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ABSTRACT

This report describes a Prescription Learning Company basic mathematics multi-media laboratory at an elementary school in Austin, Texas. Research assumptions that the Prescription Learning approach makes are explored and reviewed. A sample of 12 fifth grade students participated in attitude and achievement results of the laboratory. Twenty-four teachers also participated in an attitude study. Findings suggest that the Prescription Learning laboratory seems to have a positive effect on achievement, and both students and teachers have positive attitudes toward the laboratory. Recommendations for changes in the laboratory are presented. (Author/PK)

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DESCRIPTIVE STUDY OF A PRESCRIPTION LEARNING

BASIC MATHEMATICS SKILLS MULTI-MEDIA LAB

IN AN ELEMENTARY SCHOOL SETTING

by

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REPORT

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DEDICATION

This report is dedicated to my dear friend Renae Carol Shepler in appreciation for her support and encouragement. It was in the spirit of commitment to the best possible education each child can receive, a spirit which Renae embodies, that this report was written.

ABSTRACT

This report describes a Prescription Learning Company basic mathematics multi-media lab at an elementary school in Austin, Texas. Research assumptions that the Prescription Learning approach makes are explored and reviewed. A sample of 12 fifth grade students participated in attitude and achievement results of the lab. Twenty four teachers also participated in an attitude study. Findings are that the Prescription Learning lab seems to have a positive effect on achievement, and both students and teachers have positive attitudes toward the lab. Recommendations for changes in the lab are presented.

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CHAPTER I

INTRODUCTION

There can be little doubt that computers are the media of choice for education in the 1980's. One recent national survey of 6,000 teachers and administrators found that the availability of microcomputers had increased 150 percent over a one year period, while other audio-visual purchases saw zero percent growth over the same year (Smith & Ingersoll, 1984). In the two year period from 1983 to 1985 the number of computers in use in United States' elementary and secondary schools quadrupled from about 250,000 to over one million according to a national survey of 10,000 teachers and administrators analyzed by Becker (1986). Approximately 15 million students and 500,000 teachers used computers as a part of their school's instructional programs in the 1984-85 school year, and 85 percent of the elementary schools (K-6) in the United States had at least one computer that was used for instruction (Becker, 1986). Becker (1986) also found that the average elementary school in the United States had six computers that were used for instruction. Alfred Bork has said, "By the year 2000 the major way of learning at all levels, and in almost all subject areas will be through the interactive use of computers" (Bork, 1980; p. 53). The question this study seeks to answer, at least for one school, is, "With respect to computers in a multi media setting, where are we now, and where are we going?"

At one school in Austin, Texas computers are being used in a multi-media lab setting. The lab has been in place for one full year. The rationale for implementing the lab was twofold: it was seen as a long-term adaptation of an earlier pilot project for which special funding had been provided, and it seemed to be a hopeful way of meeting the local district goals for improving mathematics achievement scores.

The multi-media lab chosen for installation in this school was one packaged by the Prescription Learning Company of Springfield, Illinois. The lab included 15 computers, four automatic advance filmstrip-tape machines, three tape players, workbooks, self-paced learning kits, and both tutorial and drill-and-practice courseware for all machines. The courseware was designed to teach basic mathematics skills. The curriculum in the lab was mastery-based with entry level being determined by means of a pretest procedure. The lab was housed in a separate room in the school, and a full time teacher managed the operations of the lab. While, technically, this was a multi-media lab, the lab did consist mainly of computers, and both students and teachers alike referred to it as "the computer lab."

The elementary school in which this study took place is in the south-central area of the city in a residential, low-to-middle socio-economic status, neighborhood. The neighborhood is Hispanic dominant, and includes single family dwellings, multiple family dwellings, and a federally funded housing project. The school serves four-year-olds through sixth graders. It had a student population of about 700, and a teacher population of about 40 during the 1984-85 and 1985-86 school years. There was a small class size pilot project in effect during the 1985-86 school year. Each class in the school had approximately 15 students while the pilot project was in effect. This pilot project did affect the current study, since 1985-86 achievement scores were compared to 1984-85 achievement scores and normal class sizes (20 to 28 students per class) did exist in the 1984-85 school year.

The purpose of this study was to answer the following questions:

A. Does the multi-media lab improve students' math achievement?

B. Do the students feel that the multi-media lab helps them learn?

C. Do the teachers feel that the multi-media lab helps the students learn?

D. What are student attitudes toward the lab?

E. What are teacher attitudes toward the lab?

F. What changes could be made to make the lab more effective from both teachers' and students' viewpoints?

This descriptive study provides a review of the literature related to multi-media labs. It describes the procedures and results of the descriptive study for one such lab. Finally, answers for the previously stated questions are discussed.

CHAPTER II

REVIEW OF THE LITERATURE

Original research studies are not explicitly cited in the Prescription Learning Company (PLC) literature. As a first step in reviewing the literature relative to PLC multi-media basic mathematics skills labs it is appropriate to look at the implicit assumptions that the PLC multi-media lab concept makes, and identify the research on those assumptions. These are implicit, not stated, assumptions that are apparent to this researcher. The first assumption that the PLC approach makes is that students have different learning styles, or, at least, that students have different learning modality strengths. The second assumption this approach makes is that media, and specifically new technologies such as Computer Assisted Instruction (CAI), can help students achieve. A third assumption PLC makes is that students succeed academically in a curriculum with a mastery framework.

In the limited amount of research on PLC labs that is available there is a fourth assumption: that student and teacher attitudes make a difference in a learning environment. That attitudes do make a difference may appeal to the humanist in educators, but the rationale for measuring student and teacher attitudes has not been cited.

In this section studies on these four factors, learning styles, media, mastery, and attitude, will be reviewed.

Learning Styles:

The first assumption to be addressed is that students have different learning styles, or modality strengths. There is little controversy about the idea that people have different learning styles (Snow & Salomon, 1968; Barbe & Milone, 1981; Dixon, 1985). What may be an issue is the role that learning styles actually play in a classroom setting. One approach to the learning styles concept has been that of modalities of learning. This issue deals with the problem that most educational experiences are targeted toward the "average student," and that student doesn't really exist (Snow & Salomon, 1968). The use of student modality strengths is one approach to individualized learning: "The movement is based on the idea that students vary in their approach to learning, so no single instructional process provides optimal learning for all students" (Barbe & Milone, 1981, p. 378). Modalities are defined as "the channels through which perception occurs: vision, audition, and kinesthesia" (Barbe & Milone, 1981). Modality strenths are those channels through which a person learns best at any given time. In the review of literature conducted by Barbe and Milone (1981) the findings were that students do vary in their modality strengths, modality strengths do change with age, and that the relationship between modality strengths and achievement are unclear. Snow and Salomon (1968) promote the pedagogical step of identifying students' learning mode strengths and designing media and courseware to fit those strengths. Dixon (1985) proceeds with the idea that learners, especially adult learners, should be aware of their own learning styles and control their environments in order to optimize their own learning.

The assumption that students learn in a variety of different ways is probably a safe and valid assumption for PLC to make. The approach that PLC takes to student learning modalities is not the scientific identification of learning modalities followed by treatments, but a "shotgun" approach where all of the students are exposed to all of the treatments available through the multi-media lab setting. This is not necessarily a poor way to approach the situation when a large number of students are using one facility. In the particular school the current study is concerned with, 700 students were being served by the multi-media lab. To identify those students' learning modality strengths may have been ideal, but would probably not have been realistic or manageable.

Student Achievement and Media:

That student achievement can be augmented through the use of media to present materials and "interact" with students in the learning process is the se~ond PLC assumption to be considered. The literature on the effectiveness of CAI is voluminous. Research reviews and meta-analyses conducted over the past several years have indicated that when the drill-and-practice type of CAI is used as a supplement to traditional mathematics instruction students' achievement scores have increased (Vinsonhaler & Bass, 1972; Burns & Bozeman, 1981; Edwards, Norton, Taylor, Weiss, & Dusseldorp, 1975; Kulik, 1985).

Vinsonhaler and Bass (1972) summarized seven major studies on computer assisted instruction (CAI) and mathematics achievement, grades one through six, in their report. All of the studies summarized involved CAI as drill and practice. No tutorials were included. All of the studies involved used a control group of students receiving traditional instruction and an experimental group of students receiving traditional instruction with supplemental CAI for five to fifteen minutes per day. The researchers' findings were that traditional instruction with supplemental CAI was effective in improving math achievement an average of .3 grade equivalents more than traditional instruction alone. They also found that CAI drill and practice was more effective with disadvantaged students and those who began below grade level. Finally, Vonsonhaler and Bass said that traditional instruction could achieve the same achievement results as CAI, but not as efficiently.

Burns and Bozeman (1981) conducted a meta-analysis of 40 studies that incorporated CAI as supplemental mathematics instruction. Thirty three of the studies analyzed involved students in elementary schools. The studies included in this meta-analysis analyzed both CAI mathematics drill and practice and CAI tutorials. Burns and Bozeman found that traditional instruction with supplemental CAI was significantly more effective in improving mathematics achievement than traditional instruction alone. They also concluded that high and low achieving students' math achievement scores were significantly affected by CAI drill and practice, while average achieving students' math achievement scores were not significantly affected.

In yet another review of CAI research Edwards, Norton, Taylor, Weiss and Dusseldorp (1975) found mixed achievement results at all levels and various subject matters when reviewing CAI as a substitute for traditional instruction. These findings were mixed for two studies including mathematics at the elementary level. Edwards et al. also reviewed five studies that involved CAI as supplemental to traditional mathematics instruction. The authors found that when CAI was used as a supplement to traditional instruction there were consistently positive effects on mathematics achievement.

In a summary of his findings on separate meta-analyses of computer based education (CBE) at all levels Kulik (1985) concluded that the average effect of computers was to increase test scores by .31 standard deviations, which is equivalent to a gain from the 50th to the 61st percentile. The author defined CBE, for elementary schools, as a combination of CAI and computer managed instruction (CMI). He did not define these terms further. In general, CMI involves the use of computers as record-keeping devices when those records are then used to help a teacher manage instruction. Kulik also found that CBE increased retention and reduced instructional time. Specific to elementary schools, Kulik found that CAI programs raised achievement scores by an average of .47 standard deviations, while CMI raised student achievement scores by an average of .07 standard deviations.

Several smaller studies also support the contention that CAI increases mathematics achievement, however the findings are not consistent across all grade levels (Stoneberg, 1985; Sigurdson & Olson, 1983; Leitner, 1982; Leitner & Ingebo, 1984). Leitner's studies were specific to PLC labs and will be discussed later in this chapter.

Stoneberg (1985) conducted a study of the WICAT (World Institute of Computer Assisted Teaching) minicomputer system in District 8J, Oregon. This 30 station WICAT system cost $120,000 for original installation plus $18,000 a year upkeep. The lab was set up to teach basic mathematics skills. Stoneberg studied 230 students from grades two through four over one school year (153 days). These students used the lab in groups for 62 minutes per week. Using a t-test comparison, he found that third through fourth graders in the study made significant improvements over the previous year's achievement test scores in mathematics. However, second grade students in the study did not make significant gains in math achievement.

Sigurdson and Olson (1983) used commercially available software in classroom settings with seven separate classrooms in grades two through six. All of the software was concentrated on mathematics skills. The 351 students involved in the study used the computer independently for a ten minute mathematics drill once each day for one school year. The researchers found that grades three, five, and six made significant achievement gains when a pretest-posttest comparison was done.

Whether or not the same kinds of achievement gains can be made using other media is not as obvious. In fact, there is some argument about the validity of media studies, including CAI studies, at all. In an article detailing the history of media in education, Allen (1971) identified a cycle of "evaluative" type research where

> ...learning from some unspecified film or other medium was compared with learning from some unspecified presentation by an instructor or other medium (resulting in) the base upon which the entire audiovisual movement was justified (Allen, 1971, p. 6).

Allen reviews the implementation of this cycle for film, instructional television, illustrated textbooks, and programmed instruction. He also warns against CAI studies returning to the same cycle.

Clark (1983; 1985) supports Allen's idea that it is not the medium that matters, but the design behind the instruction:

> ... the best current evidence is that media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition. Basically, the choice of vehicle might influence the cost or extent of distributing instruction, but only the content of the vehicle can influence achievement (Clark, 1983, p. 445).

Clark refers to the cycle of evaluative studies as a case of "media advocacy," where there is the hope that the newest technology will, in itself, increase learning and performance beyond the capabilities of older media (Clark, 1985). Others have referred to this as the case of educational technology existing as a field with solutions in search of a problem (Ely, 1980). It seems that the answer to the question of the effect of media on achievement needs to come from further experimental research where the design of both treatment and control are the same, and only the media vary.

For the purposes of the current study achievement data is used in comparative form only, and is not conclusive due to the limitations of the study. These limitations include the small sample size, the fact that there was a significant difference in class size between the two school years when achievement data was collected, and the difference in mathematics texts in use those two years. However, achievement data does indicate degree of learning, and provides reasons for further scientific study of this multi-media lab.

Mastery Learning:

The third assumption to be explored is that of the appropriateness of the mastery learning model. The PLC lab is an exemplary mastery learning setup as defined by Jamison, Suppes and Wells (1974):

> Mastery learning is a general term used to describe a programmed instructional process in which a subject matter is subdivided into many smaller units and each student attains a mastery of a specific unit before being advanced to the next unit (Jamison et al., 1974, p. 39).

Peterson (in Jamison et al., 1974) found, in a survey of 25 mastery learning studies, that mastery learning yields significantly greater achievement results than more traditional approaches a majority of the time (in 21 out of 25 studies).

Mueller (1973) pointed out several problems that often limit applications of the mastery model. Among these problems are the following: the use of units that are not on a fixed time system in schools that are on fixed time systems, the costs of individual instruction, the lack of peer-related achievement, the dependency on individual mastery test items, and the arbitrariness in defining "mastery" and "non-mastery."

The PLC lab is an excellent example of a mastery learning program given the definition and possible flaws noted above. The activities students undertake in the lab are not on a fixed time line at all, they are not graded in any way on their performance in the lab and there are no requirements that any set amount of tasks be completed in a grading period. Each student works on a skill at his own pace until that skill is mastered, (s)he then moves on through the continuum of skills. As long as the students' prescriptions keep up with their progress through the skills continuum this self-paced system is successful. The initial cost of the lab was expensive, but the upkeep of it is only moderately so. Peer-related achievement scores may be attained via the pretests and posttests used to place students in the lab. There is a dependency on mastery test items in the lab setting, and this may be a weakness. Mastery, in the PLC lab, is defined as 75 percent correct. This is consistent with an "average" grade on a report card. In summary, it seems that the mastery model is both appropriate for the PLC lab and well applied in the "prescription" approach.

Attitudes:

Attitude studies often accompany research on the effectiveness of media. In the case of the Leitner and Ingebo (1984) study of PLC labs there was no stated purpose for identifying student attitudes. This leaves the reader with many questions: Do students have a positive attitude toward media? What are teacher attitudes toward media? Do student and teacher attitudes affect achievement scores?

Student attitudes.

First of all, most studies on student attitudes toward computers report similar conclusions to those reported by Leitner and Ingebo: students like working with media, and especially computers (Leitner & Ingebo, 1984; Kulik, 1985; Sigurdson & Olson, 1983; Stoneberg, 1985; Becker, 1984; Fisher, 1983; Swadener, 1984).

In his summary of meta-analyses Kulik (1985) concluded that students like their classes more when they receive help from a computer. He also found that student attitudes toward computers became more positive as students worked with the computers. Another finding Kulik reported was that student attitudes toward subject matter was not affected by using the computer.

