Factors Affecting Students' Performance in Sixth Grade Modular Technology Education

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Abstract

This study examined relationships between cognitive style, verbal ability, quantitative ability, prior knowledge, motivation, and achievement in modular technology education. Data were provided by 78 male and 64 female suburban sixth-grade students ($N = 142$). The Group Embedded Figures Test, Children's Academic Intrinsic Motivation Inventory, Comprehensive Testing Program III verbal and quantitative subtest scores, and a researcher-developed achievement test were used to collect data. The treatment consisted of three computerized activities. Statistically significant relationships, at the .05 level, were demonstrated in the bivariate analysis between achievement and: (a) cognitive style, (b) verbal ability, (c) quantitative ability, (d) prior knowledge, and (e) motivation. Multiple regression analysis revealed a statistically-significant model for prior knowledge and verbal ability ($F = 46.52$, $df = 136$, $R^2 = 63.1\%$, $p < 0.05$). A low-achievement profile emerged with this sample.

Introduction

A debate is raging within the technology education profession relative to the acceptance of modular technology education (MTE) and the rejection of other approaches, such as the project-based method of instruction (Weymer, 1999, p. 1). Gemmill (1993, p. 14) defined MTE as a "self-contained instructional system for self-directed, individualized instruction." MTE is generally thought of as a curriculum provided by a commercial vendor in which students learn about an area of technology by: (a) participating in interactive media presentations, (b) following instructions in workbooks, (c) writing responses in student journals, and (d) experimenting and building projects. Working in pairs, students complete instructional activities at computerized work stations. Students follow self-directed instructions that introduce and reinforce technological concepts. Many MTE curricula have a strong "hands-on" component in which students use tools to process resources, generally resulting in a completed prototype or experiment.

Personal computers are replacing the classroom teacher as the disseminator of technological content and processes in modular programs. The modular

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approach is relatively new to our profession and largely untested as to its instructional efficacy. Furthermore, MTE is replacing traditional technology education programs at an unprecedented rate.

In an effort to determine the prevalence of MTE programs in America's public schools, the following strategies were pursued: (a) the main MTE companies, in terms of market share, were contacted relative to numbers of installed labs, (b) data were compiled relative to secondary school counts, and (c) percentage frequencies were calculated for middle and high school MTE facilities. Representatives from eight companies were contacted. For purposes of this study, an MTE lab consists of eight or more modular work stations with a computerized management system. Six of the eight companies contacted were willing to reveal the number of MTE labs that they have installed as of September 2001. Among the six responding companies, there were 5,088 middle-level and 2,177 high school MTE labs.

The researcher has determined the existence of 17,542 public middle/ intermediate schools in America and 15,391 high schools (Moody, W., Ostdick, R., Rascher, C., & Thiessen, J. 2000, p. vii). Middle/intermediate school numbers were compiled by adding secondary school counts by states in *Patterson's American Education* 2000 edition data for grades 5-9, 7-12, and K-12. Data for high schools were compiled by adding data for grades 7-12, 9-12, 10-12, and K-12. Dividing 5,088 by 17,542 indicates that 29% of American middle/intermediate school contain a modular program. Similarly, dividing 2,177 by 15,391 indicates that 14% of American high schools have modular programs. These MTE frequency data are conservative estimates since only about three-quarters of the major MTE companies provided data and because both 7-12 and K-12 schools were used in calculating both middle/intermediate frequency and high school frequency numbers. These data support the widespread adoption of MTE across the US.

Through observation and teaching experience in a modular lab, the researcher has observed variance in students' ability to master the learning tasks presented via the computer-assisted instruction (CAI) used in MTE. Some students excel in modular programs while others struggle. What characteristics do students possess that enable them to become proficient at mastering the learning experiences presented in MTE? Conversely, how can technology education teachers, administrators, and MTE program developers address the needs of students at risk of failing to grasp the content presented in this learning environment? For example, 15% of the subjects in this study achieved less than 60% on the 50 point posttest used as the dependent variable.

