the second half of the course. Under such conditions, students who differ on these variables should exhibit even greater differences on achievement as the course progresses.

METHOD

Subjects

Subjects were students enrolled in a junior level college course on educational measurement. Study A was conducted during the spring quarter of 1978;

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study B was conducted during the spring semester of 1979. The University had changed from quarters to semesters and the course went from 3 quarter hours to 2 semester hours. Requirements of the course and sequencing of activities remained the same.

Measures listed below were secured for 102 of 133 students enrolled during 1978 and for 86 of 125 enrolled during 1979. Most of the students not included in the samples withdrew from the course very early in the term. A few students were absent on the days the I-E and SSHA were administered.

Instruments

Rotter's I-E Scale and the Brown-Holtzman SSHA were administered during regular class meetings. Students were given individual feedback about these measures at the end of the term. A brief description of each is presented below:

1. I-E Scale. This scale contains 29 forced-choice items, including six fille items, and was keyed so that a high score indicated a high internal orientation

2. SSHA. This inventory contains 100 items grouped into the following subscal

   a. Delay Avoidance (DA). Lack of procrastination.
   b. Work Methods (WM). Effective study procedures.
   c. Study Habits (SH). DA plus WM
   d. Teacher Approval (TA). Attitude towards teachers and their behavior.
   e. Education Acceptance (EA). Attitude towards educational practices.
   f. Study Attitudes (SA). TA plus EA
   g. Study Orientation (SO). SH plus SA (overall measure)

3. Comprehensive Exams. Achievement in each of four units of work was measure by thirty item selection type exams. Two or three alternate forms were available for each unit. Exams used were a regular part of the course. Item analys indicate acceptable quality. Measures of reliability have ranged from .70 to more than .90. Method of estimating reliability, number of students involved, and term when analysis was conducted, varied from one set of unit exams to ano

4. GPA. Overall grade point average at end of spring quarter was obtained fr the registrar's records. This measure has been shown to be correlated with ac demic achievement in the measurement course (Blumenfeld, et al. 1975) and with research on learner control in CAI (Taylor, 1976).

Procedures

Student behavior and achievement was examined under conditions imposed by self-paced computer managed instruction applied to an undergraduate educationa measurement course. A brief description of the course and the computer progra is given below. More detailed accounts can be found in Blumenfeld, et al. (19 and Blumenfeld, et al. (1977).

1. Measurement Course. Emphasis is placed upon evaluating the effectiveness of instruction and upon developing coordinated sets of instructional objective instructional procedures, and measurement procedures. The course is divided

into four units and one teaching project. The teaching project is not self-paced and student behavior related to this aspect of the course was not included in the analysis. The units are divided into modules - three modules per unit. Students are given ten to fifteen behaviorally stated objectives for each module. They are required to take module study quizzes via computer terminals on each unit they study prior to taking comprehensive exams. Study quizzes are taken outside of regular class time and are scheduled by the student at his or her convenience. Comprehensive exams are given during regular class time during six predetermined sessions distributed throughout the term. Criterion for passing a unit exam is 80%. A student may take a second exam on each unit if he fails to pass the first time. A few target points awarded at the beginning of the term, to encourage students to get started, permit a few students to pass unit I with only 70% correct. Course grade is determined by the number of units the student passes. If the student passes four units, a grade of A is recorded; three units, a grade of B is recorded, etc. Minus grades are given if students achieve 70% but not 80%. The student can decide to work on all four units or to stop after one. Upon request, incompletes are awarded to permit a student to complete one additional unit. Only work completed during the spring term was included in the analysis.

The topics included in modules one thru six are repeated in modules seven thru twelve. Objectives in the first six modules include critical concepts and less difficult tasks. Objectives in the last six modules include more advanced ideas and more difficult tasks.

2. Computer Program. The program contains twelve quizzes with each quiz containing twelve items. A pool of five selection type items is included for each objective. When a student signs on, the program randomly orders the objectives and randomly selects one item for each objective. Emphasis is provided by including two five item pools for some objectives and repeating these objectives. After a correct answer, the student is so informed. Appropriate page references for three books follow both correct and incorrect answers. If an incorrect answer is given, the student is informed as to why the answer is not correct. Correct answers are not given, but the student is provided with some direction for reconsidering the problem. At the end of the quiz the student can see a list of objectives related to the items answered incorrectly.

Criterion for passing is ten correct answers. If the student meets the criterion the program advances the student to the next module. If the student fails to meet the criterion a second or third study quiz on that module is required. A delay of ten minutes per error is imposed before the student is permitted to take another quiz. Students failing a module quiz for the third time are advanced to the next module. A student who fails three quizzes on two consecutive modules is not permitted to continue until he obtains a "password" from the instructor. After the student has completed module six, control of the computer program is given to the student. The student decides which module to go to, how many times to take a quiz on that module, and in what order to repeat modules if he so chooses. The student can avoid any delay imposed earlier because of errors.