Swadener (1984) used microcomputers in a tutorial program with high school students tutoring 68 sixth graders in mathematics. He did not find any significant effect on mathematics achievement, but reasoned that "...if one purpose of schooling is to spur interest (as opposed to attitude) [parenthetical remarks are original author's] then there is no question that microcomputers are appropriate and highly desirable" (Swadener, 1984, p. 103). Swadener found that, while both the high school and sixth grade students had positive attitudes toward computers, involvement with microcomputers had no influence on the students' attitudes toward mathematics or science and technology.

In Stoneberg's study (1985) of the WICAT minicomputer lab system he found that students in third through fourth grades, the same grade level students that had significant mathematics achievement scores, had consistently positive attitudes toward the computers when surveys were conducted at the beginning and end of the year (153 school days) long study. The second grade students, who did not have significant mathematics achievement gains, had a general attitude change toward computers that fell and turned negative over the course of the study.

Sigurdson and Olson (1983) also reported student attitude data in their study on microcomputer use in the regular classroom. They found that students in grades four through six had unchanged, and positive, attitudes toward the computers when surveys were conducted at the beginning and end of the school year. Second and third grade students' attitudes toward computers were positive, and changed further toward the positive over the course of the study. The authors found no correlation between attitude toward computers and attitude toward mathematics.

Generally, students do hold positive attitudes toward media, and especially toward computers.

Teacher attitudes.

In a national study of teacher attitudes toward media, Elliot (1984) found that teachers had highly positive attitudes toward microcomputers, even though the teachers perceived computers as highly complex. He also found that all materials, except for teacher prepared ditto masters, were perceived as expensive.

Stoneberg (1985) found that teachers had a positive attitude toward the WICAT lab system, and Leitner and Ingebo (1984), in their PLC lab study, found that teachers had positive attitudes toward both the media and the lab in general. In a district-wide survey of teachers in Denton, Texas, Lumsden and Norris (1985) collected 340 surveys and found that 85 percent of the sample agreed that computers were valuable tools in education, 80 percent disagreed with the generalization that computers are dehumanizing, 76 percent disagreed with the statement that computers are unnecessary luxuries, and 42 percent disagreed with the idea that all other educational equipment should be purchased before computers. In general, then, it seems that teachers have positive attitudes toward the use of media, and especially computers, in the schools.

Attitude and Achievement:

Research on the influence attitude has on achievement is mixed. While some studies have found that attidue does not have a significant correlation with achievement (e.g., Jackson & Lahaderne, 1967) others have found a significant and positive correlation (Neale, Gill, & Tismer, 1970; Aiken, 1976), and still others have found that attitude affected achievement for certain groups of students but not others (Aiken & Dreger, 1961; Malpass, 1953; DuCette & Wolk, 1972). Logically, it makes sense that people will do well at things they enjoy doing, or have a positive attitude toward doing; however, just because an individual likes playing tennis doesn't mean (s)he is a good tennis player, and just because someone likes doing math on computers doesn't mean (s)he will perform his/her math better. Indeed, this analogy is fitting, because the research that stands out concludes that attitude does have a significant positive correlation with achievement, but that attitude is second to ability as a predictor of achievement (DuCette & Wolk, 1972; Aiken, 1976).

Whether or not positive attitudes about one subject in school transfers to positive attitudes toward school in general, or whether positive attitudes toward computers used in mathematics transfers to positive attitudes toward mathematics is another issue. At this time research indicates that attitudes do not transfer from one subject to another, from computers to a subject, or from one subject to school in general (Aiken, 1976; Swadener, 1984; Sigurdson & Olson, 1983; Kulik, 1985).

Aiken (1976) also found that there are indications that teacher attitudes do affect student attitudes, but research on this topic is somewhat inconsistent. The best argument for surveying student attitudes may be in order to avoid the type of downfall that occurred with the programmed instruction approach (PI). A great deal of literature claimed that PI was effective in producing significant achievement gains (Jamison et al., 1974), but because it was perceived as dehumanizing it was rejected by the educational community (Allen, 1971). Monitoring student and teacher attitudes, and making the changes that these attitudes indicate are necessary, may prevent other media from suffering the same end.

Student and teacher attitude surveys are used in the current study in order to identify feelings about the lab for humanistic reasons, and in order to help identify qualities, procedures, or functions of the lab that may be improved through a change process.

Research Specific to PLC Labs:

The Prescription Learning Company (PLC) provides as background for its products general data referring to students' achievement on the company's own criterion-referenced tests (called the "Plasment" tests). The following is from a PLC marketing item:

> Prescription Learning, aware of the problems which may arise when achievement scores are the sole means used for program validation, hesitates to distribute achievement test results because of the possibility that they may be misinterpreted or used out of context.... Cumulative data from schools serviced by Prescription Learning programs during the 1983-84 school year are provided here in order to supply you with overall evaluative information. These results represent composite data because it is not a policy of Prescription Learning to publicize individual school's results.... 77 percent of students participating in Prescription Learning's mathematics programs achieved 1.5 years growth in an average period of eight months.... A large number of the students in our programs are students who fall into the bottom fiftieth percentile of their classes; and an established percentage of those low-achieving students made significant gains as measured by achievement instruments (PLC, date unknown, Demonstrating Effectiveness).

Another item from PLC indicated that the 1980-81 school year produced these results: 83.8 percent of students in grades two through six (9,46' students) "showed positive achievement in math" (PLC, date unknown, Prescription Learning Math Results). No further details were provided.

Two studies that dealt directly with PLC labs were available through the Educational Resources Information Center (ERIC) system. David Leitner (1982) conducted a study in the Portland, Oregon public schools comparing student achievement for the 1981-82 school year with PLC labs (similar to the lab in this study) to student achievement in the 1980-81 school year without PLC labs. In his study 446 Title I students were receiving supplemental mathematics instruction in PLC labs. The treatment group students were spending anywhere from 75 to 225 minutes a week in the lab. Leitner used the Portland Achievement Levels Test as both the pretest and the posttest to identify math achievement gains. There were positive, but non-significant, gains in mathematics by the students involved in the PLC lab. There was also a non-significant correlation between time spend in the lab and mathematics gains.

Leitner did another study with Ingebo (1984) reviewing the first three years of the PLC labs in Portland. In this study 558 students in grades two through eight from nine elementary and four middle schools were the treatment group subjects. All of the students were in Chapter I programs. Achievement scores showed that growth over the three year period for students in the treatment group was significant and greater than the district average. A student survey was also included in this study. The survey results indicated that 72 percent of the students liked the computer station more than any other station in the lab, 45 percent felt that the computer helped them learn the most, 24 percent felt that the small group station (working with a teacher) helped them learn the most, 38 percent felt that the computer helped them remember the most, 20 percent felt that the small group station helped them remember the most, 73 percent said they liked lab better than class, 82 percent said that the lab made work easier, and 59 percent said they remembered more from the lab than they did from the classroom. Both students and teachers were reported to have positive attitudes toward the PLC lab. A recommendation from this report was to supplement PLC courseware to match the school system's math curriculum better.

The present study seeks to document one procedure for implementing the PLC multi-media basic mathematics skills program, and to describe the learning gains and attitudes that resulted from that program. This descriptive approach may lay the groundwork for any changes that may seem necessary in the program. The descriptive approach may also lay the groundwork for any later controlled experimental studies.

CHAPTER III

METHOD

The purpose of this study was to identify student achievement, student attitude, and teacher attitude pertaining to a multimedia lab in an elementary school one year after the lab's implementation. The subjects for the study included both students and teachers.

Subjects:

The subjects for this study were 12 students, 6 males, 6 females, currently enrolled in the sixth grade. These students first used the lab during their fifth grade school year, and it was through comparison of mathematics achievement test results for their fourth and fifth grade school years that differences in achievement were identified. Eight of the students were Hispanic, three Afro-American, and one Anglo-American. The student sample included children who were in the same classroom for the 1985-86 school year, minus two students who transferred to other schools, and one whose lack of reading skills kept the student from participating in the same PLC program as the others. One of the twelve students included in the sample is only included for the attitude survey portion due to a lack of 1984-85 achievement test scores to use for comparison purposes. This student's survey could not be extracted from the sample, since the survey process was anonymous and his/her survey could not be identified. Three of the students included in the sample were not able to participate in the group interview. This researcher received written approval from the parents of all of the students who participated in this study (see Appendix A).

Only these twelve students were included in the student achievement and student attitudes sections of this study, but the multi-media lab served approximately 700 students. There are several reasons for this small sample. First, these students composed this researcher's entire 1985-86 class, minus those mentioned previously, and that eased the processes of obtaining records, surveying the students, and conducting student interviews. Second, by using students from just one class the threat of teacher differences affecting achievement and attitude data was eliminated. Third, it was felt that the faculty of the school may have misinterpreted the use of their students' achievement results in a study of this type as indicative of the teachers' effectiveness. Currently teachers in the state of Texas are under a great deal of pressure to raise student achievement scores, and this researcher did not want the current study to be associated with that pressure.

Subjects, too, were the 24 teachers, grades one through six, who participated in filling out a survey of teacher attitudes toward the lab. This made up 71 percent of the 34 teachers in grades one through six during the 1986-87 school year when the survey was conducted. Twelve teachers also participated in either one-to-one or small group focused interviews, though these were not necessarily the same teachers who had participated in the survey. Participation in the teacher survey was anonymous.

Equipment:

The multi-media system adopted by this school is one produced by Prescription Learning Company (PLC) of Springfield, Illinois. The lab was purchased for $61,492 by the School Board of the Austin Independent School District in January of 1985 after several months of searching for appropriate installations for the school. One of the major issues at hand was serving all 700 students in the school population with mathematics support in one way or another. The purchase price included all equipment, software, furniture, a staff inservice, registration and accommodations for three staff members at two PLC conferences, support services for one year, and free replacement of any equipment or software for one year (see Appendix B for a full list of purchased equipment and services). The lab was set up in August of 1985, and it was in use by late September.

The PLC multi-media lab at this school, during the 1985-86 school year, was comprised of five learning stations and one testing station. The learning stations were:

- Teacher Directed Activities (TDA), where a teacher assisted students who were working in a workbook,
- Seatwork (SW), where students worked on self-check materials,
- Tape Player (TP), where students worked with a tape player and workbook,
- Dukane (D), where students worked with a filmstrip-tape player machine, and
- Apple (A or "computer"), where students worked with the Apple computer.

During the 1985-86 school year there were 10 TDA, five SW, three TP, four D, and 14 computer stations. The fifteenth computer was used for management and hands-on-testing to update prescriptions. Tasks to be completed at the stations were drill-and-practice and/or tutorial.

Instructional Procedures:

Procedures for using the lab varied by grade level, and this must be taken into account when looking at the results of the teacher survey. Four-year-old program, kindergarten, and first grade students went to the lab one class at a time. These students worked only on the computers. Skills areas were decided upon by the lab teacher and the classroom teachers, not by a pretest process. The students worked with PLC software laden with sound and graphics reinforcements. The students worked primarily on the concepts of numeration, addition, and subtraction. Students in the four-year-old and kindergarten programs used the lab only ıce a month for 20 minutes at a time. The first grade students came to the lab every other week for 20 minutes at a time. During the 1985-86 school year there was one four-year-old program class. There were seven kindergarten and nine first grade classes.

Second and third grade students came to the lab one class at a time, two days each week, for 30 minutes at a time. They used the computers primarily, but not exclusively. The software available was graphics-oriented PLC software. Second and third grade students did participate in the lab using a prescription that was based on what PLC calls the AIMS pretest. During the 1985-86 school year there were six second grade and seven third grade classes.

The fourth through sixth grade classes for the 1985-86 school year included six fourth grades, five fifth grades, and four sixth grade classes. Fourth through sixth grades were "doubled up" in the lab during the 1985-86 school year; two classes used the lab simultaneously. Usually this meant that 30 students were in the lab at a time. These classes came to the lab three days a week for a 35 minute period each day.

Fourth through sixth grades worked in the lab on a prescription basis. A prescription is a list of skills and tasks. Students followed their prescriptions by completing the tasks listed (for an example of a student's prescription see Appendix C). The pretest used for the prescription was what PLC calls the "Plasment 1" test. Both the Plasment 1 and the AIMS tests initially place the student on a prescription skills level six to twelve months below the level achieved on the test. This prescription "...provide(s) immediate success as well as ease of articulation into needed skill work" (Prescription Learning Company, date unknown, Time on Testing and Continuums). Both tests are criterion based, give grade level equivalents as well as raw scores, are set up as both pretest and post-test, and prescribe four mathematics skills areas (from the skills listed in Table One) for the student to work on.

Students on a prescription took the pretest before coming to the lab. Their first visits to the lab involved learning how to use the equipment and how to read their prescriptions. Each student had his/her own prescription printed out and placed in a folder that the student picked up on his/her way into the lab. The student was on a rotation schedule for the media in the lab, using the computer every other day. Each prescription listed four skills subheadings and from three to ten tasks to be completed at the lab stations for each skill (see Appendix C). All of the students did receive feedback for tasks completed at the end of each lab session; e.g., with "mastery" defined as 75 percent correct, the tasks mastered by the students were checked off on their prescriptions. The prescriptions themselves were updated for one student in the lab class each day

TABLE 1:

PLC Plasment Test Objective Continuum for Mathematics
Intermediate Level (4-8) - 36 Objectives

OBJECTIVES:

Place value
Reading and writing numerals
Rounding numerals
Concepts and basic facts - addition
Addition - no regrouping
Concepts and basic facts - subtraction
Subtraction - no regrouping
Addition with regrouping
Subtraction with regrouping
Addition - three or more addends
Concept and basic facts - multiplication
One digit multipliers
Two or more digit multipliers
Concept and basic facts - division
One digit divisors
Two or more digit divisors
Multiplication factors with zero
Concept and techniques of problem solving
Solve one step word problems with whole numbers
Solve two step word problems with whole numbers
Concept of fractions
Add and subtract like fractions
Add and subtract unlike fractions
Concept of decimals
Add and subtract mixed numbers
Add and subtract decimals
Multiply fractions
Divide decimals
Identify English units of measure
Identify metric units of measure
Solve problems involving standard units of measure
Solve problems involving time and temperature
Differentiate between geometric shapes
Solve problems involving geometric principles

via a hands-on test at a separate computer station. This meant that each student's prescription was updated approximately once for every 30 visits to the lab, or once every ten weeks during the 1985-86 school year.

The hands-on test was organized so that it recalled the student's prior prescription and tested from that place in the skills continuum (Table One) on. The students were told to quit the test when it became too difficult. The prescription was based on mastery (three out of four items correct per skills area tested) of tested items and/or entry into nontested skills areas that immediately followed the location in the continuum where the student had quit the test. Each prescription always included four skills areas, whether they were nonmastered skills or nontested skills.

Teacher Roles:

Teachers in the lab included the lab teacher and classroom teachers for those classes using the lab. Teachers were responsible for behavior management, assisting students at all stations, using direct teaching methods at TDA stations, and recording scores on completed work in prescription folders. An important part of the teacher's role, according to PLC, was identifying whether or not tasks assigned were appropriate for individual students and overriding the prescription if deemed necessary. A teacher could update a prescription by having the student skip certain tasks to continue on to more advanced skills, or the teacher could see that the student went back to lower level skills on the PLC continuum by assigning tasks not on the prescription at all.

Tasks completed in workbooks at the TDA station were checked by the teacher, and after marking the number wrong the teacher would decide whether or not more practice was needed based upon a mastery level of 75 percent. Work completed at the mastery level at TDA was simply checked off on the student's prescription. Tasks completed at the SW station were self-checked, and a teacher and/or student would check that work off on the prescription. Similar procedures were used at the TP and D stations. At the computer stations the software would give the student a score, which was recorded on the student's prescription with the date that task was completed. Again, a 75 percent mastery level was in place at the computer stations.

While classes were using the multi-media lab the lab teacher was assisting with the preceding management and teaching responsibilities. His/her job also included maintaining appropriate supplies in the lab, requesting maintenance on machines when appropriate, organizing the materials in the lab, scheduling classes in the lab, and operating the prescription management system at the computer testing station.

