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A comparison of human and computerized proctoring within Keller's personalized system of instruction.

Paul Chamberlin
University of Massachusetts Amherst

A COMPARISON OF HUMAN AND COMPUTERIZED PROCTORING WITHIN KELLER'S PERSONALIZED SYSTEM OF INSTRUCTION

A Dissertation Presented

By

PAUL CHAMBERLIN

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Approved as to style and content by:

Jack Hruska

Dr. Jack Hruska, Chairperson of Committee

Jeffrey W. Eiseman

Dr. Jeffrey Eiseman, Member

Beth Sulzer-Azaroff

Dr. Beth Sulzer-Azaroff, Member

Leonard A. Stadulis

Department Head

DEDICATION

This study is dedicated to my parents and to my children.

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I am deeply grateful to my committee chairman, Dr. Jack Hruska who has been a source of guidance and support for several years. I am also thankful for the dedication, assistance, and encouragement of the other members of my committee, Dr. Beth Sulzer-Azaroff and Dr. Jeffrey Eiseman. The extensive work that this committee has done on my behalf is greatly appreciated.

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ABSTRACT

A COMPARISON OF HUMAN AND COMPUTERIZED PROCTORING WITHIN KELLER'S PERSONALIZED SYSTEM OF INSTRUCTION

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Paul Chamberlin, B. S., Suffolk University

M. S., University of New Hampshire

Directed by Professor Jack Hruska

Many faculty members who wish to use PSI have difficulty in meeting the proctoring requirements of the system. One possible alternative to human proctors is the use of computerized proctoring. The purposes of this research were to: 1. compare the effectiveness of computerized proctoring and human proctoring on achievement of remediated instructional objectives within a modified PSI format, 2. compare the effectiveness of computerized proctoring and human proctoring on the retention of successfully remediated instructional objectives on a major examination within a modified PSI

format, 3. determine student attitudes towards each mode of proctoring, 4. determine whether students prefer computerized or human proctoring within a modified PSI format, 5. ascertain the reasons for the proctor preference, 6. determine the characteristics of the subjects whose level of achievement of remediated instructional objectives with each type of proctoring was high, and 7. determine the characteristics of the subjects whose level of achievement of remediated instructional objectives with each type of proctoring was low.

The subjects were 32 students in a community college biology course that was based on PSI and was taught by the investigator. The students, who had a mean age of 27.75 years and a mean QPA of 2.85, were divided into two groups that were matched for age, QPA, attempted credits, experience with PSI, and experience with computer managed instruction. For five modules, the proctor treatment in each group alternated between experienced, external human and computerized proctoring. The computer programs, that

were developed by the investigator, administered and scored the quizzes, provided feedback and maintained student records. For the sixth module, all students had their preferred method of proctoring.

The study, which used both a within and between subject, counterbalanced design, revealed that: 1. there was no significant difference in the achievement of remediated instructional objectives on multiple choice modular quizzes or in the retention of successfully remediated instructional objectives on a multiple choice midterm examination; 2. the students had positive attitudes towards each type of proctoring but they preferred human proctoring; and 3. there were no differences between the achievement groups under either proctoring method in age, QPA, attempted credits, experience with PSI or with computer managed instruction. The major conclusion of this experiment was that computers can be used effectively as proctors within a modified PSI format.

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INTRODUCTION

Background

Two major instructional developments that originated in higher education during the 1960's were the introduction of the Personalized System of Instruction (PSI) and computers into the classroom. Both of these methods increase the flexibility of instruction and provide for the individualization of instruction. Both methods have been used, with different levels of success, as alternatives to the lecture in a wide range of disciplines. In addition, computers have been used as supplements to lectures and many investigators, including Cross (1976), Kozma, Belle and Williams (1978), and Levien (1972) have indicated that computers should be used as supplements to conventional instruction rather than as replacements. The following is a description of the: a. characteristics, materials, and procedures of PSI, b. roles of the proctor within the system, c. types of proctoring, d. ramifications of an insufficient

proctoring component, and e. computer applications in PSI.

