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ABSTRACT

This paper summarizes the successes and failures of the Plato Elementary Reading Curriculum Project, a computer-assisted instructional system funded by the National Science Foundation from 1971 to 1976. The paper discusses what the project did, the types of hardware that were used, how lessons were designed, the two approaches that were taken toward managing the curriculum, implementation in the classroom, and general observations on the accomplishments of the project and on the role of the computer in beginning reading instruction. (Author/AA)

LESSONS LEARNED IN THE PLATO® ELEMENTARY READING CURRICULUM PROJECT

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ABSTRACT

This paper summarizes the successes and failures of the Plato Elementary Reading Curriculum Project which was funded by the National Science Foundation from 1971-1976. The conclusions are the personal reflections of the author, and are not necessarily shared by all members of the project staff. The paper covers six areas: (1) a description of what the project did; (2) details about the types of hardware that were used; (3) how lessons were designed; (4) the two approaches that were taken towards managing the curriculum; (5) how Plato was implemented in the classrooms; and (6) some general observations.

LESSONS LEARNED IN THE PLATO ELEMENTARY READING CURRICULUM PROJECT

From 1971 to 1976, the National Science Foundation funded several major curriculum projects at the University of Illinois; these projects attempted to demonstrate the uses of "Plato", the computer-assisted instruction (CAI) system developed at the university.

One of the projects was the Plato Elementary Reading Curriculum project (PERC) which attempted to develop a CAI curriculum in beginning reading. This paper reports on some of the successes and failures of that project. The discussion will cover six areas: (1) a description of what the project did; (2) details about the type of hardware that was used; (3) how lessons were designed; (4) the two approaches that were taken towards managing the curriculum; (5) how Plato was implemented in the classrooms; and, (6) some general observations.

The goal of the paper is to present some general "lessons" which were learned during the project. No claim is made that PERC discovered these "lessons", although a few of them undoubtedly will offend the conventional wisdom

about CAI. The "lessons" ought to be of interest primarily to curriculum designers working in the CAI area; but it is also hoped that reading specialists will profit by learning about a major attempt to bring CAI into the reading corner.

PERC's ambitions exceeded its abilities. The fact that it fell short in some areas is no embarrassment considering how much it did accomplish; and some of the failures reported here will not be failures if others learn from them. However, it should be stated that these are the personal reflections of the author who was associated with PERC throughout most of its existence as a programmer and lesson designer; others on the PERC staff may not agree with all of the conclusions made here.

I. A Description of What PERC Did

PERC developed between twenty and twenty-five hours of curriculum. Most of the curriculum can be classified as reading readiness materials appropriate for late kindergarten through mid-first grade.

In the first three years of the project, PERC concentrated on trying out lesson designs on a limited number of students; students were taken from their classrooms to a room with several terminals and were carefully observed as they worked through experimental lessons.

In the 1974-1975 school year, PERC made its first large scale implementation. Two terminals were placed in each of fifteen classrooms in Champaign and Urbana. Most of the classrooms were first grades, but there were also kindergartens, second grades, and remedial reading classrooms. All of the teachers who were given Plato had volunteered.

The 1975-1976 school year was the demonstration year during which Educational Testing Service formally evaluated PERC. For that year, PERC added another ten classrooms which were similiar to the ones selected the year before. In mid-year, PERC began working with children from a mental

health center; thus, language-delayed and emotionally disturbed students as old as ten began using the beginning reading curriculum.

Students normally received fifteen minute sessions; they usually worked on Plato three or four times a week. However, there are wide variations in the usage patterns. In a few classrooms, almost every student worked on Plato almost every day; in others, the terminals were virtually unused. Since the terminals were located in the classroom, it was the teacher's responsibility to see to it that all students were able to use Plato; the PERC staff encouraged teachers to use Plato as much as possible, but the teachers were completely free to set their own schedules.

II. Hardware

Plato offers the most advanced CAI hardware generally available. As part of the Engineering Research Laboratory which created Plato, PERC had access to all of the latest hardware. This gave PERC the advantage of being able to use the latest technological developments; but it had the disadvantage of making PERC one of the testing grounds for the new hardware.