Procedures Specific to the Fifth Grade Sample:

A review of the prescriptions from the 12 students included in the specific 1985-86 fifth grade class that was used in this study reveals that nine of those students received one hands-on test prescription update, two students received two of these updates, and one did not receive any as (s)he was a new student the second semester. Table Two shows the classifications of skills areas covered by these students and the total number of tasks completed. Further review of these prescriptions shows that the greatest number of prescribed tasks actually documented as completed by any student who was in the class for the full year was 40, and the smallest number was 12 (Table Two). A "task" is here defined as any one piece of work that a student was assigned on a prescription; i.e., Time on Math workbook p. 40, Dukane SVE Math tape number one, CLASS II addition computer software, etc. (see Appendix C for a sample prescription). The first presc·iptions for all students who began the school year in this class were dated September 21, 1985.

In total this class spent 79 class periods in the multimedia lab for the 1985-86 school year. Seventy of those class periods were spent working on PLC courseware, or a total of about 40 hours. Nine class periods were spent working on a variety of courseware in preparation for the Texas Educational Assessment of Minimum Skills (TEAMS; a curriculum mastery test). Beyond these

TABLE 2:

A Summary of Students' Prescription Updates for the 1985-86 School Year

1 = First prescription, 2 = Second prescription, 3 = Third prescription.

STUDENTS' NUMBERS:												OBJECTIVES:
1	2	3	4	5	6	7	8	9	10	11	12*	
.	.	.	.	.	.	.	.	.	.	.	.	Place value
.	.	.	.	.	.	.	.	.	.	.	.	Reading and writing numerals
.	.	.	.	.	.	.	.	.	.	.	.	Rounding numerals
.	.	.	.	.	.	.	.	.	.	.	.	Concepts and basic facts - addition
.	.	.	.	.	.	.	.	.	.	.	.	Addition - no regrouping
.	.	.	.	.	.	.	.	.	.	1	.	Concepts and basic facts -
.	.	.	.	.	.	.	.	.	.	.	.	subtraction
.	1	.	1	.	.	.	.	1	.	1	.	Subtraction - no regrouping
.	1	.	.	.	.	1	.	.	.	1	.	Addition with regrouping
.	1	1	1&2	.	1	1	1	1	1	1	.	Subtraction with regrouping
.	1	1	.	.	1	.	1	.	1	.	.	Addition three or more addends
.	1	1	1	.	.	.	.	1	.	.	.	Concept and basic facts -
.	.	.	.	.	.	.	.	.	.	.	.	multiplication
.	.	1	1	1	.	.	.	1	1	.	.	One digit multipliers
2	2	2	.	1	1	1	1	.	1	.	.	Two or more digit multipliers
.	2	.	.	.	1	1	1	.	.	.	.	Concept and basic facts - division
1	2	.	.	2	.	2	2	.	.	.	1	One digit divisors
.	2	.	.	2&3	.	2	2	.	.	.	1	Two or more digit divisors
1&2	3	2	2	1&2	2	2	2	.	2	2	1	Multiplication factors with zero
1&2	3	2	2	1&2	.	2	2	.	2	2	1	Concept and techniques of
.	.	.	.	.	.	.	.	.	.	.	.	problem solving
1&2	3	2	2	.	2	.	.	.	2	2	.	Solve one step word problems with
.	.	.	.	.	.	.	.	.	.	.	.	whole numbers
3	3	.	.	.	2	.	.	.	2	2	.	Solve 2 step word problems with
.	.	.	.	.	.	.	.	.	.	.	.	whole numbers
.	.	.	.	.	2	.	.	.	.	.	.	Concept of fractions
.	.	.	.	3	.	.	.	2	.	.	.	Add and subtract like fractions
3	.	.	.	3	.	.	.	2	.	.	.	Add and subtract unlike fractions
3	.	.	.	.	.	.	.	2	.	.	.	Concept of decimals
3	.	.	.	3	.	.	.	2	.	.	.	Add and subtract mixed numbers
.	.	.	.	.	.	.	.	.	.	.	.	Add and subtract decimals
.	.	.	.	.	.	.	.	.	.	.	.	Multiply fractions
.	.	.	.	.	.	.	.	.	.	.	.	Divide decimals
.	.	.	.	.	.	.	.	.	.	.	.	Identify English
.	.	.	.	.	.	.	.	.	.	.	.	units of measure
.	.	.	.	.	.	.	.	.	.	.	.	Identify metric
.	.	.	.	.	.	.	.	.	.	.	.	units of measure
.	.	.	.	.	.	.	.	.	.	.	.	Solve problems involving
.	.	.	.	.	.	.	.	.	.	.	.	standard units of measure
.	.	.	.	.	.	.	.	.	.	.	.	Solve problems involving time and
.	.	.	.	.	.	.	.	.	.	.	.	temperature
.	.	.	.	.	.	.	.	.	.	.	.	Differentiate between geometric
.	.	.	.	.	.	.	.	.	.	.	.	shapes
.	.	.	.	.	.	.	.	.	.	.	.	Solve problems involving geometric
.	.	.	.	.	.	.	.	.	.	.	.	principles
27	28	40	22	33	33	34	20	12	35	25	6	TOTAL number of tasks documented as completed 1985-86

* Student present for second semester only.

79 class periods, several sessions were spent, with just this class, in the lab working on compositions with word processing software.

For the specific class included in this study the use of the lab was supplemental mathematics time. During the 1985-86 school year in the Austin Independent School District time spent on the content areas was allocated in a very specific manner by both state law and district policy. During a 32 and one-half hour week fifth grade teachers were required to teach seven and one-half hours of reading and language arts, eight and three-quarters hours of science, social studies and health, three and three-quarters hours of physical education, art and music, and five hours of mathematics. The fifth grade teachers at the school involved in this study taught an additional five hours per week of language arts. This is a total of 30 hours. Teachers of other grade levels had similar requirements to meet. Given these requirements, the principal of this school let it be known that use of the lab could be either supplemental or primary instruction. All but one teacher in this school used the lab as supplemental instruction.

Data Collection Procedures:

Achievement data for eleven of the students in the study was gained by comparing scores on the Iowa Test of Basic Skills (ITBS) achievement tests available through school records. Scores in the areas of Math Concepts, Problem Solving, Math Computation, and Math Total were used from tests taken during the 1984-85 and 1985-86 school years. The Math Concepts area of the ITBS tests knowledge of number order, place value, use of number lines, fractions, decimals, and similar conceptual relationships. The Problem Solving area of the ITBS tests the student's ability to solve word problems. The Math Computation area of the ITBS tests the student's ability to perform addition, subtraction, multiplication, and division computations with whole numbers, fractions, and decimals. The Math Total, of course, is a score computed on the basis of performance in the three aforementioned areas.

The twelve students who participated in the student survey portion of this study met as a group after school one day in early September of the 1986-87 school year. They were told that they were going to take part in a study of the lab, but that this study was not to be an evaluation of their homeroom teacher or the lab teacher (for transcript of instructions see Appendix D). They were then given the attitude survey (Appendix E). After receiving instructions on how to complete the survey, the students were given an unlimited amount of time to do so. After approximately 20 minutes all of the students had finished completing the survey. Following completion of the survey this researcher conducted a twenty minute focused interview with nine of the students (Appendix D).

Teacher surveys were also distributed in early September of 1986 (Appendix F). Only teachers in grades one through six were asked to participate in the survey, since it was felt that the four-year-old and kindergarten programs used the lab too little to give a valid evaluation. The total number of teachers in grades one through six, during the 1986-87 school year when the survey was completed, was 34. The teacher surveys were anonymous, as were those of the students.

Teachers were notified of the survey by the campus principal, and asked to complete it after it had been deposited in their campus mailboxes. Completed surveys were returned to this researcher's campus mailbox. Participants were asked to turn the surveys in within three days. They were reminded about the surveys one week after they had first been placed in mailboxes. The last of the 71 percent of surveys turned in was received ten days after the original solicitation.

Teacher interviews were conducted in small group and one-to-one situations. The purpose of these interviews was to indicate teacher attitudes toward the lab. The interviews were focused, and lasted from 15 to 30 minutes (see Appendix G for interview questions). At least one teacher at each grade level was interviewed, and a total of 12 teachers were interviewed. The multi-media lab teacher was not included in the attitude survey, because it was felt that she would be biased; however, the lab teacher was interviewed using a different set of interview questions (Appendix G). The purpose of this interview was not so much to identify attitude, but to gain information on the way the lab was conducted.

Data Evaluation Procedures:

For achievement data the ITBS scores in the areas of Math Concepts, Problem Solving, Math Computation, and Math Total were used. Scores for the 1985-86 school year were compared with those from the 1984-85 school year. This could not be done for one student, as (s)he had been out of the local district in 1984-85. A simple comparison of percentile ranking was done since there were too many limitations to a scientific analysis of the data including the small class size, a new math textbook, and teacher differences. Percentile and grade equivalency scores for all eleven students were recorded and compared. A 15 point difference in percentile score was arbitrarily chosen as "significant" on the basis of its representation of greater than 1.5 years achievement as a grade level equivalent in most cases (Appendix H). A 1.0 grade level equivalent gain is expected in one academic year.

The student attitude surveys included questions which used a modified Likert-type scale, using faces instead of numbers on the attitude scale, with a multiple choice section also added (Appendix E). The sources for survey items were two school district reports: the first was a report on the PLC labs in the Portland, Oregon Public School System (Leitner & Ingebo, 1984), and the second was a report on computers used in a classroom setting in the Edmonton, Canada, Public School System (Sigurdson & Olson, 1983). Items from each of these reports were utilized and modified. The actual

Likert-type scale was based on the latter report, while the multiple choice items were derived from the former.

Items on the Likert-type scale portion of the student survey were written with specific groupings in mind, but these groups were randomly distributed on the actual survey. Item number two did not fit in any group, but was in the survey as a distractor, and was therefore not used in the analysis of this survey. Responses for each item on the Likert-type section of the survey were tallied and a percentage for each step on the scale was computed per item (Appendix I). The same process was followed for each possible choice on the multiple choice section.

Data from the focused interview, with the group of nine students, was used to supplement and support findings from the analysis of surveys. The interview data was used in raw form, and underwent no scientific analysis.

The teacher surveys were also Likert-type, but with opposite types of descriptors at the two ends of a seven point scale for each item (Appendix F). The source for this scale was a report to the school board from district 8J in the state of Oregon (Stoneberg, 1985). The source survey was modified for use with this study. The descriptors were randomly reversed, so that neither the left nor the right side was necessarily always the positive descriptor. A handwritten note was added to the instructions of the survey, "Notice: Take your time. 1 is not always low. 7 is not always high!" It was felt that the hand-written instruction would call attention to this fact, in contrast with the type-written form, for those teachers who were in a hurry to complete the survey and might just circle all of the numbers down one side.

In addition to the Likert-type scale teacher-participants were asked to indicate whether or not they had used computers before being involved in the PLC lab. They were also asked for their grade level, and there was a space for comments.

The first step in evaluating these surveys was to reorganize the data so that the negative descriptor was always on the left, and the positive descriptor always on the right. Next, responses for each item on the Likert-type section of the survey were tallied, and a percentage for each step on the scale was computed per item (Appendix J).

Data collected from the questions about computer use and grade level was used to do an analysis comparing those with and without computer experience. The data on teachers' grade levels was also used to compare the mean average of responses for each grade level with the mean average for the full sample (for a classification of the teacher sample by grade level and computer experience see Appendix K). For these comparisons a difference of 0.5 was arbitrarily selected as "significant." A score of between 4.0 and 4.3 on the teacher survey was defined as "neutral," and anything below a score of 4.0 was defined as "negative." Any score of 4.4

or more was defined as "positive."

Data from the focused interviews with 12 teachers was used to supplement and support the findings from the analysis of surveys. The data from the interview with the lab teacher was also used to modify and support informational portions of this report. Data was used in raw form, and underwent no scientific analysis.

The data collected on student achievement, student attitude, and teacher attitude was analyzed using comparative-type techniques. One of the clearest ways to identify findings was through the reorganization of survey information and display of that information in graph form. This technique and the findings are further discussed in Cnapter Four.

CHAPTER IV

RESULTS

Results include data on the students' achievement scores, student surveys, and teacher surveys. Simple comparative analyses were used on all data. Significance was defined by arbitrary, but logical, means. Interview data was not scientifically analyzed, and is included in this chapter in raw form.

Students' Achievement Scores:

Table Three shows a summary of the changes in ITBS scores from 1984-85 to 1985-86 for the Math Concepts, Solving Problems, Math Computation, and Math Total sections of that test. The changes are given in terms of gains or losses in percentile points. Again, "significant gain" was arbitrarily chosen as a gain of at least 15 percentile points. Fifteen percentile points equals approximately a grade equivalent gain of 1.5 years, and the "normal" expectation for one academic year is a grade equivalent gain of 1.0 years. Thus, a 15 percentile point gain is more than would normally be expected in one academic year. In the Math Concepts area 64 percent of the students achieved a significant gain, 27 percent achieved a normal gain, and nine percent achieved a gain that was below normal. In the Solving Problems area 36 percent of the

TABLE 3:

A Summary of Students' Mathematics Scores:
Gains and Losses from the 1984-85 ITBS to the 1985-86 ITBS

+/- Percentile	MATH CONCEPTS	SOLVING PROBLEMS	MATH COMPUTATION	MATH TOTAL	
+60					
			+59		
			+58		
+55					
+50				+48	
+45		+43			SIGNIFICANT GAIN
+40					
+35					
	+32		+33	+31	
+30	+30(2)		+30	+30	
	+28(2)	+27	+28		
+25			+27		
			+24		
+20		+21			
	+19			+16	
+15	+17	+17		+15	
+10	+11			+11	
+ 5		+5	+6	+5	
		+1		+2	
0		+/-0		+/-0	NORMAL GAIN
		-3		-1	
- 5		-5			
	-8			-8	
-10	-10	-11	-14		
-15			-16		
			-18		
-20					
-25					
-30	-30	-31			BELOW NORMAL GAIN
-35					
-40					

N = 11

students had a significant gain, 55 percent had a normal gain, and nine percent had a gain that was below normal. In the Math Computation area 64 percent of the students had a significant gain, 18 percent had a normal gain, and 18 percent had a gain that was below normal. In the Math Total 45 percent of the students had significant gains, 55 percent had normal gains, and zero percent had below normal gains.

Student Attitude Data:

Figure One displays a graph of student survey responses, with the survey itself rearranged to group similar items together (see Appendix L for a graph of student responses with the survey in its original form). It is most obvious that "having computers in your classroom" was the most liked idea presented in the survey, and "having a short time on the computer" was the least liked idea presented.

