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A comparative analysis of the value of intrinsic motivation in computer software on the math achievement, attitudes, attendance, and depth-of-involvement of underachieving students

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by

Patricia Ann Furey Meyer

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CHAPTER I

It has been well established in the literature that Computer Assisted Instruction (CAI) can enhance academic achievement as well as provide relative cost-effectiveness of instruction (Roblyer, 1985; Clark, 1983; Kulik, Bangert, and Williams, 1983; Forman, 1982; Suppes, 1980; Edwards, Norton, Taylor, Weiss, and Dusseldorp, 1975; Suppes and Morningstar, 1969). Much of this research dealt with CAI by emphasizing the hardware itself, the new technology exemplified in the delivery of instruction. It was a new means of instructional presentation that was not dependent on the human factor of the teacher.

Computer Assisted Instruction grew out of the legacy of programmed instruction and the theories of motivation and learning exemplified by such long standing authorities as Skinner and Thorndike. However, the researchers centered on the new computer technology with barely a nodding glance to the software presented via the computer. By ignoring the contribution of the instructional software, researchers largely overlooked the research conclusions available on instructional methodology, motivation and learning that had been investigated by researchers intent on determining the best and most efficient means of presenting material to enhance learning.

Clark (1983) after reviewing the research on learning from media states that, "the media are delivery vehicles for instruction and do not directly influence learning...[but] the determination of necessary conditions is a fruitful approach when analyzing all instructional problems, and it is the foundation of all instructional theories" (p. 453). He cautions against further research between media and learning unless it focuses on the necessary characteristics of instructional methods and other variables such as the task, learner aptitude, and attributions which detail levels of difficulty, entertainment value, or enjoyment.

Although the teacher's role is reduced in the actual presentation of material in CAI, it is reasonable to presume that the principles of learning found to affect instruction in the classroom may also apply to the presentation of material on the computer. In other words, CAI may not be all good or all bad when instruction is considered. There are still a many questions to be answered concerning specific variables affecting an individual's ability to benefit from CAI. These questions now include an investigation on the efficacy of specific software rather than merely the media of the presentation, much as the educational methodology of the classroom teacher has been investigated for decades. The lack of validated software is one of the most serious limitations in the use of CAI (Pogrow, 1983; Benderson, 1985). Benderson (1985) states, "The magnitude of the software problem, as perceived by EPIE [Educational Products Information Exchange], is reflected in figures cited by Kromoski in the December 9, 1984, New York Times. Commenting on an evaluation that has now covered 600 pieces of educational software, Komoske says, ' About 5 percent of what we examined is first-rate, and about a quarter of what we have found meets minimal standards. The rest is pretty depressing---pedestrian, simple to do, and easy to produce. Schools are paying $50 for what they could have gotten in a workbook'" (p. 18). Over and over again is stated the addage, "evaluate -- evaluate -- evaluate" (Taber, 1982) when software is being considered.

Theoretical Rationale

The use of the computer in instruction has a number of advantages over traditional methods (Zientara, 1984). It can provide immediate positive feedback. It can individualize instruction to specific needs such as providing additional problems or examples when needed or eliminating material if mastery is evident. It gives constant attention, cannot be distracted from its purpose, does not become moody and has the capability of incorporating in lessons many media devices in an efficient manner that is not easily replicated in the classroom (Lepper and Malone, 1984). All of these things relate to an increase in intrinsic motivation. Lepper and Malone (1984) state, "Our hope is to illustrate the value of using computer-based learning as a laboratory for reviving classic issues in educational and social psychology and for examining those issues in a manner that highlights both their considerable theoretical significance and their immediate social importance"(p.1).

The purpose of this study is to determine what effect intrinsic motivation in software programs, using graphics and non-graphics, has on the achievement, attitudes, attendance and depth-of-involvement in underachieving students. "The computer provides a common context in which the concepts and principles developed within several historically distinct research traditions can be systematically studied" (Lepper and Malone, 1984, p.3). The principles serving as a basis for the theoretical construct on which this experiment is based come from the classic debate on the approaches to intrinsic motivation. One group of theorists sees humans as problem solvers who are motivated by challenge, competence, effectance, or mastery motivation (Bandura and Schunk, 1981; Lepper and Greene, 1978; Weiner, 1980). A second group approaches humans as information processors influenced by curiosity, incongruity and discrepancy (Kagan, 1972). A third group portrays humans as voluntary actors who must perceive control over their environment and have self-determination (Condry, 1977; Deci, 1975, 1981). But in addition to these, Lepper and Malone (1984) state computers add a factor themselves--that of fantasy involvement in the form of story plots, sound effects and other technical devices. The research issue then revolves around many provocative questions. When is learning best? When it is active or passive? When it is self-directed or externally controlled? When it is inductive or didactic? Do we have to trade off efficiency in learning to achieve depth of learning? To answer some of these questions we must look at specific approaches to computer-based instruction exemplified in educational software. For example, how do math programs with minimal or no use of graphics compare with more active fantasy enriched math programs utilizing endogenous and exogenous graphics on the math achievement, attitudes, attendance and depth-of-involvement of underachieving elementary students?

Statement of the Problem

With so much attention given to computers in the last decade, the question "What does the research say?" should give a straight forward simple answer but instead is deceptively complex. "In general the answer is not nearly as much as it can, will and already should have" (Bracey, 1982a). This then is one of the basic problems, the establishment of a pool of research going beyond the concept of the effectiveness of computers in education to define the parameters within which specific types of computer instruction are effective and with whom. The question to be researched in this study is, "What effect does intrinsic motivation in software programs have on the achievement, attitudes, attendance and depth of involvement of underachieving students?"

General Hypothesis

This is a comparative study and evaluation of contrasting philosophies of education embodied in various current approaches to the design of educational software for children. The study was done through an analysis of the educational efficacy of specific software programs used on microcomputers. These programs were used individually or in groups of two by elementary age alternative education students over the period of a semester of 18 weeks. They were used a minimum of 20 minutes 3 times per week in the subject area of math as measured by the Math Computation subtest of the Stanford Achievement Test. It was expected that students using CAI with graphics would:

1.) Demonstrate an increase in math achievement;

2.) Show increased motivation towards school by improved school attendance;

3.) Show improved school attitudes as measured on an attitude survey;

4.) Show an increased depth-of-involvement over those students using CAI with minimal or no graphics as well as over the control group.

Definition of Terms

The following terms were used in the study:

Achievement is defined as that measure of academic accomplishment demonstrated by the grade equivalent score on a standardized achievement test.

Alternative education students participate in the Alternative Education program and have met the criteria of having failed a grade level three or more times, are assigned in grades 1-5, and who have not failed due to absenteeism or qualified for special education.

Computer Assisted Instruction (CAI)/ Computer-Based Instruction (CBI) refers to educational instruction in academic subjects presented to the student by the computer through the use of specifically designed software programs.

Depth-of-Involvement is defined as the degree of cognitive involvement a student may have with an activity. It may influence how information is processed and whether that knowledge can later be remembered or used.

Endogenous or intrinsic graphics refers to the visual material that is directly related to the meaning and content of the material presented.

Exogenous or extraneous graphics refers to the visual material that is not incorporated into the meaning of the content material but is superfluous to it.

Sample and Data Gathering Procedures

Data for the experiment were gathered through the use of a standardized group measure of academic achievement in the area of math computational skills to measure the effect of the treatment on math achievement. It was administered at the beginning of the experiment as a pretest and the same measure was administered at the end of the treatment period to determine the gain in grade equivalent scores. Increased motivation through school attendance was determined through documentation of attendance in school records. An attitude survey was administered on a pre-post basis to determine changes in attitude among the groups. Depth-of-Involvement was measured through rated observations and exit interviews after no less than five sessions with the computer for each group.

Four microcomputer stations with appropriate peripherals were required for the study to be completed. Education software exemplifying the types of software design to be studied and dealing with developmental math skills on a first through fifth grade level were also required. Students were exposed to a minimun of 20 minutes of CAI a minimum of three times a week for a period of one semester of 18 weeks.

Limitations

Since the intent of almost all experimentation is to establish that the experimental treatment did or did not make a difference and to be able to generalize findings, it was necessary to consider those threats to internal and external validity which may limit the scope of the results of this particular study.

The selection of the research design was critical if the ideal of both strong internal and external validity was to be realized. This is particularly true for education research as generalization for use in the field is the generally recognized goal (Cambell and Stanley, 1963).

The Nonequivalent Control Group Design was selected in order to minimize threats to internal validity and because true randomization of the population sample was not feasible. Assignment of classes to participate in the experimental, or alternate treatment was randomly selected. However, in using this design the main threats to internal validity of maturation, history and testing were controlled. Matching between experimental, alternate treatment and control groups was not considered in order to minimize regression effects. This was also true of limiting the population pool only to students in the alternative education program. This precluded normal students as a control who would necessarily have much stronger academic acheivement as a baseline, thus being subject to greater regression effects. Matching groups would also have been difficult with the limited pool that was available in the alternative education group.

One threat to internal validity that was not controlled in the selected design was that of selection-maturation. It was expected that there would be growth in the control group scores due to maturation and other factors other than the experimental treatment. This same growth could also be reasonably expected within the experimental and alternate treatment groups, keeping this problem to a minimum. The validity and reliability of instrumentation was also of concern with the short duration of the treatment.

One limitation in the study was the instrumentation. The need to use levels of math achievement tests appropriate to the instructional level of the student was of concern. This necessitated the use of three levels of the Stanford Achievement Test, Math Computation subtest, Primary 1, 2 and 3. Although much of the content material on the different levels overlapped, there were some differences. These differences are indicated on Table 1.0. Then, in order to have a standard score that could be equated across the levels according to the norm

MATHEMATICS COMPUTATION

		Graphics: Endogenous		Graphics: Exogenous			Non graphics		
		OLM (6)	ALIENCOUNTER / FACE FLASH	MATH DIASTER	FISHING FOR ANSWERS	PLATO (2)	THE ARITHMETIC CLASSROOM (9)	THE MILLIKEN MATH SERIES (12)	PRESCRIPTIVE MATH DRILL
ADDITION WITH WHOLE NUMBERS	PRIMARY 1	●	●	●	●	●	●	●	●
	PRIMARY 2	●	●	●	●	●	●	●	●
	PRIMARY 3	●	●	●	●	●	●	●	●
SUBTRACTION WITH WHOLE NUMBERS	PRIMARY 1	●	●	●		●	●	●	●
	PRIMARY 2	●	●	●		●	●	●	●
	PRIMARY 3	●	●	●		●	●	●	●
MULTIPLICATION W/WHOLE NOS	PRIMARY 2	●		●		●	●	●	●
	PRIMARY 3	●		●		●	●	●	●
DIVISION W/ WHOLE NOS	PRIMARY 3	●		●		●	●	●	●

TABLE 10

tables, all raw scores were converted to grade equivalents. Students were given the same level test they had taken for the pretest as the posttest.

One further threat to internal validity could have been the effect of specific events in history on one group without a similiar effect on another group. These events too should have been minimal within the somewhat controlled setting of the school environment but the possibility could not be eliminated entirely.