The Plato terminal has an eight inch square screen with powerful graphic capabilities; it can write in any size and rotation, draw lines and circles, and display special characters designed by the author. PERC utilized all of those capabilities; single letters are usually written about a half inch high; boxes and circles draw the student's attention to an area on the screen; and PERC designed a large library of pictures which are used over and over again in lessons. The ability to make frogs hop across the screen, elevators move up and down the screen, and fireworks explode in the middle of the screen, has allowed PERC to create fanciful lessons which hold the attention of first graders.

Complementing the terminal's graphics is the ability to superimpose color slides on the screen. The slides can be randomly accessed within a half second; and then circles, boxes, or other screen displays can be used to focus the student's attention to pertinent sections of the slide. PERC used a great number of slides, but most of them were pictures associated with a story which the child would read on Plato; the slides were not used in main teaching sequences. Nevertheless, even this limited experience suggests that the rich graphics of the color slides offered too much information for the young children to attend to. Children did not seem to be impressed with the color pictures; but they did respond to simple screen graphics which showed stick people and low-grade animations.

The terminal was equipped with a touch panel which allowed students to touch the screen directly with their fingers. The resolution of the touch panel has been a problem; the resolution of the current touch panel is about a half an inch square; this is much too large an area for tiny-fingered first graders, and even for some adults. Students try to touch the something on the screen, but their fingers go in between the touch sensors, are are not registered; this leads to the superstitious habit of touching everything three or four times; and that habit, in turn, breaks the instructional pace of a lesson.

The low resolution of the touch panel has also inhibited some lesson designs. There have been some cases in which it would have been useful to allow the child to touch a single letter on the screen, but the lowest resolution is four normal sized letters.

Allowing students to touch the screen with their finger rather than with a light pen or stylus has had good, but mixed results. Most students easily learn how to touch the screen, and using their finger becomes very natural for them. Some students, however, are careless about the way they touch; the biggest problem is that while they are extending their index finger, a thumb, middle finger, or palm beats their index finger to the screen and registers

a wrong touch. Other students like to rest their left hand on the screen while they attempt to touch with their right index finger; of course, it is the fingers on their left hand which are registered. Despite such problems, the advantages of allowing students to touch naturally with their fingers make that kind of touch panel very desirable.

The Plato terminal comes equipped with a standard keyboard similiar to a typewriter keyboard, but with about twenty additional keys. Even the youngest students are fascinated with the keyboard and learn to use it fairly easily. All students must type their name to start a session; and they are often asked to press a special function key (the "next" key) to signal the computer that they are ready to proceed.

But many students continue to want to use the keyboard even when they can simply touch something on the screen. If the directions call for the student to touch the letter "a" on the screen, many students will try to type that letter instead. One explanation of this behavior is that the students model themselves after the adults they see using the terminals; adults spend most of their time typing at the terminal so the students want to do the same. Consequently, PERC has designed most lessons to accept either typing or touch input. It would be possible to

discourage students from using the keyboard, but that has been tried in the past; the result was that students became confused because they thought they had typed the correct answer, but they were told either that they were wrong, or that they still had to touch the answer on the screen.

The fact that students like to use the keyboard does not remove the need for a touch panel; some students never become comfortable with the keyboard beyond typing in their own name. But it does mean that lessons can be developed which depend on typing; there is a large proportion of kindergarten and first grade students who could interact with such lessons.

The final piece of hardware which PERC used was the random access audio unit. Every terminal was equipped with its own audio unit. The audio unit works like a tape recorder except that it uses a fifteen inch floppy, mylar disk instead of a spool of mylar tape. Each record (or disk) can hold about twenty minutes of recorded audio; messages can range from one-third of a second to forty seconds in length; and any message can be accessed in one half second.