Although systems similar to PSI were operational in 1912 in San Francisco and in 1919 in Winnetka, Illinois (Sherman, 1974), PSI did not evolve until after Skinner's work with teaching machines and programmed learning in the 1950's. PSI was developed primarily for Higher Education by Fred Keller and his associates at the University of Brazil in 1964. This system, which is also known as the Keller Plan, has the following major characteristics: self-pacing, mastery learning, an emphasis on written communication, immediate feedback, motivational lectures, and the use of proctors.

In PSI courses, the subject matter is modularized and a study guide--consisting of an introduction, a list of objectives and a set of study questions and assignments--is prepared for each module. The study guides are completed sequentially at a pace established by the student who must demonstrate mastery of one module before proceeding to the next one.

A proctor guide is also prepared for each module. The guide, which is used by the proctor during the proctoring session, contains remedial information, supplemental questions, and identification of potential areas of difficulty in the study guide. The remedial information refers the student to the specific assignments

that should be used to complete the objectives. The proctor can use the supplemental questions, after the quiz, to help clear up ambiguous answers or to determine the basis for a student's answer. The proctor guide may also identify problems that the proctor cannot handle and it also indicates that these problems should be referred to the teacher.

To demonstrate mastery, the student must pass a criterion-based quiz, which is administered and corrected by a proctor, at a predetermined level of achievement. The level of achievement, which is established by the instructor, is usually between 80% and 100%. At the completion of the quiz, the proctor grades the quiz, records the grades, and determines whether mastery has been achieved. If mastery is achieved on the quiz, the proctor praises the student who then proceeds to the next module.

If mastery is not achieved on the first quiz, the proctor provides the student with some encouragement and with prescriptive information on each missed instructional objective. This prescriptive information directs the student to the specific pages in the assignment that cover the objective. The proctor may also utilize the supplemental questions of the proctor guide or refer

the student to the teacher. At no point in the interaction between the proctor and student does the proctor teach or provide correct answers to the student. Sherman (p. 33, 1974) has indicated that this "student-proctor interview virtually eliminates the possibility of cheating and adds to the personalized aspects of the course."

After a specified time interval, during which the student re-studies the subject matter, the student has another quiz and proctoring session. The sequence of events will be repeated until the student achieves the mastery level; however, in some modified PSI formats, the number of retake quizzes is limited. These additional quizzes are also administered by a proctor who has the responsibility of maintaining records so that the student receives the appropriate quiz.

An added benefit of these student-proctor interactions is that the proctor may become aware of instructional problems that would usually go unnoticed by the teacher. If problems are detected, the proctor can pass this information along to the teacher who can respond to them.

While performing the functions described above, the proctor provides personal contact to the student. This contact is one way in which PSI differs from other

individualized systems of instruction. Schiller and Markle concluded in their investigation of PSI that the proctors "provide most of the personalizing aspects of the system", (1978, p. 156) and Keller (1968, p. 87) indicated that proctors "were immensely important in making the learning environment more reinforcing."

In summary, the proctors have the interrelated responsibilities of giving and grading quizzes, keeping records, providing feedback in the form of pass/fail information and remediation, and providing personal contact to students. The proctors are available for the frequent quizzes and this availability aids the self-pacing. The proctors also help the students attain the mastery level of achievement by providing immediate feedback and they may also provide feedback to the teacher and help improve the system.

The benefits that accrue to the proctors should also be noted. For example, the proctors benefit from proctoring since the position reinforces the proctors' knowledge of the subject matter and provides experience in interpersonal interactions. And, in many cases, the additional exposure to a discipline results in the selection of that particular field as a program of study.

The number of proctors needed for each PSI course is primarily dependent upon the number of students to be

served. For example, the literature suggests a ratio of one proctor for every ten students. The proctors, who may be either internal or external proctors, must be chosen on the basis of ability, interest, availability, and personal qualities. The possession of these attributes does not guarantee effective proctoring: some form of training is usually required. For example, Semb (1975), Robin and Cook (1978), and Johnson and Sulzer-Azaroff (1978) have demonstrated that proctor training improves proctor effectiveness. The training may involve weekly proctor meetings in which course materials and difficulties are discussed and/or the use of one of the training procedures that have been developed.