An area found to be of considerable concern in the pilot project was the issue of mortality because of the general nature of the population of students in the pool. There was a large dropout rate over the life of the study due to students moving, withdrawing from school or otherwise no longer participating in the project. Because no attempt at matching was made and there was no opportunity for self-selection into the study, it was expected that neither the control, experimental, or alternate treatment group would be any more likely to experience greater mortality. However, because of the motivation affects associated with computer use and the differences in the software packages to be tested, it was difficult to determine prior to the outcome if what was presumed more motivating in software would prove to be true and therefore influence dropout rates as well as the other variables measured in the study.

The external validity of the study also encompassed threats which were of concern. The first was that of population validity. Since the study used students who were clearly identified as underachievers, results would only be generalizable to that type of student. Although it would have been equally interesting to explore the effect of different software approaches to instruction with regular and gifted students, that was beyond the scope of this particular project. In addition, when attempting to generalize to other underachieving groups it would be necessary to know the specific characteristics used to define the population as underachievers in order to make valid comparisons. The alternative education students in this case were the experimentally accessible underachievers. Because the sample included this entire population within one school system, statistical inference to other underachievers in this system meeting the same criteria should be valid. However, if generalized to all underachievers in the country regardless of selection criteria, results would be much more spurious.

Because this study dealt with only a small portion of the possible software designs for instruction such as those using graphics versus those which did not, it is also extremely important in generalizing to be specific in the type of program design for which the results apply.

Although the use of computers is still new in the education setting, it was expected that there would be little "Hawthorne Effect". Clark (1983) defined the novelty effect as "the increased effort and attention research subjects tend to give to media that are novel to them" (p. 449). He stated that this sometimes results in increased effort or persistence yielding achievement gains which tend to diminish as students become more familiar with the medium. He cited the case (Kulik, Bangert, and Williams, 1983) where the effect size dissipated significantly in the longer duration studies lasting eight weeks or more. To account for this, all alternative education students were exposed to computers and computer assisted instruction in a pilot program for a full semester prior to initiation of this study. In addition, this study was conducted over a full semester consisting of 18 weeks to reduce the probability of novelty effects. Nevertheless, it must be noted that this duration is a relatively short period of time over which to increase academic growth considering the limited sensitivity of the testing instrument and the underachievement of the students.

Since CAI and pre-post testing has been generally routine due to the pilot project and to required standardized testing in the schools for other purposes, only the nature of the software was different. No disruption of normal routines was involved and no students were aware of the experimental nature of the study.

Since the study operated as a part of math instruction, it is expected that acceptance of CAI in general will be very positive with the instructor. Bracey (1982a) suggests that those with a math background look much more favorably on working with computers in the classroom and frequently are initiators of CAI. Therefore, if any teacher effects are biasing, it would be in a positive direction and have equal opportunity to influence the experimental, alternate treatment, and control group. Clark (1983) states that there is evidence that when studies concerning learning and media are subjected to meta-analysis, confusion between the medium and the method often shows up. He states that the positive effect for medium more or less disappears when the same instructor produces all treatments. For this reason an effort was made to have the same teacher instruct the students comprising both the experimental and alternate treatment groups. Because of the constraints of the natural setting, this was not possible with the control group. In lieu of using the same teacher, students in the control group were divided among three different teachers. In this manner the strength of the effects of content or methodology of any one of the instructors would be minimized.

In measuring the dependent variable of math achievement, there was the difficulty that the curricular content of the achievement test and the instructional software may not be congruent in all respects. However, because of the specificity of objectives in the math curriculum, it is far more likely in this subject area than in any other that the instrumentation measured the skills taught if the instruction was effective. An analysis of the content area tested matched against the specific skills taught by individual software programs is presented in Table 1.0.

To facilitate accurate execution of the study at the origination of the project, teachers received inservice concerning software, operation of the hardware, and instructional programming with Computer Assisted Instruction over the period of five days during a semester. Prior to the pilot project, instructions on setting up and operating computer stations were reviewed. Teachers did not use any other media or visual materials in their classroom instruction with the exception of the usual student worksheets. On-going consultation and assistance was provided throughout the pilot project and study. A total of fifteen visitations were made. Observations took place over a total of four days during the pilot and six days during the study.

It was considered difficult to separate out the effect of computer instruction in math achievement gains over classroom instruction due to the supplemental nature of the CAI investigated. Individuals continued to be exposed to math skills in the regular curriculum. Looking at the regression effects with pre and posttesting, and the use of a control group were the best methods for minimizing this problem. More specific recognition of the types of students involved in this particular alternative education program accounting for such things as socioeconomic level, past attendance history, and general intellectual ability may all prove limitations to the extent of generalizability possible.

Ethical Considerations

Because of ethical considerations, students participating as part of the alternate treatment or control group will be given the same opportunity to use the experimental group CAI software after the posttest is administered. Assignment of individual students into the experimental, alternate treatment or control group could not be completely randomized due to the limitations of scheduling although assignment of the type of software to groups once assigned was randomized. All students assigned to a class period were selected as the experimental, alternate treatment or control subject by academic period. For reporting purposes all students were identified by their student code number. Class periods were randomly assigned to groups.

CHAPTER II

The theoretical basis of this study owes much to the classic work of Thorndike and Skinner on conditioning. Thorndike's third law of learning ("*law of effect*") states, "Correct movements of an organism tend to be stamped in by the satisfaction of success and incorrect ones eradicated by the dissatisfaction of failure (Thorndike's other two laws of learning were that movements most frequently and most recently performed tend to be repeated.)" (Bowen and Hobson, 1974, p. 255). Skinner's theoretical aspects arose out of an experimental basis to propose "operant" conditioning. An animal operates on its environment to receive what it wants. The action is initiated by the animal not elicited from it as in classical conditioning. Skinner found that it was possible to get virtually complete control over animals such as rats or pidgeons by changing conditions under which they act.

Skinner's work evolved into the stimulus-response (S-R) theory of motivation.

According to the S-R theory, a child does not have to want to learn something in order to learn it, but he does have to want the reward provided for learning. This reward is termed reinforcement. Reinforcement to be effective must be immediate. When reinforcement is applied to instruction, the student works at his own rate in small enough steps to make reinforcement very likely. Under these conditions research showed learning to be highly efficient in terms of retention (Skinner, 1968).

As early as 1954, Skinner used the concepts he developed in operant conditioning to propose the development of teaching machines in his 1954 article, "The Science of Learning and the Art of Teaching". This article was later included as a chapter in his book 1968 The Technology of Teaching,. He wrote, "The simple fact is that, as a mere reinforcing mechanism, the teacher is out of date. This would be true even if a single teacher devoted all her time to a single child, but her inadequacy is multiplied manyfold when she must serve as a reinforcing device to many children at once. If the teacher is to take advantage of recent advances in the study of learning, she must have the help of mechanical devices" (Skinner, 1968, p. 22). This work was very influential in the subsequent proliferation of programmed learning. Even at this time in history, he cautioned that the program does the teaching not the machine. In his later book Beyond Freedom and Dignity, Skinner (1971) further explored the conflict between technology and naturalism.

Premack was greatly influenced by Skinner when he proposed a notion of reward that he thought useful in school situations (Bowen and Hobson, 1974). Premack expanded the concept of reinforcement proposed by Skinner. Premack believed a reward was anything someone liked doing. The use of behavior modification techniques in education exphasized the concept of using anything that appeals to the student as a reward.

Aspects of software programs salient to this study can also be traced back to other educational theorists. The ability to exert control over the learning situation may also influence learning. Neill, a reformer in the progressive education movement, was concerned about the freedom of the child. He followed up on the philosophy of

Rousseau in the 18th century and Dewey in the 19th. Neill felt that "the child must never be compelled to learn...[but] seek learning only on the basis of his own inner needs and drives" (Bowen and Hobson, 1974, p. 310).

Peters used the technique of analytic philosophy to "help clarify many basic concepts in education; concepts like education itself, as well as those of teaching, training, indoctrinating and conditioning. A precise understanding of these is necessary whatever educational theory one adopts" (Bowen and Hobson, 1974, p. 348). Peters believed that education should have intrinsic value not merely be the means to an end. He advanced a philosophical view of education in which he endeavored to resolve the conflict between traditionalism and progressivism by creating a middle-of-the-road view of education. In his philosophy, education became initiation, an intrinsic value with useful by-products. It was necessary to get the pupil to care about what is worthwhile in a way that involves awareness and voluntariness on his part. Educated is not merely trained.

Peters himself sums up his overall approach to education:

> ...in education theory my position is essentially a synthetic middle-of-the-road position. I attempt to draw out what is of value both in the traditional formal education and in the child-centered revolt against it. To reconcile emphasis on the individual with the essentially social character of education, to see the value of authority while remaining fundamentally antagonistic to it, to defend freedom while stressing the necessity for constraints when dealing with children, to maintain that some pursuits are more worthwhile than others while, at the same time, stressing importance of individual choice and individual interests. Anyone who takes such a position is likely to be attacked both by traditionalists and by progessives ---nowadays probably more by progressives; for, being more recent phenomenon, they find it difficult to accept the role of an antithesis in a developing dialectic. And, of course, texts can always be quoted to support either type of attack. This is something that anyone who tries to reconcile

> opposites must learn to live with; for the opposing voices come not just from outside but from within himself. (Bowen and Hobson, 1974)

Threads of nearly all of the major historical philosophies of education become entwined in the current study of the programming of educational software to maximize learning. Skinner designed a teaching machine based on some of his major ideas about behavioral psychology as applied to education. These ideas were that teaching should incorporate individual, interactive instruction, and should give the student immediate feedback (Zientara, 1984). In a 1984 interview he explained that "It was an attempt to do what the modern computer does... The main thing about programming is that the steps students take are so small that they're right 90% of the time" (Zientara, 1984, p. 23).

The original "teaching machines" of Skinner have become the sophisticated technological devices described as computer hardware and software yet still the maxim is: programs teach, not machines. Software designers have used the basic principles of reinforcement theory and the capabilities of the new technology to accomplish new heights of individualization, immediacy, and consistency. Programs can be designed varying the degree to which the student has control over his learning such as Neill, Peters and Premack felt was required. Theoretically, the technology now exists that intrinsic motivation can be incorporated in ever increasing levels of complexity and matched to the individual characteristics of the student. But what we still cannot answer is what factors or combination of factors will maximize learning with computer-based instruction for individuals of varying characteristics and under what circumstances. There is controversy in the research concerning whether intrinsic motivation fuels learning and if it does, to what degree (Lepper and Malone, 1984).

Treatment or Analytical Procedures

The basic premise for this study is to establish conditions in which the use of the computer will make it possible to study variables that affect intrinsic motivation in learning and consequently their eventual instructional effectiveness. According to Lepper and Malone (1984):

> A first thing that microcomputers will add to these classic motivational debates, therefore, is a laboratory in which variables relevant to each of these models--variables that influence challenge, curiosity, and control--can be systematically studied. In addition to this basic laboratory function, however, the microcomputer also offers new opportunities for studying intrinsic motivation from other perspectives as well... In short, the computer provides both a natural laboratory for studying traditional models of intrinsic motivation and a means of extending our understanding beyond those traditional models. (p. 5)

They state that the other perspectives of intrinsic motivation that the computer enables us to study include the factors that influence what can be called fantasy involvement such as graphic characters, story plots, sound effects, and all other possible technical devices that evoke a playful set, a personalization of material or involvement in fantasy (Lepper and Malone, 1984).