The audio unit is the most primitive technology with which PERC worked. There were many problems which plagued the audio effort ranging from the making of the original

recording to the actual attempt to play a message to a student in the classroom. Each time one problem was controlled, another emerged. During the NSF funded years, the audio was never reliable enough to warrant a full scale evaluation of the PERC curriculum; during those years, PERC used an experimental audio unit developed within the Engineering Research Laboratory. In the 1976-1977 school year, PERC has been able to switch entirely to a commercially available audio unit modeled after the Lab's prototype; this audio has proven highly reliable.

If students had a "good" audio unit, they still were likely to get one bad audio message in every twenty; a bad message meant that the audio played nothing, played the wrong message, or played a garbled message. Since an average lesson delivers almost twenty audio messages, it was probable that a student heard at least one bad message during each lesson. Of course, many audio units were not in good working order most of the time; the students who used those audio units heard a much higher percentage of bad messages.

Unreliable audio simply made instruction impossible. On many occasions, it was observed that the audio would confuse the students; the terminal screen would have the letter "a" on it, and the audio would tell the student,

"This is the letter b". Since messages were usually recorded in order, such a misaddressing meant that the audio unit had only missed by one message; but the results were disastrous. Students who knew better adopted the attitude that Plato was "dumb"; but students who did not know better, looked bewildered and continued on in the lesson.

There were ways to write lessons which minimized the audio problems. If messages were kept long, then a misaddressing audio might play at least half of the intended message. And since there was a great deal of continuity among lessons (described in more detail below), students learned the formats of the lessons and did not rely heavily on the audio information.

Despite the severe problems with audio, much was learned about the effective use of audio with CAI lessons. (For a more complete discussion, see "Using Audio with CAI Lessons"). The random access capability seems to be an absolute necessity. In the earliest PERC lessons, that random access capability was used primarily to support randomized drills; such a use does not really justify a random access audio unit. But eventually instructional strategies were developed which could not have been done without a random access audio unit. For example, if a

student misses an item in a drill, it has proven very effective to reinsert that item into the drill list at fixed intervals; such a strategy would not be possible with other types of audio.

A large amount of audio must be instantaneously available at any time. With the current audio unit, one record can hold twenty minutes of audio; that is not enough. Concerted efforts have been made to put as much contiguous instruction on each record. But students still must change records several times during each fifteen minute session; in the 1975-1976 school year, it was calculated that students spent an average of seven of their fifteen minutes searching for and changing records.

The reason for this is that a session is not homogeneous; it can contain a lesson on today's date, some main instruction, and a game at the end; within the main instruction there could be review material which had been covered several days earlier. Currently, the student would have to load three or four records to complete such a session. Logistically, all of that audio could fit on one record, but that would mean that every student would have to follow essentially the same sequence; or that an impossible number of records would have to be produced. Thus, the current audio technology forces a choice between an optimal sequence in which the student must change records; and a lock-step sequence which can be recorded on a single record.

III. The Development of CAI Lessons

PERC developed around one hundred distinct lesson formats; many of these formats were used in different applications so that around five hundred separate activities existed. Each of the activities takes about 2.5 minutes; the shortest lessons run around 1.5 minutes; and the longest lessons could last five or six minutes.

At the end of each lesson, students are asked if they would like to see that lesson again. Since the lessons are short, this gives the students a chance to practice to their own level of mastery. An untested hypothesis is that students will repeat lessons until they are bored because they have mastered the skill, or until they are frustrated by the lesson. Students repeat lessons about twenty percent of the time; that statistic has remained very constant over three years of experience; on any given day, the number of repeats will range between fifteen and twenty-five percent. Although some students almost never repeat a lesson, and others repeat frequently, most of the repeats are distributed evenly across all students.

All PERC lessons were delivered on the Plato terminal; PERC did not create any materials to be used away from the terminal; nor did it provide any activities for teachers to use to follow up on lessons completed at the terminal.

Consequently, PERC lessons were never more than supplementary to the normal classroom instruction; one of the goals of PERC was to develop instruction which could be used independently at the terminal without the need for an instructor.

Predictably, PERC never accomplished that goal. The experience in the classrooms proved again that any new innovation has to be integrated into the existing classroom structure. Therefore, through changes in the management sytstem discussed below, PERC has begun to move into a complementary role in the classroom; and some plans have been discussed to provide off-terminal activities to reinforce PERC lessons.