The first section of Figure One compares preferred student learning modes. The item "learning math" was included in order to identify whether the source of positive or negative feelings about the other items might have more to do with the media than the subject. Of the media in the lab it appears that the computer is the most liked, with Dukane, teacher, workbook, and tape player following in that order. Responses that had to do with being taught by a computer were very positive, as the items "being taught by a

FIGURE 1

Student Attitude Survey Results: A Comparison of Average Responses on Similar Items

1 = dislike a lot, 2 = dislike, 3 = neutral feelings, 4 = like, 5 = like a lot

ITEM	MEAN*		
5.	3.6	BEING TAUGHT BY A COMPUTER	1....2....3....4....5
1.	3.9	LEARNING MATH ON A COMPUTER	1....2....3....4....5
7.	3.6	LEARNING MATH ON A DUKANE	1....2....3....4....5
12.	3.3	LEARNING MATH WITH A TEACHER	1....2....3....4....5
16.	2.8	LEARNING MATH IN A WORKBOOK	1....2....3....4....5
10.±	2.4	LEARNING MATH ON A TAPE PLAYER	1....2....3....4....5
21.	3.9	LEARNING MATH	1....2....3....4....5
11.	3.7	ADDITION ON A COMPUTER	1....2....3....4....5
3.	2.4	ADDITION ON PAPER	1....2....3....4....5
14.	3.1	SUBTRACTION ON A COMPUTER	1....2....3....4....5
6.	2.5	SUBTRACTION ON PAPER	1....2....3....4....5
8.	4.3	FEEDBACK TO RIGHT ANSWERS ON A COMPUTER	1....2....3....4....5
15.	3.8	FEEDBACK TO RIGHT ANSWERS ON PAPER WORK	1....2....3....4....5
17.	2.7	FEEDBACK TO WRONG ANSWERS ON A COMPUTER	1....2....3....4....5
4.	2.5	FEEDBACK TO WRONG ANSWERS ON PAPER WORK	1....2....3....4....5
13.	4.2	LONG TIME ON A COMPUTER	1....2....3....4....5
19.	1.4	SHORT TIME ON THE COMPUTER	1....2....3....4....5
18.	4.7	HAVING COMPUTERS IN YOUR CLASSROOM	1....2....3....4....5
9.	4.5	HAVING COMPUTERS IN THE LAB	1....2....3....4....5
20.	3.1	HAVING MORE THAN JUST COMPUTERS IN THE LAB	1....2....3....4....5

* Numbers shown are mean averages rounded off to the nearest .1.

± N = 12 for all items, but for item number 10 N = 11.

computer," "learning math on a computer," and "addition on a computer" show. However, the average response to "subtraction on a computer" was only slightly above neutral.

The second section of Figure One includes items that compare students' attitudes about working in the paper-and-pencil mode and working with the computer. Students were fairly consistent about rating items that had to do with paperwork lower than items involving little or no paperwork. At the computer station calculating on paper is used infrequently. At the Dukane paperwork is not required at all. Paperwork is required at all of the other stations. The items "addition on paper" and "subtraction on paper" ranked as low as "learning math on a tape player."

The third section of Figure One shows that students generally like feedback better when they are correct than when they are incorrect. It also shows that, whether correct or incorrect, students like computer feedback slightly more than feedback on a piece of paper. The tendency toward computer feedback is insignificant however.

The fourth section of Figure One shows a definite preference for an extended time on the computer over a short time. The fifth section of this Figure shows that students liked having computers in the classroom only slightly more than having them in the lab, and they felt fairly neutral about having media other than computers in the lab.

A closer look at the summary of individual student responses presented in Appendix I reveals that no student felt any dislike of "feedback to right answers on the computer," while two students did feel a dislike for "feedback to right answers on paperwork." Also, no student felt any dislike of either "having computers in the lab" or "having computers in your classroom." Four students disliked the idea of "having more than just computers in the lab." The only item that no student liked the idea of was "short time on the computer." In fact, over fifty percent of the students greatly disliked spending a "short time on the computer." On the other end of the scale, over fifty percent of the students greatly liked "having computers in the lab," spending a "long time on the computer," and "having computers in your classroom."

The evaluation of the multiple choice section of the student attitude survey (Appendix I) reveals that 92 percent of the students liked the computer station the most, while eight percent like the TDA station the most. Sixty-seven percent of the students felt that the computer station helped them learn the most, 25 percent felt that TDA helped them learn the most, and eight percent felt that the Dukane station helped them learn the most. Students were fairly consistent in their responses to the similar item "Which station helps you remember the best?": 50 percent chose the computer station, 33 percent chose TDA, eight percent chose the Dukane station, and eight percent chose the TP station.

Since the TDA station is comparable to traditional instruction in small groups, the data can be interpretted as indicating that 75 percent of the students felt that nontraditional instruction helped them learn the most (Appendix I, item 23), and 66 percent felt that nontraditional instruction helped them remember the best (Appendix I, item 24). Sixty-seven percent of the students said they liked the lab better than class, and 83 percent said that the lab made math work easier; however, 83 percent also responded that they remembered more from class than they did from the lab.

Data From the Student Interview:

Nine students were interviewed in a group setting (for interview questions see Appendix D). The things students liked about the lab were working with the computers and not writing. One student remarked, "When you have the computer you don't have to work. I mean you don't have to write." Students said that they did not like working in the workbooks at the TP and TDA stations, but they said that the Dukane station was "okay."

When asked for adjectives that described the lab students came up with a mixed list, "fun, kind of fun, boring, sorry, easy, hard." Students were split on the issue of whether or not the lab helped them learn mathematics and whether lab or class helped them learn more.

Teacher Attitude Data:

Figure Two shows the mean averages of responses for each item of the teacher survey used in this study. The descriptors have been reordered so that those on the left are negative, while those on the right are positive. Thus, the higher the number, the more positive the response. The items have also been reordered so that the figure begins with that item which received the highest average response and ends with that item which received the lowest (see Appendix M for a graph of teacher responses with the survey in its original form). Teachers ranked the appropriateness, usefulness, and value of the lab highest. They ranked the lab's complexity, consumption of time, and expense the lowest. The only item that teachers, as a group, rated as negative was the expense, and that is only slightly below neutral.

A review of the more detailed data displayed in Appendix J shows that only one item escaped having any negative response placed on it, and that was the continuum between "wise" and "foolish." Only one teacher responded toward the negative end of the scale for each of these items: "useless - useful," "frustrating - easygoing," "unproductive - productive," "puzzling - understandable," "worthless - valuable," "decreases - increases achievement," and "inappropriate - appropriate use of computers." None of the items had less than seven responses (29 percent) on the positive end of the scale; that with just seven was the "expensive - reasonable" item.

FIGURE 2

Teacher Attitude Survey Results: Average Response
Per Item in Order from Most Positive to Least Positive Response

ITEM	MEAN*			
21.	6.2	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	USELESS	1....2....3....4....5....6....7.	USEFUL
17.	6.0	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.7	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.6	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.6	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.5	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.4	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	BORING	1....2....3....4....5....6....7	INTERESTING
18.	5.3	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.2	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.1	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.8	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.3	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	4.1	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	3.8	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

N = 24.

The item that had the largest percentage of negative responses was "complicated - simple" with 41 percent below four points. Thirty-seven percent of the participants responded on the negative end of the scale on the "expensive - reasonable" item. The item that had the largest percentage of positive responses was "supports math curriculum" with 95 percent above four points. Ninety-two percent of the participants responded on the positive end of the "useless - useful" scale.

In all of the findings involving a comparison of various groups' responses on the teacher survey the following criteria were arbitrarily selected: a difference of 0.5 was defined as "significant"; a score of between 4.0 and 4.3 on the teacher survey was defined as "neutral"; anything below a score of 4.0 was defined as "negative"; any score of 4.4 or more was defined as "positive."

The information at the bottom of the teacher surveys identifying whether or not the participant had used computers before the 1984-85 school year was utilized in making the comparison graph in Figure Three. Eleven teachers had not had any experience with computers before their exposure to the PLC lab and 13 teachers had had such experience. Each grade level was represented by teachers with and without prior computer experience (see Appendix K). In Figure Three the solid line represents the mean averages per item of those participants in the teacher survey who were not computer users (non-users) before being exposed to the PLC lab, and the dashed line

FIGURE 3

Teacher Attitude Survey Results: A Comparison of Computer Users' and Nonusers' Responses

ITEM	MEAN*+ NON-USERS	MEAN*± USERS	DIFFERENCE			
21.	5.7	6.6	+ .9	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	6.2	+ .1	USELESS	1....2....3....4....5....6....7	USEFUL
17.	5.6	6.2	+ .6	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.5	5.8	+ .3	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	5.6	- .1	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.4	5.8	+ .4	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.5	5.8	+ .3	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	5.6	+ .1	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.1	5.8	+ .7	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.4	5.7	+ .3	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.3	5.5	+ .2	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.2	5.6	+ .4	BORING	1....2....3....4....5....6....7	INTERESTING
18.	4.8	5.8	+1.0	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	4.3	5.7	+ .9	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.5	5.0	- .5	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.2	5.1	- .1	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.2	5.3	+ 1.1	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	4.6	+/-0	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.7	3.9	- .8	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	3.9	4.3	+ .4	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	4.0	3.7	- .3	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

\+ Nonusers, N = 11.

± Users, N = 13.

represents the mean averages per item of those participants who were computer users (users) before being exposed to the PLC lab.

There was between 0.5 and 0.9 of a point difference between the mean averages of the computer users and non-users on these items: "inappropriate - appropriate use of computers," "worthless - valuable," "frustrating - easygoing," "decreases - increases achievement," and "complicated - simple." The "complicated - simple" item was the only one that non-users rated significantly more positive than computer users. There was a difference of at least one full point between the two groups on these items: "confusing - clear" and "unknown - familiar." In both cases the computer users ranked the items more positively than non-users. On average, computer users responded on the negative end of the scale (3.7) for only one item: "expensive - reasonable." Non-users responded on the negative end of the scale (3.9) for only one item also: "time consuming - time saving."

On the majority of items the computer users and non-users responded very similarly. There was less than .5 of a point difference between the mean averages of the computer users and non-users on these thirteen items: "useless - useful," "foolish - wise," "confuses - supports math curriculum," "unproductive - productive," "puzzling - understandable," "unimportant - important," "inefficient - efficient," "ineffective - effective," "boring - interesting," "unnecessary - necessary," "limiting - expanding," "time consuming - time saving," and "expensive - reasonable."

The item at the bottom of each survey requesting the participant's grade level was utilized in Figures Four through Nine. In this series of graphs the mean average for each grade level, one through six, is compared to the mear average of the full sample. The items are in the same order as they were presented in Figure One. The mean average of the full sample is shown with a solid line, while each grade level is represented in each graph by a dashed line. These figures illustrate the obvious trend for the lower grades to rank the lab more positively than the upper grades.

In fact, the mean average for grade one participants (Figure Four) ranks three items below the mean of the full sample: "unnecessary - necessary," "unknown - familiar," and "limiting - expanding." Only the "unnecessary - necessary" item was ranked more than 0.5 of a point below the full sample mean by grade one participants. Meanwhile, the grade one mean average shows that these participants ranked five items between 0.5 and 0.9 of a point higher than the full sample mean: "inappropriate - appropriate use of computers," "useless - useful," "foolish - wise," "unproductive - productive," and "frill - essential." Four items, "unimportant - important," "ineffective - effective," "boring - interesting," and "complicated - simple," were ranked at least one full point higher than the mean for the full sample by the first grade sample. There was an insignificant difference between the first grade mean average and the

FIGURE 4

Teacher Attitude Survey Results: A Comparison of First Grade Level and Full Sample Responses

ITEM	MEAN*+ FULL SAMPLE	MEAN*± GRADE 1	DIFFERENCE			
21.	6.2	6.8	+ .6	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	6.8	+ .7	USELESS	1....2....3....4....5....6....7	USEFUL
17.	6.0	6.5	+ .5	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.7	6.5	+ .8	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	5.8	+ .1	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.6	6.5	+ .9	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.6	6.0	+ .4	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	6.5	+1.0	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	5.8	+ .3	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.5	6.0	+ .5	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.4	6.8	+1.4	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	6.5	+1.1	BORING	1....2....3....4....5....6....7	INTERESTING
18.	5.3	5.5	+ .2	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	5.8	+ .5	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.2	6.0	+ .8	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.1	4.5	- .6	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.8	4.5	- .3	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	4.5	- .1	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.3	5.3	+1.0	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	4.1	4.3	+ .2	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	3.8	4.0	+ .2	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

\+ Full sample, N = 24.

± Grade 1, N = 4.

FIGURE 5

Teacher Attitude Survey Results: A Comparison of Second Grade Level and Full Sample Responses

ITEM	MEAN*+ FULL SAMPLE	MEAN*± GRADE 2	DIFFERENCE			
21.	6.2	6.8	+ .6	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	6.8	+ .7	USELESS	1....2....3....4....5....6....7	USEFUL
17.	6.0	7.0	+1.0	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.7	6.0	+ .3	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	6.8	+1.1	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.6	6.5	+ .9	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.6	6.3	+ .7	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	6.8	+1.3	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	6.5	+1.0	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.5	6.8	+1.3	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.4	5.8	+ .4	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	6.3	+ .9	BORING	1....2....3....4....5....6....7	INTERESTING
18.	5.3	6.3	+1.0	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	5.3	+/-0	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.2	5.3	+ .1	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.1	6.8	+1.7	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.8	5.3	+ .5	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	4.3	- .3	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.3	4.0	- .3	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	4.1	4.3	+ .2	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	3.8	5.8	+2.0	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

+ Full sample, N = 24.

± Grade 2, N = 4.

FIGURE 6

Teacher Attitude Survey Results: A Comparison of Third Grade Level and Full Sample Responses

ITEM	MEAN*+ FULL SAMPLE	MEAN*‡ GRADE 3	DIFFERENCE			
21.	6.2	6.7	+ .5	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	6.7	+ .6	USELESS	1....2....3....4....5....6....7	USEFUL
17.	6.0	7.0	+1.0	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.7	6.0	+ .3	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	6.3	+ .6	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.6	6.0	+ .4	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.6	5.7	+ .1	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	5.0	- .5	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	5.7	+ .2	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.5	4.7	- .8	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.4	6.0	+ .6	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	6.7	+1.3	BORING	1....2....3....4....5....6....7	INTERESTING
18.	5.3	5.7	+ .4	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	5.3	+/-0	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.2	5.7	+ .5	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.1	5.0	- .1	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.8	5.3	+ .5	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	6.3	+1.7	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.3	3.3	-1.0	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	4.1	4.0	- .1	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	3.8	4.7	+ .9	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

+ Full sample, N = 24.

‡ Grade 3, N = 3.

FIGURE 7

Teacher Attitude Survey Results: A Comparison of Fourth Grade Level and Full Sample Responses

ITEM	MEAN*+ FULL SAMPLE	MEAN*± GRADE 4	DIFFERENCE			
21.	6.2	6.3	+ .1	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	6.2	+ .1	USELESS	1....2....3....4....5....6....7	USEFUL
17.	6.0	6.0	+/-0	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.7	5.8	+ .1	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	5.8	+ .1	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.6	5.7	+ .1	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.6	5.7	+ .1	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	5.8	+ .3	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	5.2	- .3	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.5	5.7	+ .2	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.4	5.7	+ .3	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	5.5	+ .1	BORING	1....2....3....4....5....6....7	INTERESTING
18.	5.3	5.3	+/-0	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	5.7	+ .4	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.2	5.3	+ .1	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.1	5.3	+ .2	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.8	5.5	+ .7	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	5.2	+ .6	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.3	4.0	- .3	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	4.1	5.0	+ .9	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	3.8	2.7	-1.1	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

\+ Full sample, N = 24.

± Grade 4, N = 6.

FIGURE 8

Teacher Attitude Survey Results: A Comparison of Fifth Grade Level and Full Sample Responses

ITEM	MEAN*+ FULL SAMPLE	MEAN*± GRADE 5	DIFFERENCE			
21.	6.2	5.3	- .9	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	5.0	-1.1	USELESS	1....2....3....4....5....6....7	USEFUL
17.	6.0	4.3	-1.7	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.7	5.3	- .4	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	4.5	-1.2	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.6	4.0	-1.6	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.6	5.5	- .1	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	4.3	-1.2	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	4.5	-1.0	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.5	4.8	- .7	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.4	3.8	-1.6	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	3.8	-1.6	BORING	1....2....3....4....5....6....7	INTERESTING
18.	5.3	4.8	- .5	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	4.8	- .5	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.2	4.5	- .7	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.1	4.5	- .6	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.8	3.5	-1.3	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	3.8	- .8	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.3	4.8	+ .5	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	4.1	3.8	- .3	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	3.8	3.5	- .3	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

\+ Full sample, N = 24.