The external proctors can be former students who have earned high grades in the course in previous semesters or they can be students who have gained their qualifications in other courses. The literature suggests that undergraduates perform better than graduate students because there is less tendency for the undergraduates to deliver mini lectures to the students. In most cases the students will have to be compensated in the form of money or credit; the method of compensation is determined by college or department policy. In some cases, former students may volunteer their time in order to gain experience in interpersonal interactions and to have the

chance to review the subject matter.

One other way to meet the proctor requirement is to use internal proctors. These proctors are students who are enrolled in the class and they are the first students who demonstrate mastery of each module. With this type of proctoring system, a different complement of proctors may be available for each module. Sherman (1974) has advised that the proctor materials must be more extensive if one uses internal proctors. As with the external proctors, the students must be qualified and have the time to proctor. Since these students must be present more often than their classmates, they must usually be rewarded in some manner and the form of this reward is determined by college or department policy. One possible reward could be extra points for the class. Other ways of obtaining internal proctors could involve making the proctoring a course requirement and/or recruiting volunteers for the position. In these cases the reward factor does not develop.

A major personnel problem that some institutions may have with the implementation of PSI courses is filling and maintaining the proctor positions. This problem, which may be caused by the lack of qualified personnel and/or the lack of funds, is especially acute at community colleges because of the limited pool of potential

proctors. The number of potential proctors is small because the student body consists of people who have major commitments, such as families and full time jobs, that limit their availability. In addition, students are only on campus for a two year period.

The ramifications of insufficient proctoring are widespread because it adversely influences mastery and feedback and these characteristics have been noted by many investigators as contributing to the overall effectiveness of PSI and other individualized instructional methods. For example, the lack of proctors may cause a reduction in the mastery criterion because it is incongruous to set a high level of mastery and not provide the help necessary to reach it. And, as has been demonstrated by Davis (1975) and Parsons and Delaney (1978), a low mastery criterion may lead to reduced student achievement. Furthermore, a decrease in the availability of proctors will limit the amount of the feedback provided to students and/or it will delay the presentation of the feedback. The literature suggests that both of these conditions will result in a decrease in student achievement.

The problem of filling and maintaining the proctor positions must be solved if the system is to fulfill its potential. A possible solution to this problem is the use of computers as proctors. A brief description of computer

use in higher education and its potential application in PSI follows.

Universities began to use computers during the 1950's for research and administrative purposes, but it was not until the 1960's that computers began to be used for instruction (Bork, 1978). The use of computers spread slowly until the introduction of microcomputers during the 1970's. At that time, the instructional potential of the computer began to be realized and computer use increased dramatically. An example of this growth is the requirement of some institutions, such as Brown, Drexel and the Rochester Institute of Technology (Weillisz, 1983), that entering students must have their own microcomputers.

Computers have a variety of instructional and managerial applications. Some examples of the instructional uses are drill and practice, tutoring, simulations and educational games while managerial functions include the production, administration and correction of quizzes, the maintenance of records, and word processing. For this study, computer applications will be limited to those capabilities that have implications for the proctor responsibilities. These applications are: (a) providing feedback and remediation, (b) individualizing instruction, (c) giving and grading

quizzes, and (d) keeping records. These computer functions may be used in various combinations. For example, computers may be used to produce paper quizzes that are corrected by a proctor who also provides feedback and records the grades. Or, the paper quiz may be corrected by a computer that also provides the feedback and maintains the grades. In these two examples, the student does not interact with the computer. In contrast, some computer programs require student interaction with the computer. In these programs, the student takes a quiz on the computer and receives feedback and individualized reports from it. Bork (1979) has described this interactive learning capacity of the computer as its most valuable contribution to education. The significance of this interaction is that the computers provide highly individualized contact with each student. Furthermore, this interaction, which includes immediate feedback, seems to decrease the time it takes students to complete coursework. In addition, computers have the potential to provide the administrative support to a PSI course, and, by so doing, increase the amount of time that teachers have available for students.