But the lesson has been an expensive one to learn. Because PERC attempted to provide independent instruction, lessons were developed in all areas of beginning reading. This had two effects: (a) no area was covered effectively; and (b) many of the lessons which were produced never belonged on a computer; they would be done better by a teacher or by some other medium. Because PERC had a commitment to produce a full reading curriculum, it was unable to pursue the unique uses of a computer in beginning reading; a few lessons were developed which demonstrate the potential of a computer in this area; but there were never enough resources to follow up on such lessons.

PERC followed a paradigmatic approach in developing lessons. During the first few years, a very small number of experimental lessons were tried out and continually refined. Then other lessons were written based on what had been learned; these lessons were tried out on a more limited basis, and the findings from those tryouts were fed back into all lessons. Finally, when a fairly solid body of lessons had been developed, multiple exercises were added to many of the lessons. Thus, a cohesive body of lessons was produced which still offered a great deal of variety in lesson formats.

The paradigmatic approach was followed not by design, but by necessity; no one on the PERC staff had sufficient experience to do anything else. There was pressure to produce a wide variety of lessons in the early years; if PERC had done so, it is unlikely that sufficient time would have been devoted to the lesson design principles which were evolved from the limited number of early lessons. Also, there was some sentiment to forsake the variety of lesson formats in favor of more attention to instructional sequences. Undoubtedly, more attention to the instructional sequencing would have made PERC better. But the variety of formats was a necessity if Plato was to hold the attention of first graders.

In fall, 1975, a phonics sequence was introduced into the PERC curriculum. These lessons emphasized the instructional sequence rather than lesson formats; in fact, most of the formats were very dull drills. Partly as a result of the dullness of the formats, students and teachers rebelled against the lessons, and they made specific comments about the lesson formats. Whether or not the efficient instructional sequence was effective could never be ascertained; student behavior with the lessons was so erratic that there was no way to measure whether a student had learned anything during a session.

The phonics sequence illustrates another principle which PERC practiced: there must be a high degree of continuity among lessons. While the lesson formats can be varied, the rules for interacting with the lessons must be consistent. The paradigmatic approach to lesson design allowed PERC to identify conventions and to apply them to all lessons.

The phonics lessons did not follow the current PERC conventions; the departure from the established conventions was made deliberately, and it was not felt that the differences would adversely affect the phonics lessons. The phonics lessons were given to students about fifteen percent of their time; other PERC lessons made up the other eighty-five percent. It was observed that students became highly

frustrated in the phonics lessons because they tried to do things which other lessons allowed them to do; for example, they would try to type the response, but were ignored; they tried to enter their response before the audio finished giving directions, but were not allowed to do so; and they were taken through extended remedial sequences. None of those things occurred in the other PERC lessons.

Not only were students frustrated by the phonics lessons themselves, but they carried their frustrations over to other PERC lessons. Lessons which had had low error rates in the previous year showed higher error rates while the phonics lessons were running. And observations showed that students were engaging in random, superstitious behavior which had not been widely seen before.

Many of the conventions followed in the phonics lessons had been tried out and abandoned in previous years. However, as long as all lessons followed the same inadequate conventions, student frustration was minimal. The phonics lessons did not necessarily fail because they followed poor lesson conventions; they failed primarily because there was no continuity between those lessons and other PERC lessons.

The lesson conventions which PERC follows are based on a central ideal: give the student as much control over the terminal as possible. The computer terminal is nothing

more than a machine, and it should be thought of in just those terms; it is not a surrogate teacher. Although students may talk to the terminal on occasion, they would be very surprised if the terminal answered them directly. They think of the terminal as a machine; and the nature of a machine is to be "worked" by a human. In fact, that is one of the greatest attractions of CAI: students feel that they are in control.

Much instructional design on CAI follows the stimulus-response model; the terminal delivers the stimulus, and the student gives the response. PERC tries to turn that around: the student should give the stimulus and the terminal delivers the response.