One of the important issues raised in educational computing discussions is whether factors enhancing intrinsic motivation increase or interfere with the learning of educational content. Since most school systems, not individual students, control the amount of time spent on a specific subject, there has been relatively little interest in the issue of intrinsic motivation as it affects time-on-task for instructional work that takes place during the school day. This lack of knowledge about the effect of these techniques on the mastery of the content has led to disagreement in the literature (Lepper and Malone, 1984).

Some authorities believe that the greater the level of arousal of the student, the more learning will be enhanced (Zajonc, 1965). Others believe that heightened interest will channel attention toward the instruction for better absorption of the material (Easterbrook, 1959). In addition, some researchers have proposed that increased motivation will increase active involvement and depth of processing of content material (Condry and Chambers, 1978; Craik and Lockhard, 1972); influence or change the child's mood state (Isen, Shalker, Clark and Karp, 1978); or foster subsequent recall or transfer of the information through concrete representation of abstract concepts (Anderson, 1980; Anderson and Bower, 1973). There are those who believe that the addition of extra game-like elements are distracting and tend to impair learning or at least make it less efficient and others who believe these elements enhance learning (Ohanian, 1984; Lepper and Malone, 1984; Bowman, 1982). Others question whether the negative consequences of such motivating material would outweigh any advantages (Ohanian, 1984; Kulik, Bangert, and Williams, 1983; Edwards, Norton, Taylor, Weiss, and Dusseldorp, 1975)? Will classroom work become dull and boring since it is not accompanied by the motivational devices of the computer (Bergen and Schalman, 1984)? Will the general positive attitudes spill over to classroom activities (Kulik, Bangert, and Williams, 1983; Bracey, 1982a)? Will all types of students benefit equally (Kulik, Bangert and Williams, 1983; Jamison, Suppes, and Wells, 1974)? Will motivational techniques enhance already able students' performance or will it prove more effective for those students who do not typically respond well to traditional methods (Roblyer, 1985; Kulik, Bangert, and Williams, 1983)?

Lepper and Malone (1984) summarize the factors by which motivational appeal might enhance instructional value or produce detrimental effects in terms of instructional design principles. (Table 2.1)

Table 2.1

EFFECTS OF MOTIVATIONAL EMBELLISHMENTS ON INSTRUCTIONAL EFFECTIVENESS

Attentional Effects

- Instructional Time Principle
- Attentional Focus Principle
- Goal Congruence Principle

Feedback Effects

- Informational Value Principle

Depth-of-Involvement Effects

- Depth-of-Analysis Principle
- Imagery Principle
- Identification Principle
- Self-Reference Principle

Control Effects

- Personal Control Principle

Arousal Effects

- Consolidation (Optimal Arousal) Principle

Affective Effects

- Positive Affect Principle

Multiple Channel Effects

- Multiple Representations Principle
- Multiple Contexts Principle
- Multiple Modalities Principle

Each of the factors in Table 2.1 addresses an area of motivation that can be manipulated to influence learning. The first area, Attentional Effects, deals with direct control of the student's attention to the task. Three different aspects influencing control of this attention are the instructional time, attentional focus and goal congruence. Instructional time refers to the actual time-on-task that is productive. Embellishments such as graphics may add to this time, or they may detract from it if they divert attention from the critical outcome of the task. In the same manner the second principle, attentional focus, may divert attention from pertinent material by such things as pictures or animation. The third principle, goal congruence may also enhance or divert attention. It is dependent on whether the student's goal coincides with the program's learning goals or conflicts with the instructional goal where only playing the game becomes important to the student.

Feedback Effects deal with the informational value of the feedback given. These effects are dependent on the quality of that feedback in an activity. It can be positive if it adds to the student's ability to learn or negative if it obscures the informational value of the feedback.

Depth-of-Involvement refers to the level of cognitive involvement the student has with the activity. This may affect how information is processed and whether it is retained or transferred. The first principle under this, depth-of-analysis, deals with methods of presenting material that encourage deeper processing and mental effort. The imagery principle suggests that the use of mental imagery in processing material enhances learning and retention. The identification principle suggests that the ability to provide the student with a useful point of view from which to consider and organize material may enhance learning. The fourth principle under self-reference, involves personalization of the material enhancing mastery.

The next motivational embellishment is Control Effects. As has been previously discussed, control involves the ability of the student to determine elements of the learning process. The principle under this, personal control, may affect learning to the extent the learner is permitted to use his own discretion to determine critical or incidental aspects of the learning process.

Arousal Effects are concerned with the level of student involvement in the process. The consolidation (or optimal arousal) principle would suggest that the level of arousal must be tailored to the stage of learning for optimal performance. It may aid in the consolidation of learning but disrupt initial acquisition.

Affective Effects refer to the student's affective state. The positive affect principle predicts that if this affect is positive, then learning will be enhanced positively.

The last area of motivational embellishments on instructional effectiveness detailed by Lepper and Malone (1984) is that of Multiple Channels. This deals with the processing of the same information from multiple sources or perspectives. This may enable individual students to use the channel best suited to their own learning style. The multiple representations principle suggests that the combination of several instructional approaches may enhance learning. In the same manner, learning may be enhanced when the material is applied to a variety of contexts, as represented by the multiple contexts principle. Learning may also be enhanced when material is presented across modalities simultaneously, indicated by the multiple modalities principle.

It would appear on the surface that educational software would be designed to adhere to the principles of learning that enhance intrinsic motivation. However, reviewers of educational software have criticized most available commercial programs as inadequate (Ohanian, 1984; Zientara, 1984; Bergen and Schalman, 1984; Cohen, 1983; Walker and Sherman, 1983; Bracey, 1982b).

Since there are potential trade-offs between efficiency, (with the likelihood of more short term retention) and depth-of-learning, (for understanding and long term memory) that exist in current educational software, the research question to be answered remains what motivational factors maximize the intended learning and for whom?

One area in need of study is the motivational embellishment of endogenous and exogenous graphics and its effect on instructional effectiveness in achievement and attitude. Of course student achievement may be affected by many factors, such as the attentional effects of available instructional time on the actual presentation of content, the attentional focus on the content to be learned of the individual as influenced by the graphics or by the goal congruence between the presentation format of the program and the acquisition of the actual content.

Feedback effects may also influence math achievement scores as the informational value of the material is enhanced or obscured in relation to the graphical embellishments used. Arousal effects may aid or inhibit consolidation due to the variance in the student's current stage of learning. Depth-of-involvement effects can be measured more directly through the use of rated observations and exit interviews. Information concerning the depth-of-analysis can be determined by cognitive engagement; the mental imagery used for processing of the information; the use of identification in providing a point-of-view from which to organize and consider information; and the use of personalization in self-referencing to promote processing.

It is expected that the use of graphics will influence affective effects in a positive direction and that this will be directly measurable by the attitude survey. Multiple channels effects may influence all of the areas under consideration as it permits the opportunity for the student to utilize his best channel for processing information on a level. A variety of representations, contexts and modalities as indicated by multiple channel effects should enhance the student's chance for encountering at least one means of understanding and absorbing the material presented, if not many (Lepper and Malone, 1984).

Empirical Evidence

The research that does exist tends to study the effects of computers in a global manner on achievement, affective/ motivational factors and social factors. The introduction of CAI, not any of the programming features of the software utilized, becomes the only independent variable. There have been a number of studies dealing with underachieving students which generally indicate that CAI is effective.

Jamison, Suppes, and Wells (1974) concluded that computer-based teaching, when used as a supplement to regular instruction at the elementary level, improved achievement for disadvantaged students. At higher levels it was found to be at least as effective as regular instruction but could also achieve the same result in less time. Kulick, Bangert, and Williams (1983) completed a meta-analysis of 51 separate research studies completed between 1968 and 1979 on students in sixth grade or above. They found that in almost all cases students with CAI scored better on tests than they would have without it. The analysis showed that computer-based teaching raised students' scores on final exams from the 50th to the 63rd percentile. Kulik, Bangert, and Williams (1983) were able to make a number of other conclusions from their analysis. They found that none of the features and outcomes they investigated could be considered clearly statistically significant with the number of studies available. They found positive effects on follow-up testing in four out of five studies but none of these retention effects was large enough to be considered statistically significant. Very positive attitudes were found on the part of students towards the computer in four out of four studies, and towards the course they were taking in eight out of ten studies but of these only three were statistically reliable. The computer reduced the amount of time needed for learning in two studies. They stated, "The effects of computer-based teaching seemed especially clear in studies of disadvantaged and low aptitude students, for example, whereas effects appeared to be much smaller in studies of talented students" (Kulik, Bangert, and Williams, 1983, p. 26).

The Educational Testing Service conducted a study in collaboration with the Los Angeles Unified School District. Results of this study also showed very positive outcomes (Ragosta, Holland, Jamison, 1982). "ETS found that in mathematics, children who had access to the computer for only 10 minutes a day scored significantly higher than those who did not have such access. Twenty minutes a day doubled the gain and as the study progressed, ETS found that the children increased these gains over those with no access (Bracey, 1982b, p. 52). This study focused on CAI in compensatory education.

Roblyer (1985) writes in her book <u>Measuring the Impact of Computers in Instruction</u>, "One of the great unanswered questions in education is: 'How much do computers actually improve instructional methods and, consequently, student achievement?'" (p. 5) In her book she reviews the results of research to date, both before meta-analysis and using meta-analysis to address commonly held assumptions in computer assisted instruction. However, she states that substantially more data is needed. Roblyer summarized five reviews of research from 1975 to 1980 prior to the introduction of the meta-analysis technique (Table 2.2, first five listed). Although differences in methods and focuses made it difficult to summarize, she stated that in general these studies supported the following conclusions:

--Larger gains with computer treatments seem to occur more frequently at elementary levels than at higher levels.

> --Equal achievement between computer-based and non-computer treatments are the most prevalent finding.
>
> --Supplemental-CAI seems to result in greater gains more frequently than substitute-CAI.
>
> --The factors most positively affected seem to be reduction in learning time and attitudes toward instruction and computers. (p. 11)

Despite criticisms of the meta-analysis technique, Roblyer (1985) states that this procedure, "in instructional computing should be seen as a powerful addition to -- rather than a replacement for -- previous reviews and future research in the area" (p. 14). She summarizes seven meta-analysis reviews of research from 1980 to 1985 (Table 2.2, last seven listed).

Table 2.2

SUMMARY OF 12 REVIEWS OF RESEARCH ON INSTRUCTIONAL COMPUTING

Author(s)	Year	Focus	Review Method
Visenhaler & Bass	1972	Drill/ Practice	Differences in gains
Jamison, Suppes, Wells	1974	All Studies	Sign. vs non-sign. diff.
Edwards, et al.	1975	All Studies	Sign. vs non-sign. diff.
Thomas	1979	Secondary	Sign. vs non-sign. diff.
State of Florida	1980	All Studies	Sing. vs non-sign. diff.
Kulik	1981	Math	Meta-analysis
Kulik, Kulik, Cohen	1980	College	Meta-analysis
Kulik, Bangert, Williams	1983	Secondary	Meta-analysis
Kulik, Kulik, Bangert-Drowns	1984	Elementary	Meta-analysis
Burns & Bozeman	1981	Math	Meta-analysis
Roblyer & King	1983	Reading	Meta-analysis
Glass	1982	ETA Study	Meta-analysis

Taken from Roblyer (1985 p. 26).

In general, Roblyer (1985) says the results of meta-analysis reviews support results of the previously mentioned reviews with some additional information:

--Higher effect sizes seem to be a function of grade level, with achievement decreasing as grade levels increase. The highest effect sizes appear to be found at elementary grades.