Purposes

As indicated above, some institutions experience difficulty with filling and maintaining the proctor component of PSI courses and many institutions are using computers in various ways. The investigator, who has used PSI in biology courses at a community college for many semesters and believes that the full potential of PSI was not attained due to an insufficient proctor component, wishes to gather data on the effectiveness of computers as proctors. Therefore, the purposes of this study were:

- To compare the effectiveness of computerized proctoring and human proctoring on achievement of remediated instructional objectives within a modified PSI format.
- To compare the effectiveness of computerized proctoring and human proctoring on the retention of successfully remediated instructional objectives on a major examination within a modified PSI format.
- To determine student attitudes towards each mode of proctoring.
- To determine whether students prefer computerized or human proctoring within a modified PSI format.
- To ascertain the reasons for proctor preference.

- To determine the characteristics of the subjects whose level of achievement of remediated instructional objectives with each type of proctoring was high.
- To determine the characteristics of the subjects whose level of achievement of remediated instructional objectives with each type of proctoring was low.

Research Questions and Hypotheses

The research questions and hypotheses for this study were:

Question 1. When using a modified PSI format, will student achievement of remediated instructional objectives, as demonstrated on a quiz, be greater with computerized or human proctoring?

Research Hypothesis. Student achievement of remediated instructional objectives, as demonstrated on a quiz, will be greater with computerized proctoring than with human proctoring.

Question 2. Will student retention of successfully remediated instructional objectives on a major examination be greater with computerized or human proctoring?

Research Hypothesis. Student retention of successfully remediated instructional objectives on a major examination will be greater with computerized proctoring than with human proctoring.

Question 3. Within a modified PSI format, will student preference of computerized proctoring be greater than student preference of human proctoring?

Research Hypothesis. Student preference of computerized proctoring will be greater than student preference of human proctoring within a modified PSI format.

Question 4. What are the reasons for proctor preference?

Question 5. What are the attitudes of the students toward each type of proctoring?

Question 6. What are the characteristics of subjects whose level of achievement of remediated instructional objectives with each type of proctoring is high?

Question 7. What are the characteristics of subjects whose whose level of achievement of remediated instructional objectives with each type of proctoring is low?

Definition of Terms

Computer Managed Instruction (CMI). Instruction that includes the generation, administration, and correction of quizzes; record keeping; and the presentation of individualized feedback.

Disc or floppy disc. A device, used with a microcomputer, for storing information such as grades, student records, and programs.

Individualized Learning Center (ILC). The space in which much of the college's individualized, mediated instruction occurs, housing equipment available on a sign-up basis.

Microcomputer. This type of computer functions independently of other computers and it uses programs that are stored on tapes or discs. Examples of these computers are the Apple IIe, IBM PC, and the Radio Shack TRS 80.

Personalized System of Instruction (PSI). This system, which is also known as the Keller Plan, is a modularized, personalized, individualized, self-paced system of instruction that incorporates mastery learning, immediate feedback, frequent quizzes, and proctors.

Modified Personalized System of Instruction. This system, which is used in this study, is a personalized, modularized, individualized, teacher-paced system of instruction that incorporates immediate feedback, frequent quizzes, and proctors. It also provides for one retake quiz if the passing level is not achieved on the first quiz attempt for each module.

Proctor. The proctor in PSI courses has multiple functions that include the administration and grading of quizzes, providing feedback, keeping records and providing contact with students.

Proctoring. For the purposes of this study, proctoring is limited to the administration and grading of quizzes and providing grade feedback and prescriptive information on each objective that was not achieved. This prescriptive information indicates, to the subject, the source of the material on which the missed objective was based.

Proctor Session. The session, which usually lasts less than 30 minutes, is the time in which the subject takes a modular quiz and is proctored.

Remediated Instructional Objectives. Instructional objectives on which the student receives prescriptive information from the proctor.