PERC lessons strive towards that ideal, but do not really reach it; most PERC lessons fall on a continuum ranging from complete control by the terminal to complete control by the student. There are no lessons at either end of the continuum; some lessons approach the ideal; but others (such as highly structured drills) are difficult to work student control into. But the important thing is that the lesson designer believe in that ideal and to continually seek ways of giving students the feeling (real or illusory) that they are in control of the terminal.

The following is a list of some of the PERC lesson conventions which seek to give the student control. These conventions have proven highly useful with PERC's first grade population; but they do not always work with first semester kindergarten students. Therefore, attempts to generalize past a first grade population would not be advisable.

(1) Maintain a high interaction rate. Students in PERC lessons average one response every ten seconds. Obviously, there are many situations in which it is desirable to allow students to think about about their answer; but unless such a rationale exists, all efforts should be aimed at giving the students opportunities to enter responses.

This also means that the students must be able to interrupt the terminal in order to make a correct response. If students are familiar with the lesson format, or if they can guess what the audio is about to say to them, they often can respond before the directions are finished. In most cases, incorrect responses are ignored while correct responses are accepted; in a few cases, that strategy has encouraged randomized responding and those lessons were redesigned. But in general, that strategy is effective with first graders.

(2) Make the responses as meaningful as possible. Although PERC encourages rapid responding, the responses are tied as closely to the skill being taught as possible. PERC avoids making students step their way through an explanation by just touching the screen or typing a key; when a long explanation is needed, the strategy is to get students actively involved in doing each step of the required activity.

(3) Keep remediation to a minimum. One of the constant challenges is to keep the remediation less attractive than the main instruction; if it is too elaborate, inquisitive first graders will explore all of the wrong answer contingencies. But to be effective as remediation, feedback usually has to be more elaborate than the original instruction; thus the choice has to be made between effective feedback and effective lessons.

If the only problem with remediation involved inquisitive first graders, equipping a lesson with diagnostic feedback might be justified. But the real problem is with the very students such feedback is supposed to help; since students perceive the terminal as a machine, they are positively reinforced any time they can make that machine "work". Students have been observed to be gleeful during a wrong answer remediation; they have found a way to make Plato react to them in a spectacular way, and they do not understand that Plato is telling them that they were wrong.

Remedial feedback is focused on giving students the information they need to enter an acceptable response. It is generally withheld for the first several errors; the student is simply told to "try again"; when it is determined that the student needs more help, the correct answer is circled, boxed, or has an arrow pointing towards it. Since students must make several attempts before being told the correct answer, it is hoped that they will be more highly reinforced by making the correct response on the first try.

Similiar to the convention described above, all remedial sequences must be interruptable to allow students to enter the correct answer. If that is not done, then the following sequence occurs: (a) wrong answer; (b) remediation begins; (c) student attempts to enter the right answer; and (d) remediation ends. Thus, while students are entering the correct response, they are told that they are wrong. Students have often been observed to follow that sequence, and, just as the remediation finishes, decide that their correct answer is wrong, and switch to a genuine wrong answer.

(4) Procedural errors are ignored or are remediated on a schedule. "Procedural" errors are those responses which have nothing to do with the possible answers: the student touches the screen in an unrecognized area; plays randomly

with the keyboard; or touches a display on the screen which is not associated with correct or incorrect answers. Again, because the student views the terminal as a machine, the best response in situtations such as these is no response; PERC has collected data which shows that students typically correct themselves after such an error without receiving any feedback from Plato at all. However, there are times when students are genuinely confused by a lesson; therefore, feedback similiar to that described above is given to the students on a schedule, such as, after the third, eighth, and thirteenth errors; by spacing out such feedback, the student is not encouraged to persist in the error.

(5) Always force the student to make the correct response. This convention almost makes it impossible to design tests which do not teach; but it does make tests more accurate. In early PERC lessons, students were speeded through many tests and exercises in the name of efficiency; since it could be quickly determined that a student did not know an item, the lesson simply skipped on to the next item. Besides taking the control away from the student, this encouraged students to answer randomly because the random answer always generated a new display; again, the students felt that they were successful because they made Plato "work". Current practice requires the student to enter the correct answer; and the correct answer will be pointed out after a few incorrect attempts.