--Computer-based instruction achieves consistently higher effects than other instructional treatments to which it is compared in experimental situations, but the effects usually range from small to moderate in magnitude.

--Supplemental computer-based instruction seems to result in greater effects than replacement CAI.

--Computer-based treatments seem to result in significant reduction in instructional time and in more favorable attitudes toward computers.

--In reading, there are higher effects for non-drill CAI which is used in smaller groups; in math areas, non-drill also achieves higher effects overall, although younger and lower-ability students seem to learn comparatively better from drill and older, higher-level students appear to profit more from tutorial-type CAI.

--In general, mathematics areas seem to profit more from computer-based instruction than reading/language arts areas, but at the college level, results indicate just the opposite effect.

--At least two researchers have found that, although computer-based methods usually have been shown to result in increased achievement, effect sizes are often smaller than those from studies of other, non-computer strategies such as instructional television or improved reading/study skills.

--The most current reviews indicate better results in more recently

> published studies, and with studies using CAI/CMI strategies as opposed to more unstructured "computer enrichment" activities. (p. 20)

Roblyer (1985) believed the following general conclusions could be made from her analysis. Few of the instructional activities reported in the reviews supported teacher-less learning. In most instances supplemental CAI rather than substitute CAI was found more effective. When CAI was compared with traditional classroom instruction, it usually resulted in greater effects. However, there was not evidence that this held true in larger classes, and reduced class size was generally not studied although Glass (1982) thought that this kind of research would be helpful. The belief that CAI aids retention had very little support in the current data. Reduced learning time through CAI, however, seemed to be supported particularly at higher grade levels. There was substantial evidence to refute equal effectiveness at all grade levels and all content areas. Roblyer (1985) states, "Most of the reviews reported significantly better results with lower ability learners and lower grade level students, and in mathematics as opposed to reading/language areas" (p. 24). Finally, recent studies of new technology and innovative teaching approaches give little support to superior use of the computer in this area.

Unfortunately, as was stated by Lepper and Malone (1983) and indicated repeatedly by Roblyer (1985) there are no studies available as yet investigating the use of different instructional strategies incorporated in the software programming rather than just the use of the media of the computer.

So we have the beginnings of research indicating students can improve achievement with CAI especially for underachieving students. The area of math is well established as a subject benefiting from CAI to achieve academic gains. This study proposes to take this basis of research and to define more clearly the particular circumstances under which beneficial results are obtained.

CHAPTER III

Seventy-four students were identified who met the criteria for admission to the alternative program in grades 1 through 5. The criteria for admission includes 1) students who are currently assigned a grade placement within grades 1-5; 2) students who have been retained three or more times; 3) students who if tested have been found ineligible for special education; and, 4) students who have not been retained due strictly to absenteeism. Of the original pool of 74, there was a 12% mortality rate over the life of the study totaling 9 students, seven from the control group and one each from the alternate treatment and experimental group. Therefore, the overall n of the study equaled 65.

Students selected for the study consisted of the entire pool of students eligible for alternative education in grades 1-5. Students were assigned to the experimental, alternate treatment or control group according to the class period in which they were assigned to math class from which the computer laboratory was directed. All students in a period participated as an experimental group, an alternate treatment group or as a control group. Class periods were randomly assigned as experimental, alternate treatment or control.

Treatment Data Gathering Methods

Students participating in this study received approximately 20 minutes of supplemental math instruction presented through the use of computer assisted instruction. Each student had exposure to the material at least three times a week as permitted by the school calendar. Those students participating as part of the alternate treatment group were presented math skills through software that either contained no graphics or graphics that were not part of the instructional lesson. No graphics in the presentation of the material to be learned were permitted. Only figures intrinsic to the mathematic concept itself or at the end of the lesson were permitted. This would include such things as the representation of a triangle when learning the concept triangle.

Students participating in the experimental group were presented math skills through software that contained graphics that were integrated into the program. These programs incorporated both endogenous and exogenous graphics in a variety of ways that enhance intrinsic motivation.

Software for either group could be in a game format and could use instructional experiences, tutorial instruction, games or problem solving. An attempt was made to match presentation of specific content in the same format for each group. The instructional purpose of the software could be remediation, initial instruction, standard instruction or enrichment. However, no animation or illustrations other than that just mentioned was to be used with the alternate treatment group. The experimental group used software that incorporated illustrations, graphics, or pictorial representations throughout the presentation or as elaborate immediate feedback devices. These figures may or may not have been related to the actual content of the material presented. The criteria used to select software consisted of the following:

General--Used in selecting both Experimental and Alternate Treatment software:

-Was suitable for use on the available hardware.

-Content had educational value.

-Difficulty level was appropriate to audience.

-Met curricular content of math instruction for grades 1-5.

-Was designed for use by an individual or no more than 2 students at a time.

-Users could operate easily and independently.

-Program was reliable in normal use.

Software for the Experimental Group

-Made use of high resolution graphics.

-Used graphics in providing feedback.

-May have made use of color.

-May have made use of animation

-May have made use of a game format.

-May have made use of sound as a reinforcer.

Software for the Alternate Treatment Group

-May have made use of a game format.

-May have made use of a sound as a reinforcer.

-May have used text or a figure as reinforcers.

Both groups were given the Stanford Achievement Test Math Computation Test as a pretest and posttest to measure gains in math achievement. Students in the study completed all the math subtests on the Stanford Achievement Test but only one subtest dealing with math computation was used for analysis. This was the The Math Computation and Application subtest on Primary Level 1, and the Math Computation subtest on Primary levels 2 and 3. Students completed the appropriate test level for their assigned grade. Form E of the test on all levels was given as both the pretest and posttest. Students took the same level test for both the pretest and posttest. This Math Computation subtest was selected for analysis because it most directly measured the skills being taught in the classroom and in the software programs. Because of the necessity of using three levels of The Stanford Achievement Test to measure accurately student's computational skills, scores were reported as grade equivalents. Raw scores could not be used for analysis because they represented different levels of achievement on the norms tables according to the level of the test taken. In order to compare scores across levels it was necessary to first convert raw scores to grade equivalents.

The School Attitude Measure (SAM) attitude survey was administered on a pre-post basis to all groups. The SAM Teacher's Manual (Dolan and Enos, 1980) describes this measure as a self-report survey instrument developed to provide evaluation of student's affective response to their school experience. It was designed as a measure to aid in better understanding the performance of students in the school environment. To do this it examines their perceptions of themselves as competent learners. This measure is intended to provide information valuable im making decisions about program development, individual education planning, selection and placement of students for particular programs, guidance planning, and the development of instruction standards and objectives. According to the manual,

> Even when educators place emphasis on the affective consequences of schooling, the lack of rigorous attitudinal instruments that focus on school life has contributed to a limited perspective on the evaluation of school outcomes. This has caused educators and school policy-makers to rely upon cognitive outcomes as the measure of the total impact of the school experience on students for making decisions about curriculum and resource allocations.
>
> Of the affective instruments that have been available to educators in the past, many have had limited application. Among the most serious deficiencies are:
>
> -Lack of attention to the cognitive prerequisites necessary for students to respond to self-report items (for example, inappropriate reading levels).
>
> -Failure to construct and select survey items so that students do not choose

responses simply on their social desirability.

-Inappropriateness of measures for a wide range of ages.

-Limited support from validity studies.

-Failure to address the multi-dimensional nature of affective development in schools.

-Failure to interpret affective scores in light of other indicators of the impact of schooling.

-Inappropriate assessment of intra-personal, non-school related emotions or attitudes.

The inclusion of the School Attitude Measure ... confronts many of these problems by incorporating recent techniques and methods for understanding and analyzing students' affective reponses to their school experiences. (p. 5)

There are five attitude scales included in the School Attitude Measure. They include: Motivation for Schooling; Academic Self-Concept--Performance Based; Academic Self-Concept--Reference Based; Student's Sense of Control over Performance; and Student's Instructional Mastery. Scores for each subscale are reported individually for each scale as a weighted raw score. No composite of scores is provided as each scale is considered distinct. For this reason, although the students completed all of the scales, the Motivation for Schooling scale was considered to measure most directly the attitudes influenced in the study. This was the only scale used in the statistical analysis.

The Motivation for Schooling scale was designed to measure specifically the way students have come to feel about their total school experience. It also measures how this can influence how hard they want to work in school, how highly they value school, and how much they want to pursue further schooling.

Items included in the scale, according to the manual, had to be related to the student's:

> -willingness to participate in current school experience because it is meaningful;
>
> -desire to perform competently in future school experience;
>
> -perception of the relationship of current schooling to future needs;
>
> -willingness to pursue future schooling;
>
> -perception of the importance of school relative to other activities;
>
> -perception of the way individuals significant to the student view the student's school experience. (Dolan and Enos, 1980, p. 8)

School attendance records were compiled for comparison among groups. The number of days present out of the total possible number of days of enrollment, in this case 87 days, was used as the raw score in the statistical analysis.

Rated observations were conducted on each of the students within the last month the study. This consisted of a 20 minute observation in which each student was rated once each minute as to whether they were on task or off task. Rating data were compiled to determine the total number of minutes each student spent on task out of the total 20 minutes possible. The score of the total number of minutes on task was used as the raw score in the statistical analysis.

Exit interviews were also conducted with each of the students participating in either the alternate treatment group, or the experimental group to obtain qualitative information concerning their experience with the computer. These interviews were completed immediately following the student's turn on the computer. The questions used are listed in Appendix B.

Evidence of Measurement Reliability and Validity

The Stanford Achievement Test: 7th Edition, Mathematics test form E was used as the group standardized measure for the pretest and posttest. Although the entire test was administered, only the Mathematics Computation and Applications subtest in Primary 1 and the Mathematics Computation subtest in Primary 2 and 3 were used for statistical analysis. The reliability coefficient for the subtest Mathematics Computation and Applications, Primary 1, Form E was .88. For the subtest Mathematics Computation, Primary 2, Form E and Primary 3, Form E the reliability coeficient was .90. The content validity of the test for a particular school system can be determined only by a detailed examination of the tests themselves. This was done in order to match software with instructional objectives taught in the Alternative Education Program. Trimble (1972) reviewing the math subtest in The Seventh Mental Measurements Yearbook states that after 50 years of experience gained in extensive use, these tests do superbly well what they claim to do. He also says that researchers seeking a kind of common denominator for arithmetic programs throughout the United States will do well to consider these tests.

The School Attitude Measure, a standardized self-report survey instrument, was developed to provide evaluation of students' affective response to their school experience. Bias research has shown that the test items have been written to eliminate sexism and minority bias. The reliability estimate for internal consistency is .91 for the total test. Validity studies suggest strong concurrent validity of specific subscales with other instruments that test only one aspect of affective development. The reliability coefficient for the subscale Motivation for Schooling is .76.

Research Design

The research design used in this study was the generally interpretable nonequivalent control group design with pretest and posttest.

The research design is represented by the diagram:

O_1	X_1	O_2
O_1	X_2	O_2
O_1		O_2

where (O) indicates an observation through testing; (X_1) indicates the experimental treatment; (X_2) indicates the alternate treatment; the dashed line indicates that groups were not randomly formed; and the subscripts after the observation through testing indicate the sequential order of recorded observation.