As the modular approach replaces traditional technology education programs, questions arise concerning how students' individual traits and characteristics interact with the learning tasks presented in this instructional paradigm. Limited research has been conducted regarding these relationships.

Purpose of the Study

The purpose of this exploratory study was to investigate the relationships between achievement in one sixth-grade MTE program and students' individual traits and characteristics. More specific, this research examined relationships between students' (a) prior knowledge of the MTE content, (b) verbal ability, (c) quantitative ability, (d) intrinsic motivation, and (e) cognitive style with regard to performance on a posttest instrument. It was hypothesized that performance in MTE would correlate positively with students' prior knowledge, cognitive style, fifth grade verbal and quantitative ability scores, and intrinsic motivation. Further, this study sought to identify characteristics of low-achieving students in MTE, and to develop a regression model for predicting student achievement in MTE programs.

Review of the Literature

Jonassen and Grabowski (1993) have proposed a model divulging how the broad range of students' individual differences can affect learning. According to these researchers, a geographical metaphor can be used to describe individual differences. In this metaphor, the mind is compared to a landscape consisting of peaks and valleys. Just as topography within a region is highly variable and unique, so is an individual's mental landscape. The peaks in Jonassen and Grabowski's metaphor represent trait strengths, whereas the valleys represent the absence of specific learning abilities. "The relief on an individual's landscape treats abilities and personality variables as unipolar values. The particular combination of aptitudes and traits possessed by each individual is reflected in the individual's cognitive styles, personality, and learning styles" (Jonassen and Grabowski, 1993, p. xi). The study of individual differences is analogous to mapping the relief on individuals' mental landscapes.

Due to the analytic nature of most computer programs, Gupta (1996) hypothesized that students with a field independent (i.e., articulated) cognitive style would learn more effectively in a hypermedia computer environment than students with a field dependent (i.e, global) cognitive style. Gupta found significant differences in achievement between field dependent and field independent subjects ($F = 4.48$, $df = 50$, $p < .05$). Post (1987) found significant differences in achievement between field dependent and field independent electrical engineering technology students in logic circuit content presented with CAI lessons. Post reported that field independent students scored significantly higher compared with field dependent students ($M = 25.6$, $SD = 2.5$ versus $M = 22.3$, $SD = 3.9$, $t = 3.68$ $p < .001$). Post reported that 29% of the total variance on a CAI posttest was accounted for by the variables field dependent/independent cognitive style, sex, IQ, and age.

Prior Knowledge

Jonassen and Grabowski (1993) indicated that one of the strongest and most consistent individual difference predictors, relative to achievement, is prior knowledge. This study was concerned with the relationship between students' prior knowledge relative to a domain of knowledge presented in an MTE computer program and student achievement.

Research conducted by Guthrie, Van Meter, Hancock, Solomon, Anderson, & McCann (1998) showed a moderate correlation between prior and new conceptual knowledge in a study examining reading engagement processes ($r = .303$, $p < .05$).

Achievement Motivation

Intrinsic motivation, according to Naccarato (1988), Wigfield and Guthrie (1997), and Rezabek (1995), is the inherent drive or tendency to pursue tasks simply for the sake of pursuing them, without any outside influence or push or threat of punishment. Traditionally, schools emphasize the use of externally supplied rewards and punishments as a means of controlling behavior and in directing the learning process. Modular programs, however, require a shift away from external motivation strategies in which students are rewarded and punished by the teacher. MTE programs, with their self-paced CAI instructional approach, require students to be intrinsically motivated.

Rezabek (1995) found a significant correlation between intrinsic academic motivation and academic achievement ($r = 0.374$, $p < 0.0001$). Research by Wigfield and Guthrie (1997) revealed that children with higher intrinsic motivation read more ($r = .31$, $p < 0.01$) and with more breadth ($r = .36$ $p < 0.01$) than students with lower intrinsic motivation.