Significance

The Personalized System of Instruction is an effective system in which proctors play a vital role. For a variety of reasons, proctor positions at many institutions are difficult to fill and maintain. This difficulty jeopardizes the effectiveness of PSI courses and may limit the number of courses that use the PSI format. This study will help determine whether computers can be utilized as proctors and alleviate the personnel problem associated with proctors. And, if computers can alleviate the proctor problem, they will also enhance PSI courses due to their availability and reliability.

In addition to PSI, this study also has implications for the instructional use of computers because it will identify some of the characteristics of students who benefit from computerized proctoring and will generate data on student attitudes toward using computers and computerized proctoring. This information will increase the body of knowledge that is available on computer applications in instruction.

Limitations

This study was limited to:

- Students in a Human Biology II course at Quinsigamond Community College during the spring term of 1984 who were studying human biology at the introductory level;
- Students who had little or no previous experience with computers or PSI;
- The use of experienced PSI proctors;
- Computer programs, written by the investigator in Applesoft BASIC, that manage instruction and proctor in the same way as proctors in Keller Plan courses;
- Proctoring in the form of providing prescriptive information on instructional objectives that were not achieved;
- Immediate feedback in the form of grade information, a pass/retake statement, and, if appropriate, a congratulatory statement;
- Study guides that contain an introduction, instructional objectives, study questions and assignments;
- Levels of achievement and retention based on one part of a course;

- The measurement of achievement with multiple choice items on criterion-based modular quizzes;
- The measurement of retention with multiple choice items on a criterion-based midterm examination;
- A modified PSI format that was teacher-paced and permitted only one retake quiz;
- Students who were exposed to both proctoring conditions.

C H A P T E R I I

REVIEW OF THE LITERATURE

The review will be based on the following areas:

a. The effectiveness of the Personalized System of Instruction;
b. The roles of the proctor in PSI;
c. The influence of personalization on the effectiveness of PSI;
d. The influence of feedback, mastery, and self-pacing on the effectiveness of PSI;
e. The ability of the computer to function as a proctor in PSI;
f. The effectiveness of computer based PSI courses.

The Effectiveness of the Personalized System of Instruction

Since Keller reported the results of his evaluation of PSI in 1968 an extensive body of evaluative literature on PSI in many disciplines has been published. Most of the literature is based on comparisons between PSI and

conventional methods of teaching in the areas of achievement and retention. In addition, some research compares the effectiveness of PSI to other non-traditional instructional methods such as Computer Assisted Instruction and to other behavioral instructional systems. As the effectiveness of PSI was being established, investigators began to examine the influence of the individual components on its overall success. Many of these component analyses were based on the role of the proctor and on the components of PSI that are made possible because of the presence of the proctors. Two of the functions performed by the proctors are the presentation of feedback and the personalization of the course and two proctor related components are mastery and self-pacing. Therefore, this section of the review will be based on research that examined: (a) the effectiveness of PSI on achievement and retention, (b) the role of the proctor, (c) the effectiveness of personalization, (d) the effectiveness of feedback, (e) the effectiveness of mastery, and (f) the effectiveness of self-pacing.

Starting with the evaluation by Keller in 1968 and continuing throughout the major studies conducted by Kulik and Jaska (1977) and Kulik, Kulik and Carmichael (1974), and Kulik, Kulik and Cohen (1979), content learning in PSI, as reflected in final grade averages and major

examination performance, has always equalled and usually exceeded content learning resulting from lecture courses. In their meta-analysis of 75 comparative studies, Kulik et al. (1979) concluded that PSI final examinations average about 8 percentage points higher than examinations from conventional courses and PSI final grade distributions are .8 letter grades higher than final grades in conventional courses. Taveggia (1976) summarized 14 studies that compared achievement on course content examinations between PSI and conventional college teaching that included lectures, lecture-discussions, and group discussions in a variety of subjects. He concluded that PSI was consistently superior to the conventional teaching methods examined. This conclusion differs dramatically from the one he had reached 8 years earlier with Dubin. In the earlier study, Dubin and Taveggia re-analyzed over 350 individual studies on college teaching and concluded that various teaching methods did not yield noticeable differences in student achievement on final examinations (Dubin and Taveggia, 1968).