The study took place in the natural school setting. Because of this it was necessary to use the naturally assembled grouping of the classroom in differentiating between the experimental, alternate treatment and the control group. These classes were considered relatively similiar since all of the students must meet the same criteria to participate in the alternative education program. They are not so similiar however, that one could dispense with the pretest. The assignment of experimental, alternate treatment or control group among the classes was random and under the experimenter's control. This design makes use of the control group which greatly enhances its generalizability but also acknowledges that complete randomization of subjects is not possible. This design controls for as many threats to internal and external validity as is possible under the given conditions.

The study had a duration of one semester of 18 weeks. All computer work took place during the student's regular math class as a part of the normal curriculum. Students worked on the computer individually or in groups of two. Each time they recorded the program used and the time expended. Students were given the opportunity to work on their assigned software programs a minimum of 20 minutes three times a week.

Since each class averaged eight students and class periods were 45 minutes long, two groups of students were able to work each day at 4 stations during either the first or second half of the period. Assignment to either software with graphics as the experimental group or software without as the alternate treatment group was on a classwide basis. Therefore, all students during a period were working on the same type of material. Pre and posttesting was done with a standardized group test, The Stanford Achievement Test Math Computation subtest and the School Attitude Measure, Motivation for Schooling subtest, at the beginning and end of the semester.

Specific Hypothesis

Alternative education students using a microcomputer individually or in groups of no more than two, at least twenty minutes, three times per week for one semester of 18 weeks for supplemental CAI with software containing endogenous and/or exogenous graphics:

1. Would increase mathematics achievement significantly more than students using supplemental CAI without graphics as measured on the Math Computation subtest of the Stanford Achievment Test.

2. Would improve school attitudes significantly more than students using supplemental CAI without graphics as measured by the Motivation for Schooling subtest of the School Attitude Measure.

3. Would increase school attendance significantly more than students using supplemental CAI without graphics as indicated by school attendance records.

4. Would increase depth-of-involvement significantly more than students using

supplemental CAI without graphics as measured on rated observations and exit interviews.

Statistical Analysis Procedures

The statistical analysis will use the analysis of covariance for the first and second hypotheses measuring achievement and attitudes with one repeated measure through the pre-post test of the independent variable of the control, experimental and alternate treatment groups. The analysis of variance will be used for the third and fourth hypotheses comparing the dependent criterion against the independent variable of the control, experimental and alternate treatment groups.

The Multiple Classification Analysis will be used to rank the strength of the effects of the three treatments in each of the four hypotheses.

CHAPTER IV

The purpose of this study was to determine what effect intrinsic motivation in software programs using graphics and non-graphics has on the achievement, attitudes, attendance and depth-of-involvement in underachieving students. All instruction and testing was administered in the regular classroom setting by project teachers. Pre and posttests were collected and scored for hypotheses 1 and 2. The resultant data were subjected to analyses of covariance for all groups using the Statistical Package for the Social Sciences (SPSS), ANOVA with Multiple Classification Analysis (MCA). Attendance data and observation records were collected and compiled for hypotheses 3 and 4. The resultant data were subjected to analyses of variance for all groups using SPSS, ANOVA with MCA. Information identifying the time students spent on the computer was recorded daily by participating students. Qualitative data was collected through individual interviews of participating students. (Appendix B)

Hypothesis Ho1

This hypothesis states that alternative education students using a microcomputer individually or in groups of no more than two, at least twenty minutes, three times per week for supplemental CAI with software containing endogenous and /or exogenous graphics would not increase mathematics achievement significantly more than like students using supplemental CAI without graphics and a control group as measured on the math computation portion of the Stanford Achievement Test.

Three groups were tested in this experimental design: the control group, Treatment 1, in which there was no CAI; the alternate treatment group, Treatment 2, in which students were exposed to CAI without the use of graphics as a part of the instruction; and the experimental group, Treatment 3, in which students were exposed to CAI with endogeneous and exogenous graphics for at least 20 minutes three times per week over a period of one semester of 18 weeks.

The number of students used in this experiment was 65 (Table 4.1). Of this number 62 students were analyzed to determine math achievement gains. Three students were removed from the analysis after having found spurious results on initial inspection of their pre-post test scores. The first student removed had scored a grade equivalent of 2.0 on the pretest and 7.5 on the posttest. He had an overall gain of 5.5 years in math achievement during a 5 month period even though he had missed 25 days of school. He had only 14.1 hours on the computer when the average time was 18.3 hours. The second student removed had scored a grade equivalent of 5.1 on the pretest and 0.1 on the post test. He had an overall loss of 5 years in math achievement during a 5 month period. Inspection of his test booklet revealed that he did not complete more than the first few questions on the posttest. The third student removed had scored a grade equivalent of 2.0 on the pretest and 8.6 on the posttest. He had an overall gain of 6.6 years in math achievement during a 5 month period even though he had missed 44 days of school. He had only 8.5 hours on the computer.

Table 4.1

HYPOTHESIS 1 DESCRIPTIVE DATA OF THE STUDENT SCORES ON THE MATH COMPUTATION SUBTEST OF THE STANFORD ACHIEVEMENT TEST

		PRETEST		POSTTEST	
Treatment	n[a]	Mean	Standard Deviation	Mean	Standard Deviation
Overall	62	4.32	1.82	4.64	1.91
Control	33	4.71	1.94	4.66	2.10
Non-Graphics	16	3.33	1.27	3.91	1.42
Graphics	13	4.55	1.72	5.49	1.63

Note. Mean=Grade Equivalent in years.

[a] Numbers indicate students who completed both pretest and post-test measures.

The total population mean (n=62) of the posttest math achievement scores was a grade equivalent of 4.64. The control group (n=33) had a grade equivalent mean of 4.66. The alternate treatment group using non-graphics CAI (n=16) had a grade equivalent mean of 3.91. The experimental group using graphics CAI (n=13) had a grade equivalent mean of 5.49. Students in the study completed all the math subtests on the Stanford Achievement Test but only one subtest dealing with math computation was used for analysis as this was the subtest whose instructional objectives matched those of the software programs and the regular math instruction. This was the Math Computation and Application subtest on Primary Level 1, and the Math Computation subtest on Primary Levels 2 and 3. Students completed the appropriate test level for their assigned grade. Form E of the test on all levels was given as both the pretest and posttest.

The analysis of covariance in the Statistical Package for the Social Sciences was used to test the overall significance of the treatments used in determining if those students who used software programs in math instruction with exogenous and endogenous graphics did significantly better in math achievement than those who did not, or than those who had no CAI at all. The pretest scores were used as a metric covariate to remove extraneous variation from the dependent variable of the posttest in order to increase measurement precision. The covariate on the pretest measure was found to have an F value of 78.038 with .0001 significance indicating that individuals' scores on the pretest were highly related to their posttest scores regardless of their treatment (Table 4.2).

In the analysis of covariance it was found that the main effects of the treatments, (Table 4.2), had an F value of 2.757 with a significance level of .072. Therefore the null hypothesis for the treatment effects cannot be rejected.

Table 4.2

HYPOTHESIS 1 ANALYSIS OF COVARIANCE ON THE POSTTEST SCORES OF THE MATH COMPUTATION SUBTEST OF THE SAT - COVARIATE * PRETEST SCORES

Source of Variation	Sum of Squares	DF	Mean Square	F	Sign. of F
Covariate					
Pretest	122.247	1	122.247	78.038	.0001
Main Effects					
Treatment	8.640	2	4.320	2.757	.072
Explained	130.886	3	43.629	27.850	.000
Residual	90.861	58	1.567		

Since the statistical analysis does not provide any specific information about the pattern of effects, the Multiple Classification Table was used to compare the pattern of the treatments' relationship to the criterion variable (Table 4.3). In the case of the posttest scores of the Stanford Achievement Math Computation subtest when adjusted for independents and covariates, it was found that the control group, Treatment 1, was the least effective; the alternate treatment group, Treatment 2, the next most effective; and, the experimental group, Treatment 3, had the strongest efffect although these effects were not statistically significantly different.

Table 4.3

MULTIPLE CLASSIFICATION ANALYSIS OF ACHIEVEMENT DATA - POSTTEST BY TREATMENT WITH PRETEST

Variable	n[a]	Unadjusted Dev'n Eta
Control	33	.02
Non-Graphics	16	-.73
Graphics	13	.85

[a] Numbers indicate students who completed both pretest and posttest measures.

Hypothesis Ho2

This hypothesis states that alternative education students using a microcomputer individually or in groups of no more than two, at least twenty minutes, three times per week for supplemental CAI with software containing endogenous and /or exogenous graphics would not improve school attitudes significantly more than like students using supplemental CAI without graphics as measured by the Motivation for Schooling subtest of the School Attitude Measure.

Students in the study completed all five subtests of the School Attitude Measure, Motivation for Schooling, Academic Self-Concept--Performance Based, Academic Self-Concept--Referenced Based, Student's Sense of Control over Performance, and Student's Instructional Mastery. However, because there was no overall total score used in the standardization of this test, and each subtest is considered to stand alone, though it is acknowledged that scores across subtests for an individual are generally similiar, the weighted raw score for the subtest Motivation for Schooling was used in the statistical analysis. This subtest was felt to most nearly approximate the measure of attitude with the strongest likelihood of being affected in the experimental design. The same form of the test was given to all levels as both the pretest and posttest.

The same three groups were tested in this experimental design: the control group, Treatment 1, in which there was no CAI; the alternate treatment group, Treatment 2, in which students were exposed to CAI without the use of graphics as a part of the instruction; and, the experimental group, Treatment 3, in which students were exposed to CAI with endogeneous and exogenous graphics for at least 20 minutes three times per week over a period of a semester. The number of students used in this experiment was 65 (Table 4.4). The total population mean (n=65) of the School Attitude Measure, Motivation for Schooling weighted raw scores was 43.18 out of a total possible weighted raw score of 60. The control group (n=33) had a weighted raw mean score of 43.82. The alternate treatment group using non-graphics CAI (n=16) had a weighted raw mean score of 41.63. The experimental group using graphics CAI (n=16) had a weighted raw mean score of 43.44. No cases were removed from the analysis.

Table 4.4

HYPOTHESIS 2 DESCRIPTIVE DATA OF THE STUDENT SCORES ON THE SCHOOL ATTITUDE MEASURE, MOTIVATION FOR SCHOOLING SUBTEST

		PRETEST		POSTTEST	
Treatment	n[a]	Mean	Standard Deviation	Mean	Standard Deviation
Overall	65	41.68	8.03	43.18	7.71
Control	33	42.73	6.18	43.82	6.29
Non-Graphics	16	44.06	5.47	41.62	12.14
Graphics	16	37.13	11.53	43.44	4.30

Note. *Mean=Weighted Raw Scores.*

[a] Numbers indicate students who completed both pretest and posttest measures.

The analysis of covariance in the Statistical Package for the Social Sciences was used to test the overall significance of the treatments used in determining if those students who used software programs in math instruction with exogenous and endogenous graphics improved significantly more in school attitudes than those who did not, or than those who had no CAI at all. The pretest scores were used as a metric covariate to remove extraneous variation from the dependent variable of the posttest in order to increase measurement precision. The covariate on the pretest measure, Table 4.5, was found to have an F value of 9.115 with .004 significance indicating that individuals' scores on the pretest were highly related to their posttest scores regardless of their treatment (Table 4.5).