Cognitive Style

The descriptors field dependent/independent were used by Witkin, Oltman, Raskin, and Karp (1971) to describe the extent to which an individual's perception or attainment of information are affected by the surrounding contextual or perceptual field. Field dependents find it difficult to locate and extract information because it is hidden in competing stimuli. Field independents find it easier to extract the relevant information from the surrounding field. Witkin, Dyk, Faterson, and Karp (1962) describe a field independent as:

> The person who experiences in an articulated fashion has the ability to perceive items as discrete from their backgrounds, or to reorganize a field when the field is organized, and so perceive it as organized when the field has relatively little structure (p. 14).

Regarding field dependent people, Witkin, et al. (1962) stated, “the term 'global field approach' has been suggested to describe the style of functioning that involves submission to the dominant organization of the field and the tendency to experience items as 'fused' with their background” (p. 80).

Witkin et al., contended that, “individual performances are represented continuously along the analytical-global dimension of experiencing, rather than constituting distinct 'types'“ (p. 80). “When we say that a person shows an analytical or global field approach, we mean only that he falls above or below the mean of his group on this dimension" (Witkin, et al., 1962, p. 80).

Meng and Patty (1991) have utilized this continuum of the analytical-global dimension proposed by Witkin et al. (1962) to group subjects into three cognitive style groups including field dependent (FD), field intermediate (FIM), and field independent (FI). According to this protocol, subjects scoring within one half standard deviation of the mean are considered to be field intermediate.

Due to the analytical nature of the learning tasks in MTE, field independents may learn more efficiently and score higher on the posttest developed for this study than field dependents. Research by Gupta (1996), Post (1987), Hansen (1980), Hansen (1983), Vaidya and Chansky (1980), Lipsky (1984), and Riding and Dyer (1983) has shown that students with a field independent cognitive style performed better than students with a field dependent style in mathematical and analytical tasks.

Academic Ability

In this study, academic ability was operationalized as subjects' verbal and quantitative ability scores from their fifth-grade Comprehensive Testing Program III (CTP III) test results. Verbal ability was defined as a student's "ability to apply knowledge of printed language structure and meaning appropriately, to utilize cognitive strategies in analyzing information and drawing inferences, to deduce relationships and generalize verbal attributes, and to predict outcomes and evaluate the appropriateness of predictions and strategies" (Educational Testing Service, 1995, p. 2). Verbal ability is analogous to reading comprehension.

Quantitative ability was defined as a measure of students' "ability to apply knowledge of mathematical concepts and principles, to demonstrate flexibility in thinking, to identify critical features in new situations, to make correct generalizations, and to compare mathematical expressions" (Educational Testing Service, 1995, p. 4).

Stothard & Hulme (1996) described reading as the interaction of two distinct processes, decoding and comprehension. For skilled readers decoding is a highly automated task. Skilled readers can focus their attention on comprehension of the novel material. Low ability readers typically have difficulties studying and learning from expository textual material (Helwig, Almond, Rozek-Tedesco, Tindal, & Heath, 1999). Readers with robust verbal ability skills are more likely to analyze new information and draw inferences than their peers with low verbal ability.

Variables

The dependent variable for this study was MTE posttest scores from a unit on engineering structures taught by CAI. Continuous (i.e., interval level) data were collected with a fifty point MTE posttest instrument developed by the researcher. The independent variables were: (a) academic ability with two levels of continuous data, including verbal and quantitative ability; (b) achievement motivation with one level of continuous data; (c) cognitive style with three levels of categorical data, including field dependent, field intermediate, and field independent, and one level of continuous data (i.e., raw scores), and (d) prior knowledge with one level of continuous data reported as students' pretest scores.