(b) Overt reinforcers are faded quickly. Most lessons are built around a fantasy which invites the child to make the terminal "work" by practicing a skill. As soon as that fanatasy can be established, audio and excessive visual displays are withdrawn. The student is reinforced simply by making the terminal "work"; and that motivation is effective by itself. Elaborate displays and animations are not needed.

This is one area where kindergarteners appear to differ from first graders. The kindergarten students seem to take longer to see the connections between their inputs and the terminal's reaction; it is thought that PERC lessons reduce overt reinforcements too quickly for that age group, and therefore, that PERC lessons are not appropriate for most kindergarten students.

IV. Computer Managed Instruction

For four and a half years, PERC attempted to develop an automatic curriculum management system (called "CMS"). In the earliest days of the project, an analysis of the reading process was done; from that analysis, a "reading tree" was constructed made up of behavioral objectives structured hierarchically. CMS was designed to keep track of students progress up the reading tree. Based on the students' current status and their position in the tree, CMS would select lessons for them.

While this sounds like a "teacher proof" system, it was not originally intended to be that way. The belief had been that once the automatic system was operating successfully, there would be a structure with which teachers could interact; it was planned that teachers could exercise as much or as little control over the sequence of activities as they desired; and that they could even write their own "reading tree" which CMS would use for their classroom.

The problem was that CMS never operated successfully. Nevertheless, efforts were made to allow the teachers to have some controls over the lessons presented in their classrooms; but because CMS was a complicated and unreliable system, none of those efforts ever worked. All they succeeded in doing was in trying the patience of the most patient teachers.

But the greatest problem with CMS was that it delivered poor prescriptions. Students were bounced from one lesson to the next with no continuity running through a session. It was a "hit and run" curriculum with the students getting hit with a lesson from one curriculum area (such as letter names), and then being forced to run on to unrelated area (such as memory skills). The initial philosophy had been that students could handle instruction in several areas (or "strands") simultaneously; it was thought that moving from one strand to another would provide diversity within a session, and that integration across strands would occur as instruction in one strand reinforced instruction from other strands.

The weaknesses in CMS were obvious early. Students who were interviewed about Plato indicated that they did not know what they did on Plato; they thought of Plato as a place where they played games. Teachers were critical because there was no way for them to tell which lessons their students would receive next. And CMS provided problems to curriculum designers who wanted to insure that tests were given at the appropriate time; and that instruction did not immediately precede a test, and thereby invalidate the testing situation.

Many attempts were made to try improve the quality of the prescriptions which CMS delivered; but nothing really was satisfactory. There are several underlying reasons why CMS could not have been made to work:

(1) The critical relationships in a curriculum are horizontal, not vertical. CMS was designed to manage the vertical relationships found in the hierarchically organized reading tree. In fact, there are probably very few hierarchical relationships within a curriculum; and the ones that do exist are obvious and simple to manage. Most relationships are horizontal. For example, either Skill A or Skill B might be taught first; but, it is important to know the status of Skill A in order to decide how to teach Skill B.

As a more concrete example, consider letter names and letter/sound correspondences; either could be taught first. Some teachers do not begin to teach the letter names until after the students have mastered the letter sounds; most teachers teach the names, then the sounds. But if instruction is to begin on letter sounds, it is important to know whether the students know their letter names in order to select the proper pedagogical strategy; and vice versa.

The same is true within a skill area. If a student needs a drill on a letter name, it is important to know how many other letter names the student has had; such data determine the type of drill the student should get.

The examples have been necessarily simple; many other complex relationships exist in a curriculum which could more easily be described as horizontal relationships than as vertical structures. Since CMS was designed to manage hierarchical structures, it was incapable of being modified so that it could adequately manage a curriculum.

(2) Automated decisions should be based on full histories of the student. CMS made a decision after every activity; that decision was primarily based on the student's recent performance in that activity; sometimes the activities themselves referred to data saved from several lessons in order to modify the data reported back to CMS; but in no cases were more than a handful of recent data examined in order to make a decision.