In the analysis of covariance it was found that the main effects of the treatments, (Table 4.5), had an F value of 1.500 with a significance level of .231. Therefore the null hypothesis for the treatment effects cannot be rejected.

Table 4.5

HYPOTHESIS 2 ANALYSIS OF COVARIANCE ON THE POSTTEST SCORES OF THE MOTIVATION FOR SCHOOLING SUBTEST OF THE SAM - COVARIATE = PRETEST SCORES

Source of Variation	Sum of Squares	DF	Mean Square	F	Sign. of F
Covariate Pretest	474.710	1	474.710	9.115	.004
Main Effects Treatment	156.281	2	78.141	1.500	.231
Explained	630.991	3	210.330	4.039	.011
Residual	3179.793	61	52.079		

Since the statistical analysis does not provide any specific information about the pattern of effects the Multiple Classification Table was used to compare the pattern of the treatments' relationship to the criterion variable (Table 4.6). In the case of the posttest scores of the School Attitude Measure, Motivation for Schooling subtest when adjusted for independents and covariates it was found that the alternate treatment group, Treatment 2, was the least effective; the control group, Treatment 1, the next most effective; and, the experimental group, Treatment 3, had the strongest effect although these effects were not statistically significantly different.

Table 4.6

MULTIPLE CLASSIFICATION ANALYSIS OF ACHIEVEMENT DATA - POSTTEST BY TREATMENT WITH PRETEST

Variable	n[a]	Unadjusted Dev'n Eta
Control	33	.63
Non-Graphics	16	-1.56
Graphics	16	.25

[a] Numbers indicate students who completed both pretest and posttest measures.

Hypothesis Ho3

This hypothesis states that alternative education students using a microcomputer individually or in groups of no more than two, at least twenty minutes, three times per week for supplemental CAI with software containing endogenous and /or exogenous graphics would not increase school attendance significantly more than like students using supplemental CAI without graphics as indicated by school attendance records.

The same three groups were tested in this experimental design: the control group, Treatment 1, in which there was no CAI; the alternate treatment group, Treatment 2, in which students were exposed to CAI without the use of graphics as a part of the instruction; and, the experimental group, Treatment 3, in which students were exposed to CAI with endogenous and exogenous graphics for at least 20 minutes three times per week over a period of a semester. The total population mean (n=65) of attendance was 78 out of a total possible of 87 days (Table 4.7). The control group (n=33) had a mean of 78.67 days present. The alternate treatment group (n=16) had a mean of 81.19 days present. The experimental group (n=16) had a mean of 73.44 days present. No cases were removed from the analysis.

Table 4.7

HYPOTHESIS 3 DESCRIPTIVE DATA OF ATTENDANCE - DAYS PRESENT

Treatment	n[a]	Mean	Standard Deviation
Overall	65	78.00	9.59
Control	33	78.67	9.66
Non-Graphics	16	81.19	6.17
Graphics	15	73.44	11.44

Note. Mean=Days present

[a] Numbers indicate students who completed both pretest and post-test measures.

A oneway analysis of variance in the Statistical Package for the Social Sciences was used to test the overall significance of the treatments used in determining if those students who used software programs in math instruction with exogenous and endogenous graphics improved significantly more in school attendance than those who did not, or than those who had no CAI at all. Since there was no pretest measure for this dependent criterion and only one independent variable measure, there was no covariate or interaction effect to take into account.

In the analysis of variance it was found that the main effects of the treatments (Table 4.8) had an F value of 2.945 with a significance level of .060. Therefore the null hypothesis for the treatment effects cannot be rejected.

Table 4.8

HYPOTHESIS 3 ANALYSIS OF VARIANCE ON THE DAYS PRESENT OF ATTENDANCE

Source of Variation	Sum of Squares	DF	Mean Square	F	Sign. of F
Main Effects					
Treatment	510.292	2	255.146	2.945	.060
Explained	510.292	2	255.146	2.945	.060
Residual	5371.708	62	86.640		

Since the statistical analysis does not provide any specific information about the pattern of effects, the Multiple Classification Table was used to compare the pattern of the treatments' relationship to the criterion variable (Table 4.9). In the case of the attendance data of students it was found that the experimental group, Treatment 3, was least effective; the control group, Treatment 1, the next most effective; and, the alternate treatment group, Treatment 2, had the strongest effect although these effects were not statistically significantly different.

Table 4.9

MULTIPLE CLASSIFICATION ANALYSIS OF ATTENDANCE DATA - DAYS PRESENT BY TREATMENT

Variable	n[a]	Unadjusted Dev'n Eta
Control	33	.67
Non-graphics	16	3.19
Graphics	16	-4.56

[a] Numbers indicate students who completed both pretest and posttest measures.

Hypothesis Ho4

This hypothesis states that alternative education students using a microcomputer individually or in groups of no more than two, at least twenty minutes, three times per week for supplemental CAI with software containing endogeneous and /or exogenous graphics would not increase depth-of-involvement significangly more than like students using supplemental CAI without graphics as measured on rated observations and exit interviews.

The same three groups were tested in this experimental design: the control group, Treatment 1, in which there was no CAI; the alternate treatment group, Treatment 2, in which students were exposed to CAI without the use of graphics as a part of the instruction; and, the experimental group, Treatment 3, in which students were exposed to CAI with endogenous and exogenous graphics for at least 20 minutes three times per week over a period of a semester. The number of students used in this experiment was 65 (Table 4.10). The total population mean (n=65) was 15.94 minutes on task out of a possible 20 minute observation period. The control group (n=33) had a mean of 13.45 minutes on task. The alternate treatment group (n=16)

Table 4.10

HYPOTHESIS 4 DESCRIPTIVE DATA OF DEPTH-OF-INVOLVEMENT - TIME-ON-TASK

Treatment	n[a]	Mean	Standard Deviation
Overall	65	15.94	6.53
Control	33	13.45	7.01
Non-Graphics	16	17.31	6.78
Graphics	16	19.69	.79

Note. Mean=Minutes on Task

[a] Numbers indicate students who completed both pretest and post- test measures.

using non-graphics CAI had a mean of 17.31 minutes on task. The experimental group using graphics CAI (n=16) had a mean of 19.69 minutes on task. No cases were removed from the analysis.

Students in the study were observed over a 20 minute time period and rated each minute to determine if they were on task or off task. Raw scores indicated the number of minutes out of 20 that the student was found to be on task. Exit interviews were also held with each student who participated in either type of CAI. It was found that this information could not be quantified for the type of students participating in this study but it did help provide qualitative information (Appendix B).

A oneway analysis of variance in the Statistical Package for the Social Sciences was used to test the overall significance of the treatments used in determining if those students who used software programs in math instruction with exogenous and endogenous graphics increased depth-of-involvement as demonstrated by increased time on task significantly more than those who did not, or than those who had no CAI at all. Since there was no pretest measure for this hypothesis, there was no covariate or interaction effect to take into account.

In the analysis of variance it was found that the main effects of the treatments, (Table, 4.11), had an F value of 6.261 with a significance level of .003. Therefore the null hypothesis for the treatment effects is rejected.

Since the statistical analysis does not provide any specific information about the pattern of effects, the Multiple Classification Table was used to compare the pattern of the treatments' relationship to the criterion variable (Table 4.12). In the case of the number of minutes the students were on task it was found that the control group, Treatment, 1 was the least effective; the alternate treatment group using non-graphic CAI, Treatment 2, was the next most effective; and, the experimental group using graphics CAI, Treatment 3, had the strongest effect although these effects were not statistically significantly different.

Table 4.11

HYPOTHESIS 4 ANALYSIS OF VARIANCE ON THE MINUTES ON TASK OF DEPTH-OF-INVOLVEMENT

Source of Variation	Sum of Squares	DF	Mean Square	F	Sign. of F
Main Effects					
Treatment	458.697	2	229.349	6.261	.003
Explained	458.697	2	229.349	6.261	.003
Residual	2271.057	62	36.630		

Table 4.12

MULTIPLE CLASSIFICATION ANALYSIS OF DEPTH-OF-INVOLVEMENT DATA - MINUTES ON TASK BY TREATMENT

Variable	n [a]	Unadjusted Dev'n Eta
Control	33	-2.48
Non-Graphics	16	1.37
Graphics	16	3.75

[a] Numbers indicate students who completed both pretest and posttest measures.

<u>Summary</u>

A summary and comparison of the results of each of the hypotheses tested is provided in Table 4.13.

Table 4.13 SUMMARY OF STATISTICAL ANALYSIS.

	F Value	Significance	Null Hypothesis		MCA of Treatment		
			accepted	rejected	least effect	next in effect	most effect
Achievement	2.757	.072	X		1	2	3
Attitude	1.500	.231	X		2	1	3
Attendance	2.945	.060	X		3	1	2
Depth-of-Involvement	6.261	.003		X	1	2	3

CHAPTER V

It was the purpose of this study to determine what effect intrinsic motivation in software programs using graphics and non-graphics has on the achievement, attitudes, attendance and depth-of-involvment of underachieving students. To do this four hypotheses were developed as follows:

Alternative education students using a microcomputer individually or in groups of no more than two, at least twenty minutes, three times per week for supplemental CAI with software containing endogenous and /or exogenous graphics:

1. Would increase mathematics achievement significantly more than students using supplemental CAI without graphics as measured on the Math Computation subtest of the Stanford Achievement Test.

2. Would improve school attitudes significantly more than students using supplemental CAI without graphics as measured

by the Motivation for Schooling subtest of the School Attitude Measure.

3. Would increase school attendance significantly more than students using supplemental CAI without graphics as indicated by school attendance records.

4. Would increase depth-of-involvement significantly more than students using supplemental CAI without graphics as measured on rated observations and exit interviews.

Three groups were tested in this experimental design: the control group, Treatment 1, in which there was no CAI; the alternate treatment group, Treatment 2, in which students were exposed to CAI without the use of graphics as a part of the instruction; and the experimental group, Treatment 3, in which students were exposed to CAI with endogenous and exogenous graphics for at least 20 minutes three times per week over a period of a semester of 18 weeks.

It was found through statistical analysis of the data collected using analysis of covariance for the first two hypotheses and analysis of variance for the remaining two, that only the last hypothesis showed a significant difference in the variability of performance in the three groups measured. In the case of the last hypothesis, depth-of-involvement was quantified as a measure of time-on-task. Qualitative data relating to depth-of-involvement from the exit interviews did not provide sufficient information to categorize responses for factors relating to depth-of-involvement. The following were the categories unsuccessfully applied to the student's interview responses: factual information versus imagery and fantasized imagery; content related verses personalized point of reference; and minimal, average or strong involvement in the activity presented on the computer. Responses that were received were tabulated and reported in Appendix B.

Conclusion

It is concluded from the results of this study that the use of Computer Assisted Instruction either with or without graphics does not substantially improve the achievement, attitudes or attendance of underachieving students. Although there was a significant increase on time-on-task, this did not translate during the one school semester of the study to improvement in any of the other areas. However, in two of the hypotheses, Hypothesis 1, achievement (significance of $F = .072$), and Hypothesis 3, attendance (significance of $F = .060$), the significance levels approached statistical significance.