Research Questions

The objectives of the study are expressed in the following research questions:

1. Are there significant differences among the field independent, field intermediate, and field dependent cognitive style groups with regard to posttest achievement scores in MTE?
2. Are students' verbal and quantitative ability related to MTE posttest achievement scores?
3. Is there a significant relationship between students' prior knowledge, as measured by pretest scores, and achievement in MTE programs?
4. Is there a significant relationship between students' intrinsic motivation and posttest achievement scores in MTE programs?
5. Are students' cognitive style, verbal ability, quantitative ability, prior knowledge, and intrinsic motivation related to achievement in MTE programs?

Methods

Population and Sample

The target population for this study was all sixth grade students in a suburban school district in Lancaster, Pennsylvania during the 1998-1999 school year ($N = 389$). The accessible population for this study consisted of all students enrolled in the researcher's technology education classes during first semester of the 1998-1999 school year ($n = 182$). The sample consisted of students who returned their informed consent forms and that participated in the district's Comprehensive Testing Program III (CTP III) in the spring of 1998. The sample included 78 boys and 64 girls ($n = 142$). Students had an equal chance of being included in the study due to the district's practice of heterogeneous sectioning.

Procedure

Mandatory training sessions in the MTE learning environment were provided to subjects prior to the start of this study. A 50 point pretest was administered. This test was developed from the domain of knowledge included in a commercially available MTE program that focused on engineering structures. Subjects participated in three multimedia CAI activities over four class periods. The researcher monitored subjects' progress to ensure equivalent exposure to all material presented in the CAI lessons. The domain of knowledge included information about: (a) types of bridges and structures, (b) forces and loads, (c) impacts of structures, (d) construction cost and time, (e) various road conditions, (f) careers, and (g) a unit review. A 50 point posttest, identical to the pretest, was administered after the final multimedia presentation. The posttest was administered within four days of the final computer mediated presentation. Cognitive style of the subjects was determined through the Group Embedded Figures Test (GEFT). The motivation of the subjects was determined through the Children's Academic Intrinsic Motivation Instrument (CAIMI).

Description of CAI instruction. The CAI multimedia presentations used in this study consisted of narrated text, music, sound effects, video animations, photographs, and hypertext links. Activities started with directions presented on the computer monitor. Consistent with the instructional design of the module, dyads navigated the multimedia presentations at their own rate. The computer program used in this study presented several multimedia selections. Subjects were stopped by the CAI program to answer questions in an electronic journal. The CAI program summarized the material presented in each lesson.

Subjects needed critical thinking and problem solving skills to navigate the multimedia presentations used in this study. The researcher observed that many subjects were not following the CAI program in the proper instructional order and appeared to be confused. The researcher used a checklist to monitor progress and insure equal access to the CAI instruction.

Research design. A randomized one-group pretest-posttest design was used to determine the existence of relationships between the variables. The researcher used the following controls to limit the phenomena of test effect: (a) subjects received no feedback about pretest responses prior to receiving the treatment and taking the posttest, (b) two weeks passed between the pretest and posttest, and (c) subjects wrote their responses directly on the answer booklet in the pretest while they used optically-scanable sheets for the identical posttest.

Instrumentation

Pretest and posttest instrumentation. The researcher compiled and edited the 113 statements that represented the entire domain of knowledge presented in the engineering structures module. A panel of three subject matter experts reviewed the statements for face and content validity. A second panel of subject matter experts ranked the importance of the concepts presented in each of the 113 statements (i.e., 4 = very important through 1 = not important). Statements were grouped into categories according to the means of the rankings. Statements with a mean ranking of 3.0 or above were included in the pool of potential test items. The 15 items below this level were discarded.

From this domain of knowledge, two 50 item test instruments were constructed. These instruments (i.e., Form A and Form B) each contained 25 “best choice” multiple choice and 25 true and false items. The instruments were pilot tested in April and May 1998 with sixth grade students in the researcher's technology education facility. Statistical characteristics for these pilot instruments are shown in Table 1. Item analysis from the pilot tests produced 58 potential test items with high to medium r-biserial correlations. The pre/posttest instrument used in this study was developed by selecting 50 usable items from the two pilot tests. The statistical characteristics of the pre/posttest instrument are shown in Table 1.