Recent observation, however, shows that students behave erratically during a session; students may do very well on one activity, and then decide to experiment on the next one. The data from a single activity are not sufficient to make a decision concerning the next lesson which is appropriate for a student. At the very least, the

data from the entire session must be examined; if possible, these data should be put in the context of data from other sessions; and ideally, the teacher ought to be able to set parameters which guide the interpretation of the data. There are definitely types of students who do their best on everything; and other types who like to experiment. One PERC teacher is examining data on her students to see if she can determine correlations between her intuitive appraisal of a student and the data generated by Plato.

Therefore, an automated management system does not have to make dynamic decisions. It will probably do better if it waits until the session is finished, and then prescribes a complete, coherent session for the following day. In fact, all prescriptions could be made at night time when greater computer power is available (due to lower usage by students); the management system would be able to call up complete histories of students and crunch through complicated algorithms.

(3) The rules which apply to different curriculum areas are unique to each area. CMS attempted to apply a general decision model to all areas of the curriculum; but each area of the curriculum has its own unique needs which require its own unique algorithms. It is possible that once all such algorithms are written, someone will be able

to extract some general rules which cut across all of the algorithms; but the first step must be to generate those unique algorithms.

Between twenty and thirty percent of PERC's resources were invested in CMS; and the more it failed, the more resources were sunk into it to bolster it up. Finally the entire system was scrapped in spring, 1976.

CMS was replaced by a new system called the "prescriber". The prescriber was a completely manual system which required teachers to select each activity for each student; there were template options which allowed the teacher to "prescribe" a list of activities for several students at the same time. But "prescribing" still took teachers at least one hour per week; and several teachers spent four to five hours per week.

Currently PERC is studying how teachers prescribe in order to determine the ways in which they make decisions about sequencing. The PERC staff is also attempting to prescribe effective sequences on a day-by-day basis. From these efforts it is hoped that some algorithms can be derived which can make some of the prescribing semi-automatic again. At the very least, PERC hopes to offer teachers larger packages of instruction which they can prescribe instead of the 2.5 minute activities to which they are currently limited.

V. Implementation

The elementary curriculum projects funded by the National Science Foundation attempted a unique implementation by placing the computer terminals directly in the classroom. Most other CAI projects at the elementary level have set up a terminal room to which the students are sent.

The terminal-in-the-classroom concept has had mixed results. No PERC teacher has ever asked that the terminals be removed from her classroom; and, when several classrooms had to be dropped at the end of the NSF project, some teachers were very angry because the terminals were taken away. In a survey, teachers were overwhelmingly positive about keeping the terminals in their classrooms.

There are several advantages of the terminal in the classroom which teachers often cite: (a) it allows the terminals to be treated as another center in the room and promotes the feeling that what happens on Plato is related to the other learning experiences going on in the room. (b) Teachers are able to keep track of what students are doing on Plato. (c) Teachers can schedule students on the terminal around their own needs. (d) It keeps the students in the classroom rather than making them go to another room.

Some of the disadvantages that have begun to emerge are: (a) teachers cannot watch students on the terminal as closely as they would like. (b) Teachers have a harder time coping with hardware problems than a trained terminal room proctor would; sometimes, when a terminal or an audio unit stops working, teachers stop using both of their terminals rather than try to find out what is wrong. (c) The very expensive Plato terminals do not receive enough use in a single classroom to justify their costs; this, however, may change by the time CAI is ready to move into the elementary schools on a large scale. (d) Because of the casual atmosphere associated with the terminals in the classroom, students may behave more casually than they would in a terminal room (it is not quite obvious whether this point is an advantage or a disadvantage); in the classroom, students often help one another while they are on Plato; this makes data collected on student performance in lessons only marginally useful. (e) Activity at the terminals often distracts teachers while they are trying to work with a group.