Discussion

The results of this study appear to be in contradiction to much of what has been published concerning the value of computer assisted instruction in the achievement of students. Roblyer (1985) states, "Whenever computer-based instruction is compared with traditional classroom instruction, computer methods usually result in greater effects" (p. 24). However, many of these studies when analyzed through meta-analysis are shown to have trivial to small effect sizes (Roblyer, 1985). When the medium to large effect studies are analyzed, Kulik, Kulik, and Cohen (1980), found that the only characteristic that correlated to outcomes significantly was control for instructor effect. Studies with a different teacher for the treatment group and the control group tended to yield higher effects (Roblyer, 1985). In this study the same teacher was used in both the alternate treatment group and the experimental group which may be one factor accounting for the limited statistical difference. Although different teachers were used for the control group since this was spread over three different individuals, the strengths or weaknesses of one individual's instruction were largely eliminated. Of all of Kulik's studies the most positive results were at the elementary level (Roblyer, 1985). The direction of the significance of the first hypothesis in this study would support this since it had a significance level of .072. It is also true that if there had been more students in the treatment groups, then the F value as determined by the Degrees of Freedom would have fallen within the .05 level of significance for Hypothesis 1.

Kulik, Bangert, and Williams (1983) also found very small effects for changes in attitude except in attitudes towards the computer. In this study, statistically significant effects were not found for changes in attitudes towards school. Attitudes toward the computer were not measured.

One possible explanations for the lack of achievement gains could be the relative short duration of the study in which to affect a change. Students using graphics in their programs averaged 18.29 hours of instruction over the 18 weeks of the semester. Students using no graphics as part of the instructional lesson averaged 15.74 hours of instruction. Although the standardized measure used to assess achievement is highly reliable, it is also true that test reliability makes it very difficult to accurately measure small increments of growth. The minimum period used is generally one semester which is the equivalent of 5 months growth in achievement, but this presumes one month growth for one month duration. While this is generally true for the average student, the students in this study by definition and ability are achieving at about three /fourths the average rate. This would equate with a maximum potential growth of three to four months which would be difficult to accurately measure given the standard error of the test instrument.

Another factor that could have influenced test results is a demonstrated poor attitude towards test taking by underachieving students (Bottom, 1970). This is consistent with the four teachers' comments in this study. They complained about the poor test-taking ability of these students. They cited their students' inability to work in large groups and their students' poor direction following skills as indicated by their ability to perform adequately in class but not on paper-pencil measures.

In The Education of Disadvantaged Children, Bottom (1970) states, "Some children simply can't work in large groups. For them individual testing will be necessary" (p. 93). He also states, "The child of the streets is far less likely to come to school with a positive self-image. Their lack of confidence and unworthiness often causes them to think that school is too hard and the teacher unfair in asking them to do more than they can. Such an attitude can play havoc with standardized tests. Looking at a test using words unfamiliar to them, on a plane above their reading level, and asking them to black out dots on an answer sheet are more than many students are willing to tackle. 'Then,' according to a veteran teacher, 'they begin the "guessing game," the 'let's see who can finish quickest game,' or 'to heck with this stuff, I quit' attitude'" (p. 93).

Overtesting may have been a problem in this Alternative Education Program. Students were constantly being assessed by standardized measures to meet a multitude of requirements. Again, teachers in this study complained about students' lack of seriousness in taking the tests because there were so many to take as demonstrated by the number of incomplete tests and blank pages found in their test booklets.

Another factor which may have influenced the results is the type of instruction provided for the students who participated as part of the control group. Because the Alternative Education Program is an intensive remedial program, students who were not participating in the computer assisted instruction continued to receive math instruction in very small groups. Groups were generally in the range of four to five students with a maximum of eight students at any single time. Instruction was direct, responsive, often individualized and on the instructional level of the student as indicated in repeated observation. This may have closely approximated the type of individualization that students working on the computer also received, thus reducing the variance that would occur. This supports findings in the research that indicate that the computer has not been found to be a better instructor; only that it can often accomplish what the regular teacher rarely has time for, true individualization, and can provide the same amount of instruction in a shorter amount of time. In the case of the Alternative Education Program, some of these advantages have already been built into the instructional program administratively. All that can be determined is that there was not a significant enough variance to find one method unequivically superior to another. This does not take into account, however, the issue of cost versus benefit when weighing the value of the use of computer assisted instruction.

Glass (1982) concluded from comparing the ETS study with meta-analyses of other non-computer methods of instruction that reducing class size from 25 to 10 seemed to produce the same effect size as supplemental CAI. Special teacher training to handle large classes also produced greater effect sizes. Bloom (1984) concluded even better results from meta-analysis on other strategies for improving achievement including: tutorial instruction, corrective feedback process, student time-on-task, graded homework, classroom morale, peer and cross-age remedial tutoring, higher-order questioning and teacher expectancy. Although many of these are characteristics exhibited in CAI, they were also generally characteristic of the observed instruction taking place in the regular math classroom of the Alternative Education Program.

It is interesting to note that on the multiple classification analysis of the treatments, the two rankings of the effects of treatments which match are those of achievement and depth-of-involvement. There does appear to be a relationship between depth-of-involvement as measured by time-on-task and subsequent achievement as influenced by the three treatments.

Depth-of-Involvement was the only hypothesis whose F value was significant enough to warrant rejecting the null hypothesis. However, achievement began to approach an F value that may have been significant if a higher significance level had been selected or if there had been larger numbers of students in each treatment. This would support the interpretation that achievement was affected by the experimental treatment in the predicted direction.

The ability to change attitudes towards school seems to be the most difficult to affect. This would appear to be in line with what is generally accepted, (Bottom, 1970), although attitudes towards the computer as reflected in responses to exit interview questions were positive. (Appendix B)

The limited abstract ability skills of this type of underachieving student was demonstrated on the responses to the exit interview questions making it impossible to make any further conclusions about depth-of-involvement factors. Research has shown (Clark, 1983) that often students prefer the mode of instruction that is in opposition to their most efficient means of learning. Low ability students were shown to profit most from structured learning such as drill and practice although they preferred discovery learning. It may be that the instructional design of the commercial software, regardless of its use of graphics, was not well suited to the specific characteristics of this population. Students may have preferred the game formats and graphics, finding them fun and entertaining but insufficiently designed to overcome such educational problems as lack of goal congruence (Lepper and Malone, 1984) or too distracting in fantasy content to produce significant retention above that experienced by students in regular instruction using drill and practice techniques. However, all students learned regardless of how the content was delivered.

It may be presumed that although the graphics and fantasy material do appear to make the drill more entertaining, it does not indicate that increased intrinsic motivation through Attentional Effects and Depth-of-Involvement Effects in the form of graphic material is necessary for learning to take place. Other effects such as Feedback Effects, Control Effects, Affective Effects and Multiple Channel Effects and other principles of behavior modification including appropriate instructional level and small incremental steps may be more crucial for learning to take place. These and other variables such as instructional time needed to execute the program would have to be considered to determine the preferred program to accomplish the instructional goal. Further investigation would be needed in these areas.

It also is true that students did not suffer by having supplemental CAI for a part of their math instruction. Students did equally well when they spent half of their instructional time learning through CAI as they did when in direct instruction in an individualized intensive remedial program. Therefore, decisions about the use of CAI in schools may well have to be based on other administrative and political variables (Clark, 1983). These variables may include the cost of providing instruction through CAI. It is apparent that since CAI is primarily effective as supplemental instruction, it does not replace the cost of the teacher. In this study it was compared to very small instructional groups of underachieving students which is also very expensive. With other levels of students or types of instructional skills, the cost-benefit may improve. In addition, even if CAI cannot be shown to be cost-effective, society may still insist students be acquainted with this media. Clark (1983) states that the public may insist on CAI because of, "The high expectation we have for technology of all kinds," and the "reserve about the effectiveness of our system of formal education" (p. 456). He indicated that the public tends to relate in terms of the benefit of computers to industry therefore demanding that schools become involved in technology. Benderson (1983) states, "There are those who warn...that the very structure of American education will soon become outmoded if public schools and colleges cannot move swiftly enough to train people for the computer age" (p. 29).

Implications

Roblyer (1985) stated, "the most common finding in research studies is that more research is necessary. This is certainly the case with instructional computing. But it is critically important that we begin more in-depth, focussed studies in a number of areas where data are lacking" (p. 27). More studies are needed to study systematically specific characteristics in the design and use of computer materials. Studies should also be done of the materials used in other studies that were shown effective to determine which aspects made them effective. Of factors listed by Roblyer (1985) and Lepper and Malone (1983), such as the form of feedback; the degree of learner control; the role of motivation and the form it took; other effects of screen design and graphics; the use of content areas and the skills in those areas; the impact of the instructional approach; the transfer of information to other skills; which are the most critical?

It is also critical to continue in the search for the determination of necessary conditions to facilitate the learning of students not just sufficient conditions (Clark, 1983). The present study dealt with a set of particular variables thought to influence learner outcomes, specifically the impact of intrinsic motivation in the use of graphic and non-graphic math software programs. Other studies are needed to further investigate instructional methods and other variables such as the specific task involved, the learner's aptitude, various instructional design approaches in software, the use of entertainment and personalization in programming. There must also be much more field testing of specific computer courseware by companies prior to the courseware being published to validate the effectiveness of the design features they incorporate in their software.

The study of CAI is actually the study of teaching and learning and any addition to knowledge of the field benefits the education community as a whole.

In general the results of this study suggest the general lack of sophistication in educational software today. Available software, even when its producers claim to make use of motivational techniques and superior graphics, does not demonstrably enhance the academic achievement of students above other proven instructional methodologies. Although computer graphics do appear to get the attention of the students, this study's results cannot justify a concurrent increase in students' mathematical computational abilities.

APPENDIX A

Software Programs

SOFTWARE PROGRAM	PUBLISHER
Non-Graphics	
The Arithmetic Classroom (9 disks)	Sterling Swift Publishing Co.
The Milliken Math Series (12 disks)	Milliken
Hartley Prescriptive Math Drill	Hartley Courseware, Inc.
Graphics	
DLM-Dragon Mix Alligator Mix Demolition Division Minus Mission Alien Addition Meteor Multiplication	Developmental Learning Materials
Math Blaster	Davidson & Associates
Fishing for Answers	NTS Software Inc.
Aliencounter/ Face Flash	Milliken
Plato-Whole Numbers Basic Number Facts	Control Data Publishing

APPENDIX B

Exit InterviewRating Scale

Depth-of-Involvement Effects

EXIT INTERVIEW RATING SCALE

DEPTH-OF-INVOLVEMENT EFFECTS

Questions - Responses of 32 Students

1. What did you just do? 8 - "times tables"; 5 -"multiplication"; 5 - "playing" some added the word"games" or the word "adding"; 2 - "computer"; 3 -"racing cars"; 1 "basketball"; 1 - "typing"; 2 - doing problems"; 1 - "I was playing race cars"; 1 - "I try to get correct"; 1 - "got my problem right"; 1 - "I went and smashed the space bar and shot and put answer and shot it, got it right and got a score"; 1 - "What score? I tried to do some of the hard problems. Got 2 or 3 right. Got to work on my 9's."

2. What did you think of? 11 - "it's fun"; 3 - "don't know or shrug; 2 - "it's all right"; Sampling of others: "numbers"; "I were on the machine"; "What's the answer"; "good"; "think of going home"; "if you don't know how to do it helps you"; "trying to get all them right"; "learning how to do them"; "kinda easy";"math"; "being in a real game".

3. Did any pictures come to your mind? 19 - "no" or a shrug; 2 - "basketball"; 2 - "yes" or "uh huh"; Others: "a girl"; I'm the race car driver"; "yes multiplication problem answers"; "three heads"; "yes like it was a video game"; "oh yeh, I think I'm racing"; "Yes, flowers and things"; "thinking of fish".