The literature also indicates that PSI has a positive effect on retention. For example, Corey and McMichael (1974) demonstrated that retention rates in a PSI Introductory Psychology course were superior to retention rates with conventional courses. In addition, Born

(1976), in a review of behavioral instruction, examined five studies that measured retention in PSI courses. He reported that PSI groups significantly out performed traditional instructional groups. Kulik and Jaska (1977) reported that on studies of retention, ranging from three weeks to fifteen months after course completion, PSI scores averaged twenty-four percentage points higher than the retention scores for students in conventional courses. They also revealed that these differences were greater than final exam differences. Kulik et. al. (1979) reported an increase of fourteen percentage points in the retention rates of PSI students. All of these studies were based on PSI courses that used human proctors.

PSI has also been compared to other non-traditional instructional techniques. Kulik and Jaska (1977) concluded that PSI and other behavioral systems improved student learning, as measured on final exams, better than computer assisted instruction (CAI), Audio-Tutorial (A-T), Programmed Instruction (PI), and video based instruction. In addition, they reported that PSI was more effective than the other behavioral systems on retention. Furthermore, Kulik, Kulik and Cohen (1980a), in a meta-analysis of 59 independent evaluations of the effectiveness of computer-based college teaching, indicated that PSI was more effective than computer based

instruction.

Furthermore, as an extension of their previous analyses, Kulik, Kulik and Cohen (1980b) performed a meta-analysis of 312 studies that were based on PSI, computer based instruction, video based instruction, A-T, and Programmed Instruction. They concluded that PSI had the strongest positive effect on achievement. The overall agreement for the effectiveness of PSI does not extend to the contributions of the proctor towards its effectiveness. In addition, variations in the roles of the proctors are found throughout the literature.

The Roles of the Proctor

The proctor component, which distinguishes PSI from other individualized instructional systems, has been examined in various ways. For example, in some studies, the overall influence of proctoring has been examined. In other investigations, some of the proctor functions, such as the presentation of feedback and the role of personalization have been studied. Other investigators have evaluated mastery and self-pacing which are PSI components made possible by the presence of the proctor. These studies will be discussed after a description of the role of the proctors and the relationship between the

proctors and the components of mastery and self-pacing.

The literature provides many descriptions of the proctor component that vary from general explanations to detailed listings of the proctor responsibilities. For example, in an early description, Keller (1968) provided a general description of the proctor role when he indicated that PSI included "the use of proctors which permits repeated testing, immediate scoring, almost unavoidable tutoring and a marked enhancement of the personal-social aspect of the educational process" (p. 7). This description served as a basic model for the role of the proctor in PSI courses. Similar overviews were provided by other investigators. For example, in their review of component analyses, Kulik, Jaska and Kulik (1978) noted that proctors "provide objective quiz scoring, give immediate feedback, and discuss course materials with students" (p. 7). In addition, Robin (1978) also provided a summary of proctor functions that included feedback, tutoring, social interactions and administrative assistance. In 1975 Gaynor provided a similar description that had the additional administrative functions of scheduling and recording. Other investigators have provided more extensive descriptions of the functions

provided by proctors. For example, Johnson and Ruskin (p. 20, 1977) indicated that the proctor:

> (a) immediately scores and evaluates the student's performance on successive quizzes over units of material throughout the semester, (b) indicates to the students any relevant portions of material that have not been mastered, (c) explains any apparent difficulties that a student may have before or after he/she takes a quiz, (d) suggests ways of improving student study behaviors, (e) shapes appropriate examination skills, (f) prompts consistent progress throughout the course and (g) adds greatly to the personalization of a college course.

In addition, in an evaluation of a proctor training program, Robin and Cook (1978) identified the following proctor behaviors: "greetings, presentation of feedback, evaluative comments, providing directions to proceed, listening without interrupting, presenting clear pass/fail statements, answering non-quiz related course questions, presenting closing comments, and administrative behaviors" (p. 12). The investigators determined the frequency at which the proctors engaged in these behaviors and the results revealed that most of the proctor activity was administrative.