Another unique experiment PERC was engaged in was to determine whether young children could use CAI. As described above under "hardware", even kindergarteners were able to learn how to use Plato. Either a PERC staff memeber or the teacher and her aide oriented students to Plato. Usually the students had to be supervised during the first three times they signed on to the terminal; each time, the supervisor introduced a little more to the students. The most critical thing was for students to learn to type their name; several lessons are offered on Plato which give the students additional practice doing that.

After the first three sessions, the supervisor did not help the students; sometimes the teacher had to help some students type their names; but that stage quickly passed. After a week or two, the supervisor returned to show the students how to use the slides; at the same time, the supervisor corrected any bad habits the students had fallen into. This simple orientation process has been very effective.

Another lesson PERC learned about implementation is that it might not be advisable for students to use the terminals every day. For many reasons ranging from economics to evaluation plans, PERC teachers were encouraged

to have their students use Plato every day. But some teachers reported that they felt that some students would do better if they used Plato occasionally.

Finally, the most important lesson which PERC learned about implementation was that teachers must be intimately involved in the implementation of a new curriculum in their classrooms. PERC always accepted that in principle, but did not know how far put it into practice; there were so many new things which teachers had to learn when Plato was put in their classrooms that it was difficult to determine whether the teachers could be more involved.

But when the prescriber replaced CMS, it became apparent that the teachers could do a lot more than they had been allowed to do in the past. Despite the time-consuming nature of prescribing, teachers generally say that they prefer doing it; when shortcuts to prescribing are proposed, some teachers say that they would prefer to continue to prescribe each activity separately.

Giving teachers control over which lessons were given in their classrooms created an interesting paradox. While the automated CMS was in existence, teachers called on PERC staff members to solve many little problems; a communications notes file written between teachers and PERC staff was filled with problems and complaints mainly about hardware. But when the prescriber was instituted,

the number of calls to PERC staff members dropped drastically; and the notes teachers wrote increasingly began to address pedagogical problems they saw in the lessons.

The PERC staff tends to believe that when the teachers began prescribing, they felt more in control of Plato; therefore, when something went wrong, they tried to fix it themselves rather than call on the PERC staff. The irony is that the automated CMS system made the teachers dependent upon the PERC staff; and the PERC staff was kept constantly busy trying to keep up with the teachers' requests. But the manual system fostered independent teachers who made very few demands on the PERC staff.

VI. General Observations

The lament of PERC is similiar to the lament of many other federally funded projects: PERC needed more time and more money to do the job adequately. At the end of the National Science Foundation grant, PERC would have come to an end; but the Engineering Research Laboratory has continued to support terminals for fifteen of the original twenty-five classrooms. Now, after the money is gone, PERC finally has a fairly stable environment in which to conduct research.

PERC also needed an adequate staff to do the job well. It was, and continues to be, very difficult to find people who have an expertise in reading and are able to develop a facility in computer assisted instruction. Most of the existing reading curriculum has been developed by people (such as the author) who have had little or no background in reading.

In the work that PERC did, no specific questions about the process of reading were addressed; and very little evaluation was done to assess the overall impact of the computer in the classroom. PERC really accomplished nothing which would make teachers believe that PERC offered a better way of teaching beginning reading. Nevertheless, PERC teachers insist that Plato has good effects in their

classrooms; they say that (a) more students learn to read earlier since the time Plato came into the classroom; (b) students learn to follow directions better; (c) students develop better listening skills; (d) children are more creative; and so on. The effects which teachers are most concerned with are usually related to the process of reading rather than to any specific reading skill.

Therefore, it might be that the unique role of a computer in the reading corner is to concentrate on the process of reading. There are several ways in which simply using the computer terminal might improve the reading process: (a) students may come to understand the symbolic nature of reading by learning that their symbolic interactions with the terminal have concrete consequences. (b) Students may come to understand that there are logical relationships which govern their interactions with the terminal; such an understanding may strengthen their comprehension abilities. (c) Successful interactions with the Plato terminals may build the confidence students need in order to begin to learn.

The use of computer assisted instruction in the reading classroom is many years away. It is hoped that adequate research and curriculum development will be done long before the day comes when CAI becomes techologically feasible at the elementary level.

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