RESULTS

Intercorrelations of Measures

Tables 1, 2 and 3 are divided into parts A and B and correspond to 1978 and 1979 data, respectively. Table 1 lists the intercorrelations of the SSHA

TABLE I

Intercorrelation of the SSHA Scales, I-E and GPA

		DA	WM	SH	TA	EA	SA	SO	IE	GPA
STUDY A	DA		.59	.89	.50	.67	.63	.82	.07	.33
	WM			.89	.65	.63	.68	.84	-.08	.36
	SH				.65	.73	.73	.94	-.01	.39
	TA					.77	.94	.84	-.06	.23
	EA						.94	.89	-.12	.30
	SA							.92	-.10	.29
	SO								-.06	.35
	IE									.09

(r ≥ .195 significant at .05 level)
(r ≥ .254 significant at .01 level)

		DA	WM	SH	TA	EA	SA	SO	IE	GPA
STUDY B	DA		.68	.92	.38	.60	.53	.81	.30	.21
	WM			.91	.57	.55	.62	.85	.26	.11
	SH				.52	.63	.63	.91	.30	.18
	TA					.67	.92	.77	.42	.13
	EA						.91	.83	.40	.09
	SA								.45	-.02
	SO								.43	.09
	IE									-.13

(r ≥ .212 significant at .05 level)
(r ≥ .277 significant at .01 level)

scales, I-E and GPA. It is interesting to note that in study A all correlations are significant except those involving I-E. In study B all correlations are significant except those involving GPA.

Table 2 indicates the relationship of the variables described above to unit exam scores. It can be observed that while GPA is significantly related to unit exam scores in both studies, I-E and SSHA do not possess that consistency. I-E is related to unit exams in study A but not in study B. SSHA is not related to unit exams in study A but many of the correlations approach significance in study B.

Regression Analysis

To test the original hypotheses that I-E orientation and study skills would be salient variables further analyses were conducted using SH since the relationship of the other scales to unit exams was not significant. Full and restricted regression models were used to examine the predictiveness of GPA, SH, I-E, and (SH * I-E) when the criterion was unit exam score. Regression models were computed for each of the four unit exams. GPA was included in all models. Therefore, tests conducted determined whether or not SH, I-E and (SH * I-E) could account for a significant amount of criterion variance above and beyond that accounted for by GPA. The interaction (SH * I-E) was found not to be statistically significant, nor was SH.

In study A I-E was found to be significant at the .01 level for units I, II, and III and at the .05 level for unit IV. However, I-E did not account for a significant amount of criterion variance beyond that accounted for by GPA in study B. The multiple R^2 for the full and restricted models are given in Table 3.

Ad Hoc Analysis

Trends

It was hypothesized that the effects of variation in locus of control and study habits upon student performance would increase as the term progressed. Therefore, intercorrelations across modules and units were examined to determine if any trends could be detected. In study A the correlation matrix indicated that DA was the most likely scale to generate a significant trend. Cumulative exam scores across the four units were recorded for both the first and fourth quartile groups on the delay avoidance scale. Traditional analysis of variance for trend was inappropriate because of extreme heterogeniety of variance. Therefore, log-log transformations were made for each student's cumulative exam score curve.

The slope of the regression line for each of these log-log transformations was computed. This was used as a measure of trend. The means of the slopes for the two groups were .86 and .65; the variances were .05 and .08. Students who scored high on DA had the higher mean slope. A test of these values indicated that the difference between the means of the slopes was significant at the .01 level. Obtained t was 2.776 with df = 48. This trend was not found to be present in the data obtained in study B.

Use of CMI Program

No directional hypotheses with respect to student utilization of the CMI program were formulated. However, it is reasonable to assume that succesful

TABLE 2

Correlations of SSHA Scales, I-E and GPA with Unit Exam Scores

	Unit Exam	DA	WM	SH	TA	EA	SA	SO	IE	GPA
STUDY A	I	.03	.20	.13	.11	-.04	.04	.09	.29	.46
	II	.10	.15	.14	.05	.01	.02	.09	.35	.31
	III	.18	.12	.16	.11	.06	.10	.13	.33	.37
	IV	.26	.16	.23	.08	.11	.11	.19	.19	.38

($r \geq .195$ significant at .05 level)
($r \geq .254$ significant at .01 level)

STUDY B	I	.14	.21	.19	.05	.16	.12	.19	-.04	.33
	II	.16	.23	.21	-.02	.16	.07	.17	-.13	.48
	III	.26	.25	.28	.02	.22	.13	.24	-.07	.50
	IV	.19	.21	.22	-.02	.18	.08	.16	.04	.34

($r \geq .212$ significant at .05 level)
($r \geq .277$ significant at .01 level)

TABLE 3

Regression Analysis Models Indicating Significance of I-E

Criterion: Unit Exam	R^2 of Full Model (GPA, SH, IE)	R^2 of Restricted Model (GPA, SH)	F	df	p
I	.28	.21	8.577	1,98	<.01
II	.21	.10	13.502	1,98	<.001
III	.23	.13	11.744	1,98	<.001
IV	.18	.15	3.158	1,98	<.05

Comparison of full and restricted models indicates that I-E accounts for a significant amount of exam score variance beyond that accounted for by GPA.