Equally as important as what proctors do is what proctors do not do: they do not teach. None of the descriptions noted above included teaching as one of the proctor responsibilities. Moreover, Keller (1974)

indicated that the proctor "was not a teacher or a coach in the traditional sense of these words" (p. 21). Hess (1974) specifically indicated that the proctor was not a source of critical information and that the proctor was not a teaching assistant. Furthermore, in the Policy and Procedure Manual for the Mastery Learning Center at the University of Massachusetts, Sulzer-Azaroff emphasized that the proctoring session was not the time for instruction but it was for evaluation of the student's performance. Bowles (1978) also emphasized that the proctor was not a teacher.

In summary, the proctors have interrelated responsibilities that include: (a) providing immediate feedback, in the form of grades and prescriptive information; (b) performing the administrative roles of giving and grading quizzes, and keeping records; and (c) providing personal contact to students. These functions are incorporated into PSI not only because they provide the services indicated but also because they help maintain the mastery and self-pacing components. For example, the indicated functions provide the frequent quizzes that help the students demonstrate mastery and go at their own pace. The immediate feedback also helps the students achieve mastery. All of these functions encompass personal contact with students.

The Influence of Personalization on the Effectiveness of PSI

The literature is divided on the effectiveness of the personalizing function of the proctor. For example, Keller (1968), (1978), and (1981) consistently emphasized the importance of the interpersonal relationships between proctors and students. He reiterated this view in an interview in 1984 (Chase, 1984). In 1968 Keller acknowledged other possible means of providing feedback to students, but he concluded that these alternatives would be poor substitutes for the direct social interactions provided by the proctors. Schiller and Markle (1978) indicated that the proctors provide "most of the personalizing aspects of the system" (p. 156). In a summary of comparative research on Personalized Instruction, Taveggia (1976) indicated that the use of proctors, as described by Keller (1968), along with self-pacing and mastery, contributed to the superiority of PSI.

However, the positive attitude towards the proctor is not universal. For example, Gaynor (1975) minimized the interpersonal relationships and Kulik, Kulik and Smith (1976) suggested that interactions with the staff do not

seem to be critical to the success of PSI. Kulik and Jaska (1977), and Caldwell et al. (1978) formed similar conclusions. Furthermore, Semb (1981) classified proctors as facilitators to PSI and noted that "proctors *per se* are not a necessary part of the system as far as the student's interaction with it is concerned" (p. 2). Similarly, Kulik et al. (1978) concluded that the:

> Amount of tutorial help available from proctors, for example, seems unrelated to overall student achievement. As long as quizzes are graded immediately, students perform at high levels in PSI courses. Additional action taken by proctors--discussion of individual quiz answers, individual troubleshooting--seem not to add to the success of PSI courses (p. 12).

The influence of various degrees of personalization have also been examined. Barton and Ascione (1978) examined the influence of two types of proctoring on performance and procrastination measures in a self-paced, introductory developmental psychology course. In their study, two groups of students had proctors who administered and graded quizzes, and provided feedback in the form of grade information and pass/fail status. The subjects in the proctored group had proctors that built up rapport with and praised the students, answered initial questions and provided verbal remediation. The non-proctored group did not receive any of these specific behaviors; however, they did receive written remediation.

Therefore, the proctored group received more personalized proctoring than the non-proctored group. The results, which differed from those obtained in other studies, indicated that the non-proctored students performed better than proctored students on most performance measures and they procrastinated less. The authors attributed this difference to the: (a) written remediation received by the non-proctored group, (b) better preparation for quizzes, and (c) less threatening and faster remediation. They also suggested that "in a self-paced course, with multiple choice examinations, proctors need not engage in rapport building, answer initial questions, provide praise or verbal remediation" (p. 20). Interestingly, their results demonstrated that the students preferred to interact with the proctors, receive verbal remediation and have their initial questions answered. In a similar study, Fernald, Chiseri, Lawson, Scroggs, and Riddell (1975) found no difference in performance between a group of students who received much contact with a proctor and a group of students who received little contact with a proctor. However, they also found that the students preferred the much contact condition.