Table 1
Descriptive Statistics for Pilot Test and Research Instrument

Instrument	*n*	*M*	*SD*	Range	KR 20
Pilot Tests					
Form A	87	38.02	5.17	23 – 47	.72
Form B	73	35.77	4.52	21 – 45	.61
Research Instrument					
Pretest	142	28.92	5.56	14 – 43	.70
Posttest	142	35.96	6.14	19 – 50	.80

Note. Form A and B administered as a posttest only, scale of measurement = 50.

Perception measurement. The GEFT is a perceptual instrument that measures cognitive style. It consists of two scored sections each containing nine complex figures. Each complex figure has simple figure embedded within it. The subject's score is the total number of embedded figures that were correctly traced in the two scored sections of the test. GEFT results in this study were used to place students along a field dependent/field independent continuum. The GEFT instrument yielded the following statistical results with this sample: M = 6.93, and SD = 4.54, Chronbach's alpha = .87.

Verbal and quantitative ability measurement. Subjects' fifth-grade CTP III verbal and quantitative ability subtests were used to determine academic ability. The CTP III test used in this study was normed for a suburban population (n = 3,000). The researcher did not have access to students' individual test booklets and, therefore, could not calculate sample-specific reliability for these CTP III subtests. Educational Testing Services (1995) reported the following K-R 20 reliability data for the instrument used with the norming sample: verbal ability r = .83, and quantitative ability r = .82.

Motivation measurement. The general motivation scale of the Children's Academic Intrinsic Motivation Instrument (CAIMI) was used to determine the intrinsic motivation of the subjects in this study (Gottfried, 1986). Chronbach's alpha was r = .82 for this sample. Construct and criterion-related validity have been established for the CAIMI instrument through the confirmation of hypotheses based on motivation theories (Gotfried, 1986, p. 13).

Data Analysis

Statistical procedures selected for the analysis of the relationships between MTE performance, academic ability, prior knowledge, motivation, and cognitive style included descriptive statistics of frequency distributions, means, and standard deviations. These data are presented in Table 2. Pearson's product moment correlations, *t*-tests, and linear regression analysis were used to examine the bivariate relationships between the response and predictor variables. These data are shown in Table 2. Multiple regression was used to examine the multivariate relationships between the predictor and response variables and to develop the regression model. An alpha level of .05 was used for all tests of significance.

Table 2
Variables, Scale of Measurement, Means, Standard Deviations, and Frequencies

Variable	Scale	*M*	*SD*	*n*
Pretest	50	28.92	5.56	142
Posttest	50	35.96	6.14	142
Verbal	100	50.15	28.95	142
Quantitative	100	52.13	27.48	142
GEFT	18	6.93	4.79	142
FD	18	2.10	1.21	42
FIM	18	6.98	1.35	52
FI	18	12.91	2.47	48
CAIMI	80	68.20	8.23	142

Results

This research attempted to explore how students' individual differences affect performance in MTE. The one-group pretest-posttest design, used to determine the existence of relationships between the variables, limits the generalizability of the findings. Research results should be interpreted conservatively.

Cognitive Style and MTE Achievement

Significant differences between the field independent, field intermediate, and field dependent cognitive style groups were revealed in the bivariate analysis with regard to MTE posttest scores. In this analysis, the GEFT cognitive style was coded categorically (i.e., FI, FIM, or FD). The FI cognitive style group was used as the baseline for comparison. Significant differences were revealed between the FI and FIM ($t = 3.35$, $p < 0.05$) and the FI and FD ($t = 6.10$, $p < 0.05$) groups.

Ability and MTE Achievement

Significant relationships were demonstrated in the bivariate analysis between students' verbal and quantitative ability and MTE posttest achievement scores. These results are shown in Table 3.

Prior Knowledge and MTE Achievement

A significant relationship was demonstrated between between students' prior knowledge and MTE posttest achievement scores in the bivariate analysis. This result is shown in Table 3.