I	.129	.126	.278	1,83	<.60
II	.231	.222	.940	1,83	<.34
III	.242	.236	.574	1,83	<.45
IV	.158	.157	.038	1,83	<.85

Comparison of full and restricted models indicates that I-E does not account for a significant amount of exam score variance beyond that accounted for by GPA.

students will utilize learning resources differently than less successful students. The twenty five students who had the highest score on a combination of I-E and DA were identified along with the twenty five students who had the lowest score on this variable. The variable was obtained by multiplying each student's I-E score by his DA score. The mean number of quizzes per module and the mean number of minutes per module were computed for each of these groups. Only the first nine modules were considered because a very small percentage of students worked on Unit IV. This fact will be considered later. Nine out of nine times the high group's mean number of quizzes per module was greater than the mean of the low group. Eight out of nine times the mean of the high group's number of minutes per module was greater than the mean of the low group. On the average, members of the high group took more study quizzes, but spent less time per quiz than did members of the low group. High students were not only practicing more but also distributing the practice across a greater number of examples. Once again, it was found that this relationship did not occur in the data collected from study B.

Accurate records of when students took module quizzes and unit exams were obtained for study B. This data was examined several ways, but no consistent relationships between student characteristics and the utilization of the CMI program were observed.

Discussion

It is important to note at the beginning of this discussion that an unusually small percentage of students worked on unit IV during the termsstudy A was conducted. For example, thirty six percent of the students listed on our first day roster for the previous quarter worked throughout the term and received a grade of A or A- for the course. In study A only sixteen percent of the students listed on our first day roster worked throughout the term and received a grade of A or A-. In study B 33% earned a grade of A or A-. A non-scientific explanation is that the 1978 students suffered thru a very difficult winter. When the sun finally appeared during the spring querter, students stopped working on all non-required school tasks. We observed this sudden cessation of study and were given this answer when we raised questions about it.

It was assumed in 1978 that the small number of students completing unit IV would tend to restrict the range of scores involved and not invalidate the results. The failure to replicate the results in 1979 leads one to other speculations. For example, the 1979 students had 50% more time to do the same amount of work and were not harressed by bad weather and school closings. It is possible that differences in I-E and SSHA interact with conditions of stress and high demands. When such conditions are not present, as in study B, all students have time to do the job even if differences in ability and motivation exist.

This is an attractive hypothesis, but it is also suspect because of the change in the observed relationships between I-E and SSHA scales. Weather and length of term should not have had an affect here. It is also the case that the relationships between I-E and SSHA in study B are more consistent with the data reported by Ramanaiah (1979).

Study A supported the conclusion that the I-E and SSHA scales tapped important atudent characteristics when course structure permitted students to control pace, practice conditions, utilization of resources and total amount of material to be studied and mastered. Study B does not support those conclusions. Only additional replications will provide help in deciding which aet of data should command one's confidence.

At least two things should be considered when looking at the results of study A and study B. One is that apparently the most relevant psycho-social variables have not been adaquately identified. The second, and more importantly is that the different results give further support for the necessity to replicate. The two studies reported were conducted by the same researcher, on very comparable students, in highly similar settings, yet produced divergent results. These varying rasults indicate the potential pitfall of generalizing results based on only one study.

When trying to identify the relevant learning characteristics in a natural setting, the potential interactions and the types of relationships between variables are enormous. What may be needed to map out many of these possible relationships, develop a matrix, and systematically develop studies to investigate the relationship between these variables and learning. One may take a particular model such as suggested by McGuire (1960) and Whiteside (1964) which takes the position that when one is trying to account for complex behavior, one has to look at atleast three classifications of behavior. One is the person variables which includea things auch as personality, intelligence, sex roles, learning characteristics, etc. The second is the charactaristics of what is to be learned. Suppes (1966) and Gagne' (1965) have given excellent examples of how to deliniate the components of what is to be learned through a task or job analysis. The third is the environmental or context variables. These would include such things as the structure as well as the environment of the learning situation, interactions with peers, expectations produced by the environment (significant others within the environment). Thia three dimensional matrix may facilitate the identification and systematic investigation of the variables which mey influence and/or "cause" the differential effectiveness of "learning" as reported in the literature.

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*However, one must be very careful of over generalizing to other samples before independent replications are conducted. The authors have collected replication data which they expect to present at a future time in conjunction with the findings of this paper.

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