± Grade 5, N = 4.

FIGURE 9

Teacher Attitude Survey Results: A Comparison of Sixth Grade Level and Full Sample Responses

ITEM	MEAN*+ FULL SAMPLE	MEAN*± GRADE 6	DIFFERENCE			
21.	6.2	5.3	- .9	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS
3.	6.1	5.3	- .8	USELESS	1....2....3....4....5....6....7	USEFUL
17.	6.0	5.0	-1.0	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
4.	5.7	4.3	-1.4	FOOLISH	1....2....3....4....5....6....7	WISE
20.	5.7	4.7	-1.0	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
11.	5.6	4.7	- .9	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
16.	5.6	4.3	-1.3	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
8.	5.5	4.3	-1.2	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	5.3	- .2	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
14.	5.5	5.0	- .5	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
5.	5.4	4.3	-1.1	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	3.7	-1.7	BORING	1....2....3....4....5....6....7	INTERESTING
18.	5.3	4.3	-1.0	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	4.7	- .6	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
1.	5.2	4.3	- .9	FRILL	1....2....3....4....5....6....7	ESSENTIAL
10.	5.1	4.3	- .8	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
2.	4.8	4.3	- .5	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
15.	4.6	3.7	- .9	LIMITING	1....2....3....4....5....6....7	EXPANDING
12.	4.3	4.3	+/-0	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
7.	4.1	2.7	-1.4	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
13.	3.8	3.0	- .8	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE

* Numbers shown are mean averages rounded off to the nearest .1.

\+ Full sample, N = 24.

± Grade 6, N = 3.

full sample mean average for eleven items. No item was ranked on the negative side of the scale. The "expensive - reasonable" item was ranked as neutral by this group, and the "time consuming - time saving" item was ranked within 0.3 of a point on the positive side of neutral. The remaining nineteen items were ranked on the positive side of the scale by the first grade group.

The mean average for grade two teacher participants (Figure Five) ranks only two items below the mean of the full sample: "limiting - expanding" and "complicated - simple." Neither of these items was more than 0.5 of a point below the mean average of the full sample. The grade two mean average ranks five items between 0.5 and 0.9 of a point higher than the full sample mean: "inappropriate - appropriate use of computers," "useless - useful," "unproductive - productive," "puzzling - understandable," and "boring - interesting." Eight items, "worthless - valuable," "confuses - supports math curriculum," "unimportant - important," "frustrating - easygoing," "inefficient - efficient," "confusing - clear," "unnecessary - necessary," and "expensive - reasonable," were ranked at least one full point higher than the mean for the full sample. There was an insignificant difference between the mean average of the second grade sample and the mean average of the full sample for eight items. No item was ranked on the negative side of the scale by the second grade sample. One item, "complicated - simple," was ranked neutral on the scale, and two other items, "limiting -

expanding" and "time consuming - time saving," were ranked within 0.3 of a point of the positive side of neutral by this group. The remaining eighteen items were ranked on the positive side of the scale by the second grade sample.

The mean average for grade three participants (Figure Six) ranks five items below the mean of the full sample: "unimportant - important," "inefficient - efficient," "unnecessary - necessary," "complicated - simple," and "time consuming - time saving." Both the "inefficient - efficient" and the "complicated - simple" item were ranked more than 0.5 of a point below the mean average of the full sample. The grade three mean average ranks four items between 0.5 and 0.9 of a point higher than the full sample mean: "useless - useful," "confuses - supports math curriculum," "ineffective - effective," and "expensive - reasonable." Three items, "worthless - valuable," "boring - interesting," and "limiting - expanding," were ranked at least one full point higher than the mean for the full sample. There was an insignificant difference between the mean average of the third grade sample and the mean average of the full sample for twelve items. One item was ranked on the negative side of the scale by the third grade sample: "complicated - simple." One item was ranked as neutral by this group: "time consuming - time saving." The remaining nineteen items were ranked on the positive side of the scale.

The mean average for grade four participants (Figure Seven) ranks three items below the mean of the full sample: "frustrating

- easygoing," "complicated - simple," and "expensive - reasonable." One of these items, "expensive - reasonable," is ranked more than 0.5 of a point below the mean average of the full sample. The grade four mean average ranks three items more than 0.5 of a point higher than the full sample mean: "unknown - familiar," "limiting - expanding," and "time consuming - time saving." No item was ranked at least one full point higher than the mean for the full sample. There was an insignificant difference between the mean average of the grade four sample and the mean average of the full sample for seventeen items. Only one item was ranked on the negative end of the scale by the fourth grade sample: "expensive - reasonable." One item was ranked as neutral by this group: "complicated - simple." The remaining nineteen items were ranked on the positive end of the scale.

The mean average for grade five participants (Figure Eight) ranks all but one item, out of 21, below the mean of the full sample. Five of these items are ranked between 0.5 and 0.9 of a point below the mean average of the full sample: "inappropraite - appropriate use of computers," "inefficient - efficient," "frill - essential," "unnecessary - necessary." and "limiting - expanding." Nine items were ranked at least one full point below the full sample mean: "useless - useful," "worthless - valuable," "confuses - supports math curriculum," "unproductive - productive," "unimportant - important," "frustrating - easygoing," "ineffective -

effective," "boring - interesting," and "unknown - familiar." Only one item was ranked above the full sample mean average by the grade five sample; the "complicated - simple" item was ranked 0.5 of a point above the mean average of the full sample. There was an insignificant difference between the mean average of the fifth grade sample and the mean average of the full sample for seven items. Six items on the fifth grade mean average graph are ranked in the negative area of the scale: "effective - ineffective," "boring - interesting," "unknown - familiar," "limiting - expanding," "time consuming - time saving," and "expensive - reasonable." One item, "unproductive - productive" was ranked right at neutral by the fifth grade sample. Two items, "worthless - valuable" and "unimportant - important," rank within 0.3 of a point of the positive side of neutral. The remaining twelve items were ranked on the positive side of the scale by the fifth grade sample.

The mean average for grade six participants (Figure Nine) ranks all but one item below the mean average of the full sample. The sixth grade sample ranked eight items between 0.5 and 0.9 of a point below the full sample; "inappropriate - appropriate use of computers," "useless - useful," "unproductive - productive," "decreases - increases achievement," "frill - essential," "unnecessary - necessary," "limiting - expanding," and "expensive - reasonable." This group ranked nine items at least one full point below the full sample: "worthless - valuable," "foolish - wise," "confuses - supports math curriculum," "puzzling - understandable," "unimportant - important," "ineffective - effective," "boring - interesting," "confusing - clear," and "time consuming - time saving." The one item that was ranked evenly with the full sample was the "complicated - simple" item, and that ranking was within 0.3 of a point of the positive side of neutral along with eight other items: "foolish - wise," "puzzling - understandable," "unimportant - important," "ineffective - effective," "confusing - clear," "frill - essential," "unnecessary - necessary," and "unknown - familiar." There was an insignificant difference between the mean average of the sixth grade sample and the full sample for four items. The sixth grade group ranked four items on the negative side of the scale: "boring - intersting," "limiting - expanding," "time consuming - time saving," and "expensive - reasonable." The remaining eight items were ranked on the positive side of the scale.

Data From Teacher Interviews:

In order that the teachers interviewed remain anonymous, interview data is not classified by grade level. At least one teacher at each grade level, one through six, was interviewed (see Appendix G for interview questions). Every teacher interviewed mentioned that a strength of the lab was the exposure to computers that the low socio-economic status student population of this school received.

Another strength that most eachers mentioned was that the lab either reviewed or reinforced math concepts learned in the classroom. Several teachers pointed out that the lab provided more review than reinforcement. Teachers identified "reinforcement" as practice that followed a recently introduced skill and "review" as practice of a skill learned in the more distant past. Other strengths that teachers mentioned were the following: that all 700 of the students in the school were involved in the lab in some way, an alternative media was available to the students, an alternative pedagogical approach to a concept may be presented in a lesson with these media, the students felt good about working with the computers, and that there was a trained professional in the lab to handle the technical and organizational areas as well as to help teach. Primary level teachers were positive about the graphics, bells, buzzers, and music the computer software used to motivate and reward students for correct answers. Teachers did orient their responses to the computers in the lab, and not the multi-media capabilities of the lab.

When asked what the weaknesses of the lab were, teachers at each grade level noted that they did not receive enough time in the lab. Teachers who had students on a prescription basis remarked that the prescriptions were not updated often enough, and that this was one reason they said the lab offered a review of skills rather than a reinforcement: the prescriptions were not keeping up with the students' rate of learning new skills and/or the teachers' rate of progress through the mathematics textbook in their classrooms. These teachers felt that the lab was not correlated with the curriculum well enough. Several teachers remarked that, because the lab usually provided a review of skills, the skills covered in the lab were not challenging or moderately novel enough.

Another weakness cited was the inflexibility of the basic skills orientation. One teacher meant by this the inability to do more word processing, reading skills, computer programming, and use other software. Another teacher meant having more classroom teacher control of what is covered on a prescription, or having power to override the prescription. Upper elementary teachers noted the lack of skills software with graphics and at least one teacher called the available materials "cut and dried." An interesting weakness of the lab was noted by a bilingual teacher when (s)he said that the Spanish-dominant students could not use the media equipment in the lab on their own because, even though math is a "universal" language, there was too much English reading involved in both the drill and tutorial types of courseware.

Improvements that teachers felt could be made to the lab included more frequent hands-on tests to update student prescriptions, more time in the lab and/or time for each student to use a computer each lab session, and more supplementary software to enrich student learning, motivate upper elementary students with graphics, and better reinforce the curriculum taught in the classroom. Teachers noted that some improvements over the first year of the lab had already been made for its second year: the software was more accessible, the students did not do as much in the workbooks, and the upper elementary classes used the lab one class at a time.

When asked whether or not the multi-media lab was worth the time and effort that students spent there first through fourth grade teachers responded that it was, and fifth and sixth grade teachers responded that, during the 1985-86 school year, it was not.

All of the teachers interviewed agreed that the students had positive attitudes towards the lab, and especially toward working with computers. Teachers felt that students had neutral attitudes toward the non-computer media.

The teachers interviewed were divided on the issue of whether or not the lab had increased student achievement as measured by standardized tests. Primary teachers felt that their students had not spent enough time in the lab for it to affect the students' test scores, some upper elementary teachers saw improved achievement scores as a result (at least in part) of the time spent in the lab, others did not.

Most teachers felt that they knew enough about the lab, since there was always a professional in the lab who knew its operation well. The teachers interviewed seemed to feel comfortable about their roles in the lab. One teacher did feel that (s)he would like more information about the skill levels and software available so that (s)he could provide his/her students with more appropriate software.

Most of the information from the interview with the lab teacher was factual information about how the lab operated (see Appendix G for a list of the focused interview questions). (S)He was also asked about the strenths and weaknesses of the lab. The lab teacher felt that the strengths of the lab were in the stimulations provided by the multi-media approach, the variety of learning styles that were addressed by the media, the flexibility of the prescription process to identify skill strengths and weaknesses that were at, above, or below grade level norms, the individualization each machine offered, the immediate feedback that the computer offered,and the systematic and logical way in which the lab was operated (to teach students how to follow directions).

The lab teacher remarked that the weaknesses of the lab during the 1985-86 school year were the infrequent updates of student prescriptions and the intense demand on the organizational system of scheduling, organizing materials, and data collecting (saving information from hands-on tests) in the lab. This teacher said that the lack of courseware in some of the skills areas for some of the machines in the lab was also a weakness. (S)He also stated that the lack of graphics-oriented software for the upper elementary grades was a weakness.

The lab teacher's perception of classroom teacher attitudes toward the lab was that those teachers in the primary grades felt good about the lab from the beginning because of the computer graphics, and that those teachers who were doubled up in the lab had mixed feelings because of the noise, confusion, and difficulty in checking students' work brought about by the crowded lab conditions. The lab teacher felt that teachers who saw their students' improvement in mathematics skills had better attitudes toward the lab than those who did not. (S)He also felt that "the more flexible the teacher, the more positive the attitude."

When asked about his/her perception of student attitudes toward the lab, the lab teacher said that (s)he thought students felt good about the lab because it was "bound to hit their learning style." The following are this teacher's perceptions of student attitudes toward the various lab stations: some students liked TDA because it gave them an opportunity to be alone with their teacher, most students liked the computers because it is such a new technology for them, the students seemed to like working with the Dukane because it includes mathematics in a story context, and the TP and SW stations students seemed to feel were just "okay," because these stations presented information in a fairly "cut and dried" manner.

The lab teacher described his/her job as a busy one. (S)He reported spending two hours per school day, outside of the school day, organizing materials and doing paperwork. His/Her job included taking inventory in order to replace missing or damaged items, checking the equipment daily, monitoring the classes that came to the lab, updating student prescription files, scheduling use of the lab, and keeping up with teacher and administrator expectations for the lab.

Of all these results, the most remarkable are the vast differences in teacher attitudes when grade level groups are compared. Also notable are student attitudes toward paperwork and computers, and student achievement gains in the Math Concepts and Math Computation areas of the ITBS. The reasons behind these findings will be discussed in Chapter Five.

CHAPTER V

CONCLUSIONS AND DISCUSSION

This study has documented the use of a Prescription Learning Company (PLC) basic mathematics skills multi-media lab at one elementary school in Austin, Texas. A literature review has indicated that the four assumptions made about the lab seem valid: students do have individual modality strengths, computer assisted instruction (CAI) usually does increase mathematics achievement when it is used in supplemental instruction, the mastery model is an effective approach to increasing achievement in an individualized manner, and both student and teacher attitudes do make a difference in achievement sometimes. Five questions were asked concerning the multi-media lab at the elementary school involved in this study:

A. Does the multi-media lab improve students' math achievement?

B. Do the students feel that the multi-media lab helps them learn?

C. Do the teachers feel that the multi-media lab helps the students learn?

D. What are student attitudes toward the lab?

E. What are teacher attitudes toward the lab?

F. What changes could be made to make the lab more effective from both teachers' and students' viewpoints?

In this summary chapter these questions are answered to the extent that the data presented in this study allows.

Student Achievement:

Since this was a descriptive study done in an ex-post-facto style, there are too many limitations to the study to make any broad generalizations about any one specific factor influencing mathematics achievement. However, when one looks at the data it is recognizable that a large percentage of the students involved in this study did make significant achievement gains in those areas that the PLC multi-media lab was strongest in supporting: namely, the Math Concepts and Math Computation sections of the Iowa Test of Basic Skills (ITBS). In both the Math Concepts and Math Computation sections of the achievement test 64 percent of the students achieved a significant gain in the 1985-86 school year when compared to the 1984-85 school year.

The PLC multi-media lab at this elementary school focuses on mathematics support through drill-and-practice and tutorial techniques. The tutorials are geared toward mathematics concepts; students are taught about number concepts. Tutorials also precede drill-and-practice exercises that are designed to increase students' mathematics computation. A glance at the PLC Plasment Mathematics

Continuum (Table One, p. 28) yields the information that only five out of the 36 skills areas on the continuum deal with problem solving. Furthermore, data showing the actual Plasment continuum skills areas entered by the student sample involved in this study (Table Two, p. 32) shows that only two of these problem solving skills areas were reached, and those by only seven students. With this information in mind, it is not surprising to see that only 36 percent of the students had a significant gain in the Problem Solving section of the ITBS. Indications are that the PLC multi-media lab did have a positive effect on student achievement for those students included in this study.