Instrinsic Motivation and MTE Achievement

A significant relationship was demonstrated between students' intrinsic motivation and MTE posttest achievement scores in the bivariate analysis. This result is shown in Table 3.

Multivariate Analysis

Statistically significant relationships were revealed for verbal ability and prior knowledge, with regard to posttest scores, in the multivariate analysis. The variables of cognitive style (continuously coded GEFT scores), quantitative ability, and intrinsic motivation (CAIMI) displayed nonsignificant relationships in this analysis. The regression model, presented in Table 4, explained 63 percent of the total variance observed on students' posttest scores and was statistically significant ($F = 46.52$, $df = 136$, $p < 0.05$).

Table 3
Bivariate Correlations and Regression Results Between Predictor Variables and MTE Posttest Scores

Variable	Correlations *R*	Bivariate R^2	Regression *t*	Results *p*
Continuous GEFT	.541	29.3	7.68	.000
Verbal	.731	53.4	12.68	.000
Quantitative	.632	40.0	9.65	.000
Prior Knowledge	.742	55.1	13.16	.000
Motivation	.255	6.5	3.14	.002

Note $n = 142$, 140 degrees of freedom in the regression analyses.

Table 4
Multiple Regression Results for the Independent Variables with MTE Posttest Scores as the Response Variable

Independent Variable	*t*	*b*	*r*	*p*	*VIF*
Prior Knowledge	4.65	.42	.742	.000	2.5
Verbal	2.99	.06	.731	.003	3.4
GEFT	2.04	.17	.541	.075	1.6
Quantitative	1.24	.02	.632	.218	2.5
CAIMI	-0.27	-0.01	.255	.787	1.2

Note $F = 46.52$, $df = 136$, $p < 0.000$, $R^2 = 63.1\%$, intercept = 18.5.

Conclusions

Statistically significant relationships were demonstrated in the bivariate analysis between the MTE posttest and: (a) cognitive style as measured with the GEFT instrument; (b) quantitative ability and verbal ability as measured with subjects' fifth-grade CTP III test scores; (c) prior knowledge as measured with the pretest; and (d) motivation as measured with the CAIMI intrinsic motivation instrument. The bivariate analysis also revealed statistically significant differences between the FIM and FI and the FD and FI cognitive style groups relative to MTE posttest performance.

The magnitude of the relationships between students' posttest scores with verbal ability and prior knowledge was surprising. As bivariate predictors, verbal ability accounted for 53.5% and prior knowledge 55.1% of the total MTE posttest variance in this sample.

Multiple regression was used in the multivariate analysis to determine the existence of relationships between MTE posttest scores (dependent variable) and the students' cognitive style, verbal ability, quantitative ability, and intrinsic motivation (independent variables). Based upon the bivariate analysis, it is reasonable to conclude that verbal ability and prior knowledge enable a student to do better on the MTE posttest. Quantitative ability, cognitive style, and intrinsic motivation correlated significantly with MTE posttest scores in the bivariate analysis. However, these variables "washed out" in the multivariate analysis. The predictor variables used in the multivariate analysis did not show multicollinearity with each other (i.e., variance inflationary factor 5). These data are reported in Table 4.

Several possible explanations were found in the data for the non-significant relationship between CAIMI intrinsic motivation and the MTE posttest. In the regression equation the beta value for CAIMI was -.01. Used as a predictor of MTE posttest scores, CAIMI actually took away from the overall strength of the regression model. CAIMI displayed a low correlation with MTE posttest scores in the bivariate analysis (r = .255). The CAIMI variable may not have been an accurate measurement of the intrinsic motivation construct. An alternative explanation is that the subjects in this study all displayed high levels of intrinsic motivation. For example, the CAIMI had a maximum possible score of 80 and the sample mean was 68.20, with a standard deviation of 8.23. The CAIMI scores were high with little variability.