4. Were you involved in your thoughts or pictures? 13 -"yes"; 11 - "no"; Others: "get involved, the game make me involved"; "yes, I take it real serious"; "yes, like a person working"; "the rabbit coming out of the hat"; Yes, I get involved by playing good"; Sometimes me being up there and wish the computer could talk and tell it is right instead of showing me"; "add"; "thinking it is good, help me".

5. Did you enjoy what you were doing? 32 "Yes" with only 4 comments: 2 - "It's fun"; 1 - "it make math fun"; 1 - "helped me out".

6. What did you learn? 23 - "time tables" or "multiplication"; 3 - "adding and subtracting"; Other: "learn how to do problems quickly"; Yes, how to use the

keys, keyboard, disk drive, hold disk.";
"I learned my digits like my times
tables, it's fun"; "how to do computer
whole bunch"; "math"; time tables fast".

All responses were recorded verbatim. If a student did not respond at first to the question additional prompts were given to elicit a response. An attempt was made to categorize responses to these questions to determine if the content was:

Factual

Imagery

Fantasized Imagery

Responses then were reviewed again to determine if they were:

Content Related

Had a Personalized Point of Reference

Finally responses were reviewed to determined if the student expressed:

Minimal Involvement

Average Involvement

Strong Involvement

However, as indicated by the responses shown, responses were rarely detailed enough to categorize content.

REFERENCES

Anderson, J. R. (1980). Cognitive psychology and its implications. San Francisco: Freeman.

Anderson, J. R. & Bower, G. H. (1973). Human associative memory. Washington, D.C.: Winston.

Bandura, A. & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-instruction. Journal of Personality and Social Psychology, 41, 586-598.

Benderson, A. (1983). Focus 11 computer literacy. Princeton, Jew Jersey: Edcuational Testing Service.

Benderson, A. (1985). Focus 16 beyond computer literacy. Princeton, New Jersey: Educational Testing Service.

Bergen, S. & Schalman, L. (1984, Nov./Dec.). Who's pushing the buttons? Classroom Computer Learning, pp. 52-55.

Bloom, B. S. (1984). The two-sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. Educational Researcher, 13(6), 4-16.

Bottom, R. (1970). The education of disadvantaged children. West Nyack, New York: Parker Publishing Company, Inc.

Bowen, J. & Hobson, P. R. (1974). Theories of education. New York: John Wiley and Sons Australasia Pty. Ltd.

Bowman, R. F. (1982, September). A "Pac-Man" theory of motivation: Tactical implications for classroom instruction. Educational Technology, pp. 14-16.

Bracey, G. W. (1982a). Computer assisted instruction: What the research says and doesn't say can and can't say about its effectiveness. unpublished manuscript.

Bracey, G. W. (1982b, Nov./Dec.). Computers in education: What the research shows. Electronic Learning, pp. 52-54.

Bracht, G. H. & Glass, G. V. (1968). The external validity of experiments. American Educational Research Journal, 5, 437-474.

Brady, H. & Slesnick, T. (1985, April/May). Girls don't like fluffware either. Classroom Computer Learning. pp. 22-26.

Bruner, J. S. (1961). Knowing and Learning. Harvard Educational Review, 31(1), 21-32.

Burns, P. K. & Bozeman, W. C. (1981). Computer-assisted instruction and mathematics aechievement: Is there a relationship? Educational Technology 21(10), 32-40.

Buros, O. K. (1972). The seventh mental measurements yearbook. Highland Park, New Jersey: The Gryphon Press.

Campbell, D. T., & Stanley, J. C. (1963), Experimental and quasi-experimental designs for research. Chicago: Rand McNally.

Clark, R. E. (1983). Reconsidering research on learning from media. Review of Educational Research, 53(4), 445-459.

Cohen, V. B. (1983, January). Criteria for the evaluation of microcomputer coursework. Educational Technology, pp. 9-14.

Cook, T. D., & Campbell, D. T. (1979). Quasi-experimentation design & analysis issues for field settings. Chicago: Rand McNally.

Condry, J. C. (1977). Enemies of exploration: Self-initiated verses other-initiated learning. Journal of Personality and Social Psychology, 35, 459-477.

Condry, J., & Chambers, J. (1978). Intrinsic motivation and the process of learning. In M.R. Lepper & D. Greene (Eds.), The hidden costs of reward. Hillsdale, N.J.: Erlbaum.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-684.

Deci, E. L. (1975). Intrinsic motivation. New York: Plenum.

Deci, E. L. (1981). The psychology of self-determination. Lexington, Mass.: Heath.

Dolan, L. J., & Enos, M. M. (1980). School attitude measure teacher's manual.

Glenview, Illinois: Scott, Foresman and Company.

Downey, M., & Kelly, A. V. (1979). Theory and practice of education. New York: Harper and Row, Publishers.

Duckworth, E. (1979). Either we're too early and they can't learn it or we're too late and they know it already: The dilemma of "applying Piaget". Harvard Educational Review. 49(3), 297-312.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and organization of behavior. Psychological Review, 66, 183-201.

Edwards, J., Norton, S., Taylor, S., Weiss, M., & Dusseldorp, R.(1975). How effective is CAI? A review of the research. Educational Leadership. 33, 147-153.

Forman, D. (1982, January). Search of the literature. The Computing Teacher, pp.37-51.

Glass, G. V. (1982). Assessment of the effectiveness of computer-assisted instruction in the ETS-Los Angeles Study. In Rogosta, Holland, and Jamison

(Eds.), Computer-assisted instruction and compensatory education: The ETS/LAUSD study. The final report, #19. ETS: Princeton: New Jersey.

Isen, A. M., Shalker, T., Clark, M., & Karp, L. (1978). Affect, accessibiligy of material in memory, and behavior: A cognitive loop? Journal of Personality and Social Psychology, 36, 1-12.

Jamison, D., Suppes, P., & Wells, S. (1974). The effectiveness of alternative instructional media: A survey. Review of Educational Research, 44, 1-61.

Kagan, J. (1972). Motives and development. Journal of Personality and Social Psychology, 22, 51-66.

Kearsley, G., Hunter, B., & Seidel, R. J. (1983, January). Two decades of computer based instruction projects: What have we learned? part one, T.H.E. Journal, pp. 90-94.

Kearsley, G., Hunter, B., & Seidel, R.J. (1983, February). Two decades of computer based instruction projects: What have we learned? part two, T.H.E. Journal, pp. 88-96.

Kuhn, D. (1979). The application of Piaget's theory of cognitive development to education. Harvard Education Review 49(3), 340-360.

Kulik, J. A. Bangert, R. L. & Williams, G. W. (1983). Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 75(1), 19-26.

Kulik, J. A., Kulik, C-L. C., & Cohen, P. A. (1980). Effectiveness of computer-based college-teaching: A meta-analysis of findings. Review of Educational Research, 50(4), 525-544.

Lepper, M. R. (1985). Microcomputers in education: Motivation and social issues. American Psychologist, 40(1), 1-18.

Lepper, M. R. & Malone, T. W. (1984). Intrinsic motivation and instructional effectiveness in computer-based education. In R.E. Snow & M.J. Farr (Eds.), Aptitude, learning, and instruction: III. Hillsdale, N.J.: Earlbaum.

Lepper, M. R., & Greene, D. (1978). Overjustification and beyond: Toward a means-end analysis of intrinsic and extrinsic motivation. In M. R. Lepper & D. Greene (Eds.), _The hidden costs of reward_. Hillsdale, N.J.: Earlbaum.

Malone, T. W. (1981a, December). What makes computer games fun? _Byte_, pp. 258-277.

Malone, T. W. (1981b). Toward a theory of intrinsically motivating instruction. _Cognitive Science_, _4_, 333-369.

Ohanian, S. (1984, Nov./Dec.). How today's reading software can zap kids' desire to read. _Classroom Computer Learning_, pp. 27-31.

Pogrow, S. (1983). _Education in the computer age: Issues of policy, practice, and reform_. Beverly Hills: Sage Publications.

Ragosta, M., Holland, P., & Jamison, D. (Eds.), (1982). _Computer-assisted instruction and compensatory education: The ETS/LAUSD Study. The final report #19_. ETS: Princeton: New Jersey.

Roblyer, M. D. (1985). _Measuring the impact of computers in instruction: A_ non-technical review of research for educators. Washington, D.C.: Association for Educational Data Systems.

Skinner, B. F. (1954). The science of learning and the art of teaching. In J. Bowen, & P.R. Hobson. Theories of education. New York: John Wiley and Sons Australasia Pty. Ltd.

Skinner, B.F. (1968). The technology of teaching. New York: Appleton-Century-Crofts.

Skinner, B. F. (1971). Beyond freedom and dignity. New York: Alfred A. Knopf.

Suppes, P. (1980). The future of computers in education. In R.P. Taylor (Ed.). The computer in the school: Tutor, tool, tutee. New York: Teachers College Press.

Suppes, P. & Morningstar, M. (1969), Computer-assisted instruction. Science, 166, 343-350.

Taber. (1982). Twentieth annual AEDS convention proceedings. Washington, D.C.: Association for Educational Data Systems.

Tobias, S. (1982). When do instructional methods make a difference? Educational Researcher, 11(4), 4-9.

Walker, R. A. & Sherman, C. (1983, November). Evaluating educational software. PC Magazine, pp. 519-521.

Weiner, B. (1980). Human motivation. New York: Holt, Rinehart and Winston.

Zajonc, R.B. (1965). Social facilitation. Science, 149, 269-273.

Zientara, P. (1984). B .F .Skinner: Computers can cure what's wrong in American education. In S.J. Taffee (Ed.), Computers in education 85/86. Guilford, Conn.: The Dushkin Publishing Group, Inc.

Vita

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Abstract

A COMPARATIVE ANALYSIS OF THE VALUE OF INTRINSIC MOTIVATION IN COMPUTER SOFTWARE ON THE MATH, ACHIEVEMENT, ATTITUDES, ATTENDANCE, AND DEPTH-OF-INVOLVEMENT OF UNDERACHIEVING STUDENTS

Patricia Ann Furey Meyer

The College of William and Mary in Virginia, April 1986

Chairman: George M. Bass

It was the purpose of this study to determine what effect intrinsic motivation in software programs using graphics and non-graphics has on the achievement, attitudes, attendance and depth-of-involvement of 65 underachieving students. The study was conducted in the natural school setting over the period of a semester. Data was collected on three groups, the control group (n=33), the alternate treatment group in which students were exposed to CAI without the use of graphics as a part of the instruction, and the experimental group in which students were exposed to CAI with graphics for at least 20 minutes three times per week. An ANCOVA was done on the pre and posttest Math Computation scores of the SAT and the pre and posttest weighted raw scores of the Motivation for Schooling subtest of the SAM. An ANOVA was done on attendance data and a measure of depth-of-involvment defined as time-on-task.

Results indicated that there was no statistically significant difference in the academic achievement, attitudes or attendance among the three groups. However, gains in academic achievement did approach statistical significance. Results for the measure of time-on-task did achieve statistical significance indicating greater involvement 8with graphic programming.

It was concluded that the use of CAI with or without graphics does not substantially improve the achievement, attitudes or attendance of underachieving students significantly more than other intensive remedial instructional techniques.