Student Perceptions of Learning:

According to information reaped from the student surveys, the students do feel that the multi-media lab helps them learn. Since the TDA station is comparable to "traditional instruction" in small groups, data from the multiple choice section of the survey indicates that 75 percent of the students felt that the nontraditional approaches helped them learn the most, and 66 percent felt that nontraditional approaches helped them remember the best. Also, 83 percent said that the lab made mathematics work easier, (Appendix I). These findings are almost identical to those of Leitner and Ingebo (1984) in their study of PLC labs. Leitner and Ingebo found that 76 percent of the students felt that the nontraditional approaches helped them learn the most, and 80 percent felt that nontraditional approaches helped them remember the best. Eighty-two percent of the student subjects in the Leitner and Ingebo study responded that the lab made math easier. In both the Leitner and Ingebo study and the current study a majority of the student subjects felt that they remembered more from the classroom than they did from the lab; 83 percent of the students felt this way in the current study and 61 percent felt this way in the Leitner and Ingebo study.

The nine students who were present for the group interview in the current study were split on the question of whether or not the lab helped them learn. Four students said it did, four said it did not, and one was not sure. The students who said that the lab did help them learn were some of the more mature students in the class, and they indicated that the variety of materials helped. Those that said the lab did not help them learn cited the lab as being boring, and not supporting the same things they were doing in their mathematics books.

Teacher Perceptions of Learning:

Teachers felt that the multi-media lab helped students learn. On the teacher survey 71 percent of the participants responded positively to the item concerning the effect of the lab on student achievement. The average teacher response was also in the positive (5.3 on the 7.0 point scale). When asked, in the focused interview, whether or not the lab had affected student achievement most teachers were hesitant to draw a specific relationship between the two because it was the first year of the PLC lab, students were not in the lab often enough, and there was little problem solving courseware in the lab. Teachers did agree, however, that the lab reinforced and reviewed concepts and computation processes that were on the achievement test and in the grade level curriculum. Several teachers used the phrase "students were exposed to the concepts" when referring to the lab.

Student Attitude:

The fifth grade students involved in this case study, generally, had a positive attitude toward the PLC multi-media lab. Sixty-seven percent of the students responded that they like the lab better than class when asked on the student survey. The students' average response was positive on all items on the survey that dealt with lab media, except for a slightly negative average response to the Tape Player (TP) (2.4 on a 5.0 scale). The students were especially positive about the computer itself, with 92 percent claiming it as their favorite station, 67 percent responding that they learn the most from the computer, and 50 percent saying that the computer helped them remember the best. Students also felt slightly more positive about feedback to both correct and incorrect answers on the computer than they did to feedback on paper. All of these findings are consistent with the findings of Leitner and Ingebo (1984) in a similar study of PLC labs.

Students were very consistent about ranking paper-and-pencil type work lower than Dukane and computer work; the latter two require little or no paper-and-pencil work. Sixty-seven percent of the students responded that they liked the lab better than class. This finding is consistent with that of Leitner and Ingebo (1984), who reported that 73 percent of the student subjects liked the lab better than class. This, too, may have something to do with students' attitudes toward paperwork. In the regular classroom writing is an operation that students are constantly doing in order to allow the teacher to evaluate the students' knowledge of subject matter. In both the current study and the study conducted by Leitner and Ingebo findings indicated that students liked the lab better than the classroom, but students also felt that they learned more in the classroom setting. Why this difference exists is not clear, but it may have more to do with the difference in the amount of time spent in these two locales than anything else. Students spend more time in the regular classroom setting, studying a variety of subjects, so they remember more from that setting than they do from the lab where they spend a limited amount of time studying mathematics only

When interviewed about what they like about the lab it was clear that the lack of paperwork and the lack of homework were two strong associations that made the lab appealing to the students. In fact, some students equated "working" with "writing." It seems that the paperwork issue was a plus for the computer lab, in the students' eyes. What may be as important is the question of whether the paperwork issue is a minus for the regular classroom. It certainly seems important that teachers be concerned with not alienating students to the art of written expression.

When interviewed about what they didn't like about the lab, the students responded with workbooks, Teacher Directed Activity (TDA), and Tape Player (TP). Some said that the TP and TDA were "okay." Most agreed that the Dukane station was "okay." When the survey data is consulted, it is obvious that there is not a strong dislike of the non-computer stations, overall. The students reacted positively to having other media, besides the computer, in the lab.

Though the difference was statistically not significant, the students reacted to feedback from the computer, whether feedback to correct or incorrect answers, slightly more positively than feedback on paper. It may be that the dehumanizing affect of computers resulted in students being aware that it was their work, and not their whole being, that the feedback was targeted at. Also, the computer gave feedback for every single problem that the student worked, while feedback on paper is usually more general. Given the computer generated feedback it may be easier for students to learn from both their mistakes and their correct actions. The computer was the only machine in the lab capable of giving feedback.

All of the students interviewed agreed that the computer was their favorite station. They indicated that they liked working with the computer in itself, and they enjoyed it when they were sometimes given educational computer games to play if they finished their work early. When asked for adjectives that described the lab the students presented a mixed bag: fun, kind of fun, boring, sorry, easy, hard. The students who participated in the group interview were also split 5-4 on which was more interesting lab, or class, respectively.

These students did have at least one computer in their classroom for the majority of the year, and they responded slightly more positively toward having computers in the classroom than having them in the lab. It is interesting that they responded in the way they did to these items when it is taken into consideration that the students responded negatively to working in pairs on the computer when asked about that in the interview, and they usually did not work on the computer alone in the classroom. Also, the students reacted negatively to spending a short time on the computer, but in the classroom their time on the computer was much shorter than the time they spent on the computer in the lab. Their responses may have to do with the feeling of availability the students had when the computer was in the classroom. It is also a possibility that the students felt more positive about the kinds of software that were used in the classroom: drill in game format, educational simulation games, and LOGO programming.

The students' attitudes toward mathematics may have pulled some of the other responses up from the "neutral" position on the scale (Figure One, p. 43), but their attitudes toward mathematics were not extreme and probably did not distort the overall picture. Indeed, it is remarkable that the students ranked the paper-and-pencil items so low, when their attitude toward mathematics was quite high, since they do mathematics in the paper-and-pencil mode the majority of the time. Had students with less positive attitudes toward mathematics been surveyed the full scale may have shifted slightly toward the negative. Indications from research are that attitudes do not transfer readily (Aikens, 1976; Swadener, 1984; Sigurdson & Olson, 1983; Kulik, 1985), hence the positive attitudes toward mathematics probably did not affect the full scale much, if at all.

When teachers were asked, in their interviews, about how they perceived students' attitudes there was a unanimous agreement that the students felt positive and excited about having and using the lab. The primary teachers noted that the students felt that using the lab was a type of reward. Several teachers remarked about how they were not allowed to forget their computer class time, because the students were constantly reminding them. One upper elementary teacher who did not feel so positive about the lab himself/herself, and noted that the students did not feel positive about all of the stations, remarked, "I've never heard a child say 'I don't want to work on the computer'."

Teacher Attitudes:

On the average, teacher attitudes toward the PLC multimedia lab were positive. The only item that teachers, as a full sample, rated on the negative end of the scale was the expense of the lab. Research shows that teachers perceive all media that is any more "high tech" than a ditto machine as expensive (Elliot, Ingersoll, & Smith, 1984), and, furthermore, this lab was a substantial investment. The remainder of the survey indicates that teachers felt the lab was worth its expense; they rated it as useful, effective, important, productive, efficient, valuable, helpful in increasing achievement, supportive of the curriculum, and an appropriate use of computers.

The fact that the full sample rated the lab as neutral on the time saving - time consuming item does not seem consistent with the positive rating teachers gave the lab for efficiency. However, "efficient" means "productive without waste," and this rating is consistent with the positive rating teachers gave the lab for being productive. The fact that teachers felt neutral about the amount of time saved or time consumed by the lab is realistic; it is time neither saved nor lost, but simply time spent. Some teachers thought it was time well spent, others did not.

The fairly low rating given to the lab's quality of being either complicated or simple can be explained by the generalization that the lab is fairly complicated, and it gets more complicated as the classes using it get bigger. In the interview with the lab teacher, (s)he stated that the lab was a complicated place, and that (s)he worked overtime organizing so that it would be as simple for students as possible. There are diskettes, diskette boxes, folders, nonconsumable workbooks, answer keys, tapes, filmstrips, and schedules to keep in order. Up to ten minutes per period may be wasted in organizational time, depending on how well the students involved know the system and operate within it.

Another area that was not ranked very highly by the full sample was the quality of the lab as either limiting or expanding. Though the lab does use computers, they are used in a fairly simple instructional format. In interviews teachers repeatedly stated that the lab provided good reinforcement and review, but especially review. Review, as defined by these teachers, was practice on concepts and computations that had been covered in the classroom in the "distant" past. Reinforcement was viewed by these teachers as practice on concepts and computations that were covered in the classroom more recently. The fact that the lab was seen as a skills review session by teachers helps to explain the high rating given to "supports math curriculum, and the moderate rating given to the expanding capacity of the lab.

The moderate rating the PLC multi-media lab at this school received for teachers' familiarity with it can best be explained by looking at the difference in attitude between those who had used computers before being involved with the PLC lab (users) and those who had not used computers before being involved with the PLC lab (nonusers). Computer users felt much more familiar with the lab than did nonusers. In fact, most of the differences that are significant between the computer users and non-users would be expected. Computer users felt the lab was not only more familiar, but more valuable, more easygoing, and more clear. These ratings reflect the users' knowledge and comfort with computers, since most teachers and students in the school do refer to the multi-media lab as "the computer lab." Many of the teachers who had used computers before being involved in the lab probably used those computers in their classrooms, where management can be a problem when there are 15 to 25 students and one computer; therefore, the higher rating for the appropriateness of the computers in a lab setting by computer users.

It is interesting to note that computer users felt that the lab was more a frill than did nonusers. Being that computers were less a mystique to the users, it may be that they did not feel it was as essential that the students use computers. Meanwhile those who had not used computers before may have felt that students needed to learn to use computers in order to function in the society of the future. This attitude, that the multi-media lab's value was in the fact that it exposed these low socio-economic-status students to modern technology, was prevalent in teachers' responses to interview questions. In fact, every teacher interviewed mentioned the importance of teaching this particular group of students how to use computers, when discussing the strengths of the lab.

Users also felt that the lab was more complicated than did nonusers. This probably has little to do with computers themselves. It has been noted that the lab is a fairly complicated place because of all of the courseware, etc. that must be organized. Computer users, seeing this as a "computer lab," may have seen the situation as more complicated than their past experience with computers. This view probably did not take into account the other media and the use of the lab by 700 students.

While there was surprisingly little difference in attitudes between computer users and nonusers, there was a great difference in attitudes between the teachers at the different grade levels. The reasons for these differences, though, may not be as opaque as they seem. The primary grades (first through third) used the computers in the lab more than they used the other media, and first grade used the computers exclusively. Primary grades also used motivating software that included drill-and-practice in gaming situations with graphics, bells, buzzers, and music. Grades one through three also used the lab one class at a time. Meanwhile, the intermediate grade (fourth through sixth) classes were doubled up, using what several teachers referred to as "cut and dried" software, and using all of the media in the lab including an overcrowded situation of sometimes as many as ten students at the TDA stations. These conditions are probably reflected in the difference in teacher attitudes per grade level, and the marked difference between the primary and upper intermediate grades.

Some of the differences may have to do with the number of computer users and nonusers on that grade level (Appendix K). In the primary grades the numbers are fairly even, in fourth grade there is a strong majority of computer users, and in the fifth and sixth grades there is a majority of nonusers. In the primary grades it is doubtful that use or nonuse had anything to do with the high ratings, as mentioned above this probably had more to do with the lab conditions. Since users seemed to rate the lab higher than nonusers, the high number of users at fourth grade may account for ratings that are quite consistent with the full sample average. Fourth grade teachers did rate the items that were characteristically high for users (familiar, valuable, easygoing, clear, and appropriate) consistently high.

The low ratings given by teachers of grades five and six were probably due to a combination of factors. One of the factors contributing to these low ratings may appear to be the large percentage of nonusers on these two grade levels (Appendix K); however, the characteristic signs of an influence by the user/ onuser effect were not rated consistently low by the fifth or sixth grade teachers. It is most likely, then, that these teachers's relative nonuse of computers was not a strong factor in deciding the low ratings they gave the lab. The deciding factors for these low ratings must lie elsewhere.

One of the lower ratings for both fifth and sixth grades was the "boring" rating, whereas the teachers in grades one through four rated this toward the "interesting" end of the scale. As evidenced by teacher interviews, there is little doubt that this is a reflection of the courseware, and specifically the software being used on the computers. Also, when interviewi g these upper elementary teachers it became clear that there was a strong feeling that the students were not placed properly on the skills continuum. These teachers did not realize at the time that the Plasment Test placed students six months to a year behind their actual grade equivalency scores. Especially in fifth grade, where teachers are encouraged to complete a majority of their curriculum by February, when the Texas Educational Assessment of Minimum Skills (TEAMS) test is conducted, there was dissatisfaction with the infrequency of prescription updates. Many of these students did not receive a prescription update until March of 1986, meaning that they spend over half of the school year on skills that they had tested six months to a year above on the continuum. Thus, it would seem that the lack of motivating software, review level placement on the original prescription, and infrequent prescription updates were the deciding factors in the fifth and sixth grade level teachers' rating the lab low relative to ratings given by teachers at other grade levels.

One criticism of the lab that was not reflected in the survey, but came out in an interview, was the lack of nonlinguistic or non-English materials. The school this PLC multi-media lab is housed in has a fairly large bilingual Spanish-English and mono-lingual Spanish speaking student population. All of the tutorial computer software is in English, and involves quite a bit of reading. The drill-and-practice software also involves a good deal of reading just to follow directions. This is a hindrance for non-English speakers and poor readers alike. Either a teacher or another student must read aloud to these children. If another student does this it is a waste of that student's instruction time. If a teacher does this, especially in the double classes, the classroom is lacking TDA stations and/or general management. In fact, this problem was one reason a student who was in the sample class for this study was not included in the actual sample; (s)he worked on materials below his/her mathematics level except when at TDA because his/her mathematics level was so far above his/her reading level that (s)he could not read the material on the correct mathematics skills levels.

Recommended Changes:

Some changes have already been made to the PLC multi-media lab at this school based on the experience of the first year of the program. The most significant change is that each grade level uses the lab one class at a time. This has helped make teachers more available to monitor the appropriateness of the courseware, and specifically software, that students are using, made the lab less crowded and complex, and allowed students to update their prescriptions, via a hands-on test, more often. In order to allow one class to use the lab at a time at all grade levels, the intermediate grade levels were cut from three lab classes a week to two.

Another change that has been implemented is the use of a Plasment 2 pretest that does not "top out" as low as the Plasment 1 test used previously. This provides more accurate original placement of students with advanced mathematics skills.

One change that will, hopefully, accompany the single class use of the lab is more teacher monitoring of student activities. When reviewing the 1985-86 students' prescriptions this researcher was left wondering what the students were doing with all of their time. The greatest number of tasks completed by any student was 0 in 70 sessions (see Table Two, p. 32, for a comparison of tasks completed per student). Either the students were not marking down all of the tasks that they had completed, or they were wasting time, and/or they needed more teacher supervision to help them check off completed tasks and stay on task. Of course, with the larger classes in the lab it was more difficult for teachers to monitor the students, more time was wasted on organizational "housekeeping," and the students may have been more distracted.

The major weakness that the lab still suffers from is that students prescriptions are not updated often enough. When interviewed, teachers who worked on grade levels that used prescriptions were adamant about this condition. Even with 15 students in the lab, one testing station can only update two prescriptions per week. That means it would take seven and one half weeks to update the prescriptions for one full class.

The strength that the PLC basic skills multi-media lab has as a place where mastery learning takes place is thwarted by the ineffectiveness of outdated prescriptions. The prescription is the key to the mastery learning element of the individual student moving at his/her own rate through a meaningful skills continuum. The skills continuum is not meaningful if the student is not accurately placed on that continuum. This is especially true when taking into account the fact that the Plasment 1 test automatically places the student six months to one year below grade level on the skills continuum. That means that the student spends up to seven and one half wee', on review materials. During the 1985-86 school year some students' prescriptions were not updated until early March. These students spend over half of the year on review materials.