The multiple regression model developed in this study was used to determine whether students were at risk in terms of MTE achievement. A profile for low achieving students was developed in this analysis; the identification and remediation of "MTE low-achievers" was one objective of this research project. This profile was defined as students having scores one standard deviation below the mean on the MTE pretest, CTP III verbal and quantitative ability tests, GEFT cognitive style instrument, and CAIMI intrinsic motivation instrument. Using this approach, about 15 percent of the students in this sample (n = 21) were identified as low achievers.

The regression equation for the low-achievement group is:

posttest score = intercept value (i.e., 18.5) + .42 x pretest score + .06 x verbal ability score + .17 x GEFT score + .02 quantitative ability score -.01 x CAIMI intrinsic motivation score. Substituting scores one standard deviation below the mean on each of the predictor variables in the multivariate analysis predicted a low achievement group score of 58.8% [18.5 + .42 x 23.36 + .06 x 21.20 + .17 x 2.14 + .02 x 24.65 +59.97 x -.01] with a mean of 29.9, representing 15% of the students.

Students with low verbal ability, lacking prior knowledge, and preferring the field dependent cognitive style were especially at risk in this study. The researcher observed that many students preferring a non-analytical cognitive style got lost in the CAI learning tasks used in this research. These students had difficulty separating important information from less important details. Field dependent and field intermediate students lacked the analytical skills needed to navigate the computer-based instruction program used in this study.

Discussion

At-risk students can be identified and corrective action taken by helping them gain access to the material presented in the MTE program. The results of this study point to students' verbal ability and prior knowledge as two primary predictors of MTE achievement. Access to standardized test results and robust pretesting should assist practitioners wishing to identify potential low-achievers.

The results of this study call into question the utility of testing students on their cognitive style preference and intrinsic motivation level. Although these variables demonstrated statistically-significant relationships with the response variable in the bivariate analysis, it is doubtful that collecting these data would provide an adequate return on investment. Nonanalytical and unmotivated students should be identified and monitored. These students seem to lack the ability, and/or the will, to navigate the multimedia lessons and directions provided in the MTE program.

Recommendations for practitioners include: (a) identification of students with low-verbal ability at the onset of instruction, (b) the use of a robust pretest to identify students lacking prior knowledge, and (c) direct observation at the learning stations to identify students that prefer a non-analytical cognitive style.

The following strategies should be considered after potential low-achievement students have been identified: (a) obtain constant feedback from field dependent and field intermediate learners in regard to their progress through the computer program; (b) develop an enabling vocabulary list; (c) pair low-verbal with high-verbal students; (d) determine whether low-verbal students have mastered the content through daily check ups; and (e) provide enrichment activities for students lacking in prior knowledge.

MTE product developers should field test their products with diverse populations to determine whether low-achieving profiles appear. Also, MTE programs should have appropriate readability levels and they should include field-tested, logical, step-by-step directions presented only through the computer. The regression model developed in this study should have utility for MTE product developers and vendors relative to the identification of low-achievement profiles. If significant profiles appear, corrective action should be taken before marketing of the MTE product.

Research is lacking regarding individual differences and the instructional methodologies utilized in MTE programs. This correlational research was a first step at identifying factors influencing achievement in MTE programs. Replication studies should seek to determine whether similar results between these variables can be expected with diverse populations. Additional research is needed relative to developing effective CAI/MTE instructional design. Finally, an investigation of issues affecting policy decisions with regard to adopting MTE as an instructional paradigm should be pursued.

In theory, students should learn at their own pace and through their sensory preference in MTE. This appeared to be the case with regard to the high-achieving students in this study. Analysis of the data also revealed a profile for low-achieving students in this sample. For these children, access to the domain of knowledge presented in the MTE program was limited. This finding is disturbing in light of the increasing popularity of these programs. This result begs the question: "Why is the technology education profession anxious to abandon its traditional instructional methodologies in favor of an emerging, yet largely untested, curriculum innovation?" Based upon these findings, vendors should analyze their MTE programs to ensure that members of the low-achieving student profile are not educationally disenfranchised.

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