With third and fifth grade teachers being pressured to teach the curriculum that is tested on the TEAMS test before February, and all teachers pressured to teach their curriculum before the ITBS test in April, it is no wonder that many teachers felt only neutral or worse about the time spent in the lab. If another testing station were purchased, then the time it takes to cycle a class through the prescription updating process would be cut in half. The lab would then serve more as a reinforcement of, and introduction to, concepts rather than functioning as a review of concepts. Especially with the attitudes of the upper elementary teachers taken into account, this would be a worthwhile investment, and a welcome change. Upper elementary teachers are under some pressure to prepare students for the rigors of junior high school. There is a need to send the students to junior high with a thorough mastery of basic mathematics skills. Ideally, the PLC program can help to meet this need, but not if prescriptions do not keep up with actual student skills.

Another area in which the results of this study indicates changes are needed is that of providing motivating software for the upper elementary grades, and more variety of software for all grades. Data from teacher interviews and surveys indicates that the primary teachers have a better attitude about the lab, at least in part, because of the motivating software available to the students, while upper elementary teachers felt that the software available to their students was "cut and dried." The multi-media lab can be an enriching, expanding, and challenging place for students beyond the use of the media and including the use of pertinent courseware. A large variety of courseware is available at moderate expense through computer consortiums and public domain software. Perhaps more stimulating courseware for the non-computer media can be obtained also. Finding these resources, and identifying ways to purchase this courseware, may be an appropriate activity for a committee made up of representatives from each grade level. Representatives with interests in bilingual education should also be represented, as this is a concern of the school's community. This committee should seek not only more motivating, enriching, and varying software at each grade level, but also software that is not language dependent for non-English speakers and low reading skills students.

Another task the faculty and administration of this school may need to approach is that of writing some alternative plans for use of the lab should class size at this school increase. If part of the problems the lab has suffered from in the past were due to the crowded conditions in the actual room, then these conditions may return with an increase in class size. Plans might include expanding the physical size of the lab, adding more equipment (and especially computers), serving only Chapter 1 students, serving each class in shifts, and reducing the amount of time spent in the lab.

Breaking the lab down into individual media to be used in the classrooms would not seem a wise or popular alternative, since teachers agree that the lab is an appropriate setting (Appendix M), this would be a waste of the time spent getting the lab to work smoothly, and it would not lend itself to appropriate use of the mastery learning/prescription concept or the use of the courseware. Becker's (1984) research supports the lab approach that this school has taken, concluding that labs provide more consistent computer use, more hours per week student use, and a higher percentage of total school population use. Becker (1984) also found that the lab setting fostered better student attitudes toward the computer.

Finally, the faculty and administration at this school may want to review their objectives for this lab. It appears that the original objectives were worthy ones. The lab does seem to be a good investment of time and money. The lab does seem to increase mathematics achievement, and/or support the grade level curricula. Part of the complexity of using the lab has been the fact that it has been used to serve all 700 of the students in the school, but it seems that this was a good choice, since students are excited about the lab and teachers recognize its value at some level (i.e., at least it is valued for student exposure to modern technology). However, this researcher postulates that it is not enough to value the lab for "high tech's" sake. It is not enough that the students simply work <u>on</u> computers doing the same things they do anyway. What unique use can these computers be put to? Would it be worthwhile to network the computers in the lab so that one teacher could monitor and direct all of the students working on the computers from that teacher's own computer station? Should the school emphasize reading as well as the mathematics curriculum? How can the computers be used to strengthen students' higher level thinking skills, rather than just drilling facts? Are the media in the lab being utilized to support students' learning modality strengths in the most efficient manner? These are some questions that need to be asked, and the answers need to be explored. This is not to say that the computers should be disregarded as a different mode for learning mathematics, but that the computers could also be used to meet other individual learning needs.

It seems that the faculty and students of this school feel good, in general, about the multi-media lab that they use. When purchasing such labs, as more and more schools in the United States are doing (Becker, 1984; Becker, 1986), schools must look at the costs and benefits of the sv tem thay are purchasing. Clearly, the school this study has focused on received a worthy dose of benefits for the $61,492 cost of this lab. What this school did not get for its investment was a system that uses the management capabilities of the computer; in the PLC lab management is computer-aided but driven by the lab and classroom teachers. However, in order to purchase a minicomputer capable of management a lab similar to the

World Institute of Computer Assisted Teaching's (WICAT) $120,000 system would be required (Stoneberg, 1985). It is not clear that the difference in cost between these two systems would result in a difference in benefits. Leitner et al.'s studies (Leitner, 1982; Leitner & Ingebo, 1984) of the less expensive PLC labs found achievement and attitude gains that are comparable with Stoneberg's (1985) findings in his study of the more expensive WICAT system. Furthermore, the research on CAI is not clear on the effects, on attitude or achievement, of a system that combines CAI and computer managed instruction (CMI) in the elementary school setting (Kulik, 1985). As schools look toward purchasing these labs they must compare the costs and benefits of each lab with the goals and objectives of the schools' programs.

In conclusion, it appears, at least for one class, that the lab has had a positive effect on mathematics achievement. Both teachers and students recognize that the lab helps the students learn. Teachers, generally, feel good about the lab, as do students. A questio was posed at the beginning of this report, "With respect to compute in a multi media setting, where are we now, and where are we going?" N. the lab at this school seems to be a successful educational endeavor ι s positive effects on both attitude and achievement. Where the school is going with the PLC program can only be determined by the teachers and administrators of the school. This report has recommended some changes that could be made to the multi-media lab, in order to keep up with the changing needs of teachers and students. The types of changes that are made in the objectives, equipment, and use of the PLC multi-media lab will set the stage for the accomplishment of future goals; thus defining where we are going.

A foundation has been laid for further study of this lab, and others like it. The survey-interview format has been successful in identifying appropriate changes in the lab. Any future studies should, ideally, be scientifically controlled studies using a pretest-posttest control group design. Student and teacher surveys should be included both before and after the experiment conducted in such studies. The existing Plasment tests should be checked for reliability and validity, then, if they are reliable and valid, they should be used as the pretests and posttests for scientifically controlled studies. Finally, the control group should use a mode of instruction that is similar to the PLC lab in instructional design, and both the control and experimental groups should receive supplemental mathematics instruction in future studies.

APPENDICES

APPENDIX A:

APPROVAL FORM FOR STUDENT PARTICIPANTS

Dear Parent:

Hello! I'm glad to see (student name) back at ( ) School this year. I would like to meet with all of the students who were in my room last year this Wednesday after school. Miss ( ) and I will be doing a survey and asking the students some questions about how they like learning in the school's computer lab. We are administering this survey as a part of one of my requirements for a Master's degree in education at The University of Texas. We should be through with the survey by 3:30 on Wednesday.

Please return this to Mr. ( ) by Wednesday, 9/24.

Yes, my child ______________________________ has my permission to participate in the ( ) School computer lab survey and interview.

signed ____

APPENDIX B:

PLC LAB PURCHASED EQUIPMENT AND SERVICES

Equipment:

Quantity	Description
15	Commodore 1702 Color Monitor
15	Apple II Computer
15	Apple Disk II with controller
1	Apple Disk II drive only
2	Apple Imagewriter printer
1	10 megabyte Profile hard disk
5	Voice device
4	Dukane with headset
1	Tape recorder
2	Tape player
20	Study carrel
13	Study carrel shelf
2	Computer desk
2	Computer desk shelf
2	Study table
22	Multi-outlet box
X	Filmstrip-tape courseware
X	Tape-workbook courseware
X	Workbooks
X	Self-check skills kits
X	PLC software
X	Brand-name support software

Services:

Delivery and installation of all hardware, software, and furniture.
Initial inservice of multi-media lab teacher and significant others.
Diagnostic instruments and scoring services.
90 day warranty on all hardware.
Consultant services twice monthly, for one year.
Invitations for three to two area PLC workshops.

X = actual number of items unavailable.

APPENDIX C:

EXAMPLE MATH PRESCRIPTION

Date: 00/00/00
Student Name: X XX
Student Number: 0000
Alternate ID: Teacher Name
Grade: 05
Group/Period: 00
Continuum Level: 1

VENDOR	DESCRIPTION	DATE COMPLETED
Skill Area: 2307 - Concept and Basic Facts - Subtraction		
CLAS II	SUBTRACTION LESSON S1	
CLAS II	SUBTRACTION LESSON S2	
SRA COMPUTAPES	MODULES 1-2; AS-10;11;12	
SRA COMPUTAPES	MODULES 1-2; AS-13-17;28;29	
MISSION MATH	SUBTRACTION WRKSHTS 1-4; TAPE 1	
MISSION MATH	SUBTRACTION WRKSHTS 5-8; TAPE 2	
MISSION MATH	SUBTRACTION WRKSHTS 22-24; TAPE 6	
TIME ON MATH	BOOK 3; PP.5;6;7;8;9;10;13	
ORBIT II	SUBTRACTION LESSON 1	
Skill Area: 2313 - Subtraction - No Regrouping		
S.V.E. MATH	A520-2 WB PP. 5;6/A520-8 WB PP.17	
CLAS II	SUBTRACTION LESSON S3	
SRA COMPUTAPES	MODULES 1-2; AS-18;19;20;32;35	
SVE MATH	SUBTRACTION A520-2; A520-8	
MISSION MATH	SUBTRACTION WRKSHTS 9-12; TAPE 3	
TIME ON MATH	BOOK 3; PP.11;19;14	
ORBIT II	SUBTRACTION LESSON 2	
Skill Ara: 2218 - Addition - With Regrouping		
S.V.E. MATH	A520-3 WB PP.7;8/A520-8 WB PP.11;12	
S.V.E. MATH	A520-9 WB PP.19;20/A520-11 WB P.23	
CLAS II	ADDITION LESSON A5	
CLAS II	ADDITION LESSON A6	
SRA COMPUTAPES	MODULES 1-2; AS-4: AS-9	
SRA COMPUTAPES	MODULES 1-2; AS-21-26;30;31	
SVE MATH	ADDITION A520-3; A520-5	
SVE MATH	ADDITION A520-9; A520-11	
SVE MATH	WORD PROBLEMS 580-1; 580-2	
MISSION MATH	ADDITION WRKSHTS 13-16; TAPE 4	
TIME ON MATH	BOOK 2; PP.14;15;16;17;18-20	
ORBIT II	ADDITION LESSON 3	
Skill Area: 2318 - Subtraction - With Regrouping		
S.V.E. MATH	A520-4 WB PP.9;10/A520-6 WB PP.11	
CLAS II	SUBTRACTION LESSON S4	
SRA COMPUTAPES	MODULES 1-2; AS-33; AS-34	
MISSION MATH	SUBTRACTION WRKSHTS 13-16; TAPE 4	
TIME ON MATH	BOOK 3; PP.15;16;17-19;20-30;31-35	
ORBIT II	SUBTRACTION LESSON 3	

APPENDIX D:

INSTRUCTIONS TO STUDENTS ON COMPLETION OF THE SURVEY AND INTERVIEW

1. Purpose: I am workin~ on my Master's Degree at U.T. I am doing this as a part of a class I am taking. I also want to know how you like the computer lab and whether or not you think that the lab is a good way to learn math.

2. Directions: (Hand out the form) Do not put your name on it. It will not be graded. I do not want you to worry about me evaluating what you think. I will not know who filled out which survey. You are not grading me or the computer lab teacher. You are telling how you feel about some of the things you do in the lab.

[GRAPHICS ON BOARD]

The sad face stands for negative, or bad, feelings that you have about something and disliking it a lot. The frowning face stands for something that you don't feel real bad about, but you feel a little bad about it, and you dislike it. The straight face means you don't like that thing, but you don't dislike it either. You feel so-so about it. The smiling face stands for something you feel pretty good about and you like okay. The happy face stands for feeling really great and liking something a lot.

[WORDS "FEEDBACK" AND "PAPER WORK" ON BOARD]

Does anyone know what the word "feedback" means? Feedback is the response, or answer, you get when you do something. When the computer tells you that you've done a problem right or wrong, that's feedback. When a teacher writes on your paper or tells you how you've done on your work, that too is feedback.

Does anyone know what the words "paper work" mean? Paper work is work that you do on a piece of paper. Anything that you do by writing on paper is paper work.

3. Questions? Fill out survey.

4. Interview:

- What do you like about the lab?
- What do you dislike about the lab?
- What are some adjectives that would describe the lab?
- What is the best thing about the lab? What is the worst?
- Does the lab help you to learn math?
- Which do you like better -- the lab or the classroom?

APPENDIX E:

STUDENT ATTITUDE SURVEY FORM

Read each statement about the Computer Lab at (   ) School. Circle the face that shows what you feel.

1. LEARNING MATH ON A COMPUTER ....
2. MULTIPLICATION ON A COMPUTER ....
3. AODITION ON PAPER ....
4. FEEOBACK TO WRONG ANSWERS ON PAPER WORK ....
5. BEING TAUGHT BY A COMPUTER ....
6. SUBTRACTION ON PAPER ....
7. LEARNING MATH ON A OUKANE ....
8. FEEOBACK TO RIGHT ANSWERS ON A COMPUTER ....
9. HAVING COMPUTERS IN THE LAB ....
10. LEARNING MATH ON A TAPE PLAYER ....
11. AODITION ON A COMPUTER ....
12. LEARNING MATH WITH A TEACHER ....
13. LONG TIME ON A COMPUTER ....
14. SUBTRACTION ON A COMPUTER ....
15. FEEOBACK TO RIGHT ANSWERS ON PAPER WORK ....
16. LEARNING MATH IN A WORKBOOK ....
17. FEEOBACK TO WRONG ANSWERS ON A COMPUTER ....
18. HAVING COMPUTERS IN YOUR CLASSROOM ....
19. SHORT TIME ON THE COMPUTER ....
20. HAVING MORE THAN JUST COMPUTERS IN THE LAB ....
21. LEARNING MATH ....

<u>Circle the best answer:</u>

22. Which lab station do you like the most? TP TOA OUKANE COMPUTER SW
23. Which station helps you learn the most? TOA SW COMPUTER TP OUKANE
24. Which station helps you remember best? SW TP TOA OUKANE COMPUTER
25. Oo you like lab better than class? YES NO
26. Ooes the lab make math work easier? NO YES
27. Do you remember more from the lab or class? LAB CLASS

APPENDIX F:

TEACHER ATTITUDE SURVEY FORM

TEACHERS: Please respond to the following statement by circling a number on the scale closest to the word describing your thoughts. This survey is being administered as a part of a Master's Degree requirement. It is also an opportunity for you to give some feedback about the lab. Please return it to ( )'s box when finished. Thank you.

Which of the words below best describe ( ) School's Prescription Learning computer lab from 9/85 - 9/86 from the teacher's perspective (not the student's)?

1.	ESSENTIAL	1	2	3	4	5	6	7	FRILL
2.	FAMILIAR	1	2	3	4	5	6	7	UNKNOWN
3.	USELESS	1	2	3	4	5	6	7	USEFUL
4.	WISE	1	2	3	4	5	6	7	FOOLISH
5.	INEFFECTIVE	1	2	3	4	5	6	7	EFFECTIVE
6.	BORING	1	2	3	4	5	6	7	INTERESTING
7.	TIME SAVING	1	2	3	4	5	6	7	TIME CONSUMING
8.	IMPORTANT	1	2	3	4	5	6	7	UNIMPORTAN
9.	FRUSTRATING	1	2	3	4	5	6	7	TEASYGOING
10.	NECESSARY	1	2	3	4	5	6	7	UNNECESSARY
11.	UNPRODUCTIVE	1	2	3	4	5	6	7	PRODUCTIVE
12.	SIMPLE	1	2	3	4	5	6	7	COMPLICATED
13.	EXPENSIVE	1	2	3	4	5	6	7	REASONABLE
14.	INEFFICIENT	1	2	3	4	5	6	7	EFFICIENT
15.	EXPANDING	1	2	3	4	5		7	LIMITING
16.	UNDERSTANDABLE	1	2	3	4	5	6	7	PUZZLING
17.	WORTHLESS	1	2	3	4	5	6	7	VALUABLE
18.	CONFUSING	1	2	3	4	5	6	7	CLEAR
19.	INCREASES ACHIEVEMENT	1	2	3	4	5	6	7	DECREASES ACHIEVEMENT
20.	SUPPORTS MATH CURRICULUM	1	2	3	4	5	6	7	CONFUSES MATH CURRICULUM
21.	INAPPROPRIATE USE OF COMPUTERS	1	2	3	4	5	6	7	APPROPRIATE USE OF COMPUTERS

HAD YOU USED COMPUTERS WITH STUDENTS BEFORE 9/85? YES NO

YOUR GRADE LEVEL? ______________________

APPENDIX G:

TEACHERS' FOCUSED INTERVIEW QUESTIONS

1. Questions for the lab teacher:

What do you feel are the strengths of the multi-media lab?

What do you feel are the weaknesses of the lab?

Do you feel that is effective?

What is your perception of teacher attitudes toward the lab?

What is your perception of student attitudes toward the lab?

If there were one thing you could to to improve the lab, what would you do?

What is the process of testing to get proper prescriptions?

What helps to keep students moving along smoothly on their prescriptions?

What hinders movement on prescriptions?

How do the various grade levels use the lab differently?

Do you feel that the machines help or hinder achievement?

How would you describe your job?

2. Questions for grade level teachers:

What are the strengths of the multi-media lab?

What do you feel are the weaknesses of the multi-media lab?

What could we do to improve the lab?

Do you think it is worth the time and effort that your students spend there?

Does the lab support your grade level curriculum?

What is your perception of student attitudes about the lab?

Do you think that the lab effects student achievement based on your view of 85-86 test scores compared with 84-85 test scores?

Do you feel that you know enough about the lab?

APPENDIX H:

STUDENTS' MATHEMATICS ACHIEVEMENT SCORES: ITBS PERCENTILES AND GRADE EQUIVALENCIES

		1984-85 ITBS				1985-86 ITBS				CHANGE FROM 84-85 TO 85-86			
STUDENT #		MATH CONCEPTS	SOLVING PROBLEMS	MATH COMPUTATION	MATH TOTAL	MATH CONCEPTS	SOLVING PROBLEMS	MATH COMPUTATION	MATH TOTAL	MATH CONCEPTS	SOLVING PROBLEMS	MATH COMPUTATION	MATH TOTAL
1	%*	54	84	94	80	86	79	76	82	+32	-5	-18	+2
	G.E.+	5.0	6.1	6.3	5.8	7.7	7.0	6.6	7.1	+2.7	+.9	+.3	+1.3
2	%	52	39	04	31	22	08	63	23	-30	-31	+59	-8
	G.E.	4.9	4.4	3.2	4.2	4.7	3.5	6.2	4.8	-.2	-.9	+3.0	+.6
3	%	24	06	14	11	52	33	41	42	+28	+27	+27	+31
	G.E.	3.9	2.7	3.8	3.5	5.9	5.1	5.6	5.5	+2.0	+1.4	+1.8	+2.0
4	%	32	12	22	19	22	29	52	34	-10	+17	+30	+15
	G.E.	4.2	3.1	4.1	3.8	4.7	4.9	5.9	5.2	+.5	+1.8	+1.8	+1.4
5	%	69	84	72	77	86	89	56	82	+17	+05	-16	+05
	G.E.	5.6	6.1	5.3	5.7	7.7	7.6	6.0	7.1	+2.1	+1.5	+.7	+1.4
6	%	12	01	19	04	31	22	52	34	+19	+21	+33	+30
	G.E.	3.4	1.8	4.0	3.1	5.1	4.5	5.9	5.2	+1.7	+2.7	+1.9	+2.1
7	%	54	55	84	63	65	52	70	63	+11	-3	-14	+/-0
	G.E.	5.0	5.0	5.7	5.2	6.5	5.9	6.4	6.3	+1.5	+.9	+.7	+1.1
8	%	32	41	28	34	52	42	34	45	+30	+01	+06	+11
	G.E.	4.2	4.5	4.3	4.3	5.9	5.5	5.4	5.6	+1.7	+1.0	+1.1	+1.3
9	%	91	69	44	77	83	58	82	76	-08	-11	+28	-01
	G.E.	6.9	5.5	4.7	5.7	7.5	6.1	6.8	6.8	+.6	+.6	+2.1	+1.1
10	%	32	33	32	34	60	33	56	50	+28	+/-0	+24	+16
	G.E.	4.2	4.2	4.4	4.3	6.3	5.1	6.0	5.8	+2.1	+.9	+1.6	+1.5
11	%	43	29	14	28	73	72	82	76	+30	+43	+58	+48
	G.E.	4.6	4.0	3.8	4.1	6.9	6.7	6.8	6.8	+2.3	+2.7	+3.0	+2.7

* % = Percentile

+ G.E. = Grade Equivalent

APPENDIX I:

STUDENT ATTITUDE SURVEY RESULTS:

A SUMMARY OF RESPONSES PER DESCRIPTOR AND PER ITEM

ITEM #*		DISLIKE A LOT	DISLIKE	NEUTRAL	LIKE	LIKE A LOT
1		8%$^{+}$(1)	8%(1)	0	50%(6)	33%(4)
2		17%(2)	0	33%(4)	25%(3)	25%(3)
3		25%(3)	33%(4)	17%(2)	25%(3)	0
4		25%(3)	25%(3)	25%(3)	25%(3)	0
5		17%(2)	0	17%(2)	42%(5)	25%(3)
6		33%(4)	17%(2)	17%(2)	33%(4)	0
7		0	25%(3)	17%(2)	33%(4)	25%(3)
8		0	0	25%(3)	25%(3)	50%(6)
9		0	0	8%(1)	33%(4)	58%(7)
10$^{\pm}$		36%(4)	27%(3)	9%(1)	18%(2)	9%(1)
11		17%(2)	8%(1)	8%(1)	25%(3)	42%(5)
12		17%(2)	17%(2)	8%(1)	33%(4)	25%(4)
13		17%(2)	0	0	17%(2)	66%(8)
14		25%(3)	0	25%(3)	48%(5)	8%(1)
15		8%(1)	8%(1)	33%(4)	0	50%(6)
16		17%(2)	8%(1)	50%(6)	25%(3)	0
17		33%(4)	0	42%(5)	17%(2)	8%(1)
18		0	0	8%(1)	17%(2)	75%(9)
19		67%(8)	25%(3)	8%(1)	0	0
20		25%(3)	8%(1)	25%(3)	17%(2)	25%(3)
21		17%(2)	0	8%(1)	25%(3)	50%(6)
		COMPUTER	DUKANE	SW	TDA	TP
22	?	92%(11)			8%(1)	
23	?	67%(8)	8%(1)		25%(3)	
24	?	50%(6)	8%(1)		33%(4)	8%(1)
		YES	NO			
25	?	67%(8)	33%(4)			
26	?	83%(10)	17%(2)			
		LAB	CLASS			
27	?	17%(2)	83%(10)			

* Item numbers correspond to descriptors in Appendix E.

+ Percentage is rounded off to the nearest whole number. The total per item does not always equal 100.

± N = 12 for all items, but for item number 10 N = 11.

APPENDIX J:

TEACHER ATTITUDE SURVEY RESULTS:

A SUMMARY OF RESPONSES PER DESCRIPTOR AND PER ITEM

#		1	2	3	4	5	6	7	
1	FRILL	0	0	12%(3)	25%(6)	17%(4)	21%(5)	25%(6)	ESSENTIAL
2	UNKNOWN	8%*(2)	4%(1)	8%(2)	12%(3)	25%(6)	29%(7)	12%(3)	FAMILIAR
3	USELESS	0	0	4%(1)	4%(1)	17%(4)	25%(6)	50%(12)	USEFUL
4	FOOLISH	0	0	0	17%(4)	25%(6)	29%(7)	29%(7)	WISE
5	INEFFECTIVE	4%(1)	0	4%(1)	17%(4)	17%(4)	33%(8)	25%(6)	EFFECTIVE
6	BORING	4%(1)	4%(1)	8%(2)	8%(2)	12%(3)	29%(7)	33%(8)	INTERESTING
7	TIME CONSUMING	8%(2)	8%(2)	12%(3)	37%(9)	8%(2)	17%(4)	8%(2)	TIME SAVING
8	UNIMPORTANT	4%(1)	4%(1)	4%(1)	17%(4)	4%(1)	25%(6)	42%(10)	IMPORTANT
9	FRUSTRATING	0	4%(1)	0	25%(6)	12%(3)	33%(8)	25%(6)	EASY GOING
10	UNNECESSARY	4%(1)	4%(1)	8%(2)	25%(6)	8%(2)	17%(4)	33%(8)	NECESSARY
11	UNPRODUCTIVE	0	4%(1)	0	17%(4)	21%(5)	29%(7)	29%(7)	PRODUCTIVE
12	COMPLICATED	4%(1)	4%(1)	33%(8)	17%(4)	8%(2)	25%(6)	8%(2)	SIMPLE
13	EXPENSIVE	17%(4)	8%(2)	12%(3)	33%(8)	4%(1)	17%(4)	8%(2)	REASONABLE
14	INEFFICIENT	0	4%(1)	4%(1)	12%(3)	17%(4)	37%(9)	25%(6)	EFFICIENT
15	LIMITING	4%(1)	12%(3)	12%(3)	8%(2)	21%(5)	33%(8)	8%(2)	EXPANDING
16	PUZZLING	0	0	4%(1)	17%(4)	17%(4)	37%(9)	25%(6)	UNDERSTANDABLE
17	WORTHLESS	0	0	4%(1)	12%(3)	17%(4)	17%(4)	50%(12)	VALUABLE
18	CONFUSING	0	4%(1)	4%(1)	17%(4)	21%(5)	37%(9)	17%(4)	CLEAR
19	DECREASES ACHIEVEMENT	0	4%(1)	0	25%(6)	25%(6)	25%(6)	21%(4)	INCREASES ACHIEVEMENT
20	CONFUSES MATH CURRICULUM	0	4%(1)	4%(1)	12%(3)	21%(4)	25%(6)	37%(9)	SUPPORTS MATH CURRICULUM
21	INAPPROPRIATE USE OF COMPUTERS	0	0	4%(1)	8%(2)	8%(2)	21%(5)	58%(14)	APPROPRIATE USE OF COMPUTERS

* Percentage is rounded off to the nearest whole number. The total per item does not always equal 100.

N = 24.

APPENDIX K

TEACHERS' COMPUTER EXPERIENCE BY GRADE LEVEL

Grade Level:	N:	Computer Users:	Non-Users:
1	4	2	2
2	4	2	2
3	3	2	1
4	6	5	1
5	4	1	3
6	3	1	2
Totals:	24	13	11

APPENDIX L:

STUDENT ATTITUDE SURVEY RESULTS: MEAN RESPONSE PER ITEM

1 = dislike a lot, 2 = dislike, 3 = neutral feelings, 4 = like, 5 = like a lot

ITEM	MEAN*		
1.	3.9	LEARNING MATH ON A COMPUTER	1....2....3....4....5
2.	3.4	MULTIPLICATION ON A COMPUTER	1....2....3....4....5
3.	2.4	ADDITION ON PAPER	1....2....3....4....5
4.	2.5	FEEDBACK TO WRONG ANSWERS ON PAPER WORK	1....2....3....4....5
5.	3.6	BEING TAUGHT BY A COMPUTER	1....2....3....4....5
6.	2.5	SUBTRACTION ON PAPER	1....2....3....4....5
7.	3.6	LEARNING MATH ON A DUKANE	1....2....3....4....5
8.	4.3	FEEDBACK TO RIGHT ANSWERS ON A COMPUTER	1....2....3....4....5
9.	4.5	HAVINC COMPUTERS IN THE LAB	1....2....3....4....5
10.±	2.4	LEARNING MATH ON A TAPE PLAYER	1....2....3....4....5
11.	3.7	ADDITION ON A COMPUTER	1....2....3....4....5
12.	3.3	LEARNING MATH WITH A TEACHER	1....2....3....4....5
13.	4.2	LONG TIME ON A COMPUTER	1....2....3....4....5
14.	3.1	SUBTRACTION ON A COMPUTER	1....2....3....4....5
15.	3.8	FEEDBACK TO RIGHT ANSWERS ON PAPER WORK	1....2....3....4....5
16.	2.8	LEARNING MATH IN A WORKBOOK	1....2....3....4....5
17.	2.7	FEEDBACK TO WRONG ANSWERS ON A COMPUTER	1....2....3....4....5
18.	4.7	HAVING COMPUTERS IN YOUR CLASSROOM	1....2....3....4....5
19.	1.4	SHORT TIME ON THE COMPUTER	1....2....3....4....5
20.	3.1	HAVING MORE THAN JUST COMPUTERS IN THE LAB	1....2....3....4....5
21.	3.9	LEARNING MATH	1....2....3....4....5

* Numbers shown are mean averages rounded off to the nearest .1.

± N = 12 for all items, but for item number 10 N = 11.

APPENDIX M:

TEACHER ATTITUDE SURVEY RESULTS: MEAN RESPONSE PER ITEM

ITEM	MEAN*			
1.	5.2	FRILL	1....2....3....4....5....6....7	ESSENTIAL
2.	4.8	UNKNOWN	1....2....3....4....5....6....7	FAMILIAR
3.	6.1	USELESS	1....2....3....4....5....6....7	USEFUL
4.	5.7	FOOLISH	1....2....3....4....5....6....7	WISE
5.	5.4	INEFFECTIVE	1....2....3....4....5....6....7	EFFECTIVE
6.	5.4	BORING	1....2....3....4....5....6....7	INTERESTING
7.	4.1	TIME CONSUMING	1....2....3....4....5....6....7	TIME SAVING
8.	5.5	UNIMPORTANT	1....2....3....4....5....6....7	IMPORTANT
9.	5.5	FRUSTRATING	1....2....3....4....5....6....7	EASYGOING
10.	5.1	UNNECESSARY	1....2....3....4....5....6....7	NECESSARY
11.	5.6	UNPRODUCTIVE	1....2....3....4....5....6....7	PRODUCTIVE
12.	4.3	COMPLICATED	1....2....3....4....5....6....7	SIMPLE
13.	3.8	EXPENSIVE	1....2....3....4....5....6....7	REASONABLE
14.	5.5	INEFFICIENT	1....2....3....4....5....6....7	EFFICIENT
15.	4.6	LIMITING	1....2....3....4....5....6....7	EXPANDING
16.	5.6	PUZZLING	1....2....3....4....5....6....7	UNDERSTANDABLE
17.	6.0	WORTHLESS	1....2....3....4....5....6....7	VALUABLE
18.	5.3	CONFUSING	1....2....3....4....5....6....7	CLEAR
19.	5.3	DECREASES ACHIEVEMENT	1....2....3....4....5....6....7	INCREASES ACHIEVEMENT
20.	5.7	CONFUSES MATH CURRICULUM	1....2....3....4....5....6....7	SUPPORTS MATH CURRICULUM
21.	6.2	INAPPROPRIATE USE OF COMPUTERS	1....2....3....4....5....6....7	APPROPRIATE USE OF COMPUTERS

* Numbers are rounded off to the nearest .1.

N = 24.

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