In a study that included an examination of different amounts of proctoring, Farmer, Lachter, Blaustein, and Cole (1972) compared the final examination scores of

students who received proctoring on 25%, 50%, 75%, and 100% of the 20 study units in a psychology course. The students in each group had the appropriate percentage of quizzes graded in the presence of a proctor and they received the same type of proctoring. The investigators found no significant differences on the final exam scores among the groups. Similar conclusions were made by Kulik et al. (1978). They examined 6 comparisons of control groups with ample interaction with proctors to experimental groups with limited or no interaction. In all comparisons, the quizzes were scored objectively and immediate feedback was provided. Therefore, the essential difference between the groups was the amount of personal contact they received. One of the overall conclusions of the investigators was that student achievement did not seem to be related to the amount of interaction between proctors and students provided that the quizzes were graded immediately.

Although the literature does not provide strong support for a positive relationship between proctoring and achievement, it does suggest that the presence of proctors has a positive influence on the rate of student progress, as measured by retake rates, through a course. For example, Farmer et al. (1972) demonstrated that proctoring in a personalized course decreased the time it took to

complete the course and decreased the number of retakes that were necessary to demonstrate mastery. Similarly, Johnson and Sulzer-Azaroff (1975) indicated that non-proctored students required more retakes than proctored students to demonstrate mastery.

The Influence of Feedback, Mastery, and Self-Pacing on the Effectiveness of PSI

This section of the review will be based on an examination of the influence of feedback, mastery and self-pacing towards the overall effectiveness of PSI.

In general, the value of feedback has been recognized as a critical element in the learning process. For example, Gagne (1970) stressed the value of feedback in the learning environment and Mc Keachie (1976) has stated that "the more feedback given, the more learning results" (p. 824). The literature provides overwhelming evidence for the effectiveness of immediate feedback in PSI. For example, Calhoun (1976) concluded that the immediate feedback was one of the least expendable components of PSI and Kulik and Jaska (1977) indicated that immediate feedback was critical to the effectiveness of PSI.

Furthermore, Kulik et al. (1978) examined four studies that compared the influence of immediate and delayed feedback on achievement and concluded that "delaying feedback in PSI courses interferes with student retention of course material" (p. 8). In contrast, Robin (1978) has suggested that the feedback may not have to be immediate and that a one class period delay may not result in inferior student performance. He indicated that "one possible reason for this finding was that the feedback may have been confirmatory rather than informative" (p. 86). However, he also cautioned that delayed feedback in some courses, such as those that involve programmed and/or hierarchial materials, may distract students and reduce retention. Interestingly, he also indicated that the students preferred the immediate feedback.

The mastery criterion of PSI receives widespread support in the literature. For example, Hursh (1976), Taveggia (1976), Kulik et al. (1976), and Kulik et al. (1978) indicated that unit perfection contributed to the superiority of PSI. Caldwell, Bissonnettee, Klishis, Ripley, Farudi, Hochstetter and Radiker (1978), in their examination of the components of PSI, concluded that "of the five essentials, mastery is the essential essential" (p. 65). Semb (1981) also suggested that mastery learning

was the mainstay of PSI. Furthermore, he suggested that the role of the other components was to support the mastery criterion. In contrast, Fernald (1975), in a study that involved the manipulation of pacing, mastery and proctor contact, found that the perfection requirement had no effect on quiz or exam performance in an introductory psychology course. However, the investigators noted that "the results may have been due to quizzes that were not very difficult" (p. 149).

Instructional systems that include a mastery criterion usually have a concurrent self-pacing component that allows the students to proceed through the course at their own rates. The literature is inconclusive about the influence of self-pacing on the effectiveness of PSI. For example, Taveggia (1976) indicated that self-pacing, along with mastery and the use of proctors, contributed to the superiority of PSI. Similarly, Fernald et al. (1975) found that self-pacing increased student achievement in a psychology course. In contrast, Farmer et al. (1972) indicated that self-pacing does not seem to be critical to the success of PSI. In subsequent studies, Kulik et al. (1976) and Kulik and Jaska (1977) suggested that self-pacing was not critical to PSI. Moreover, Calhoun (1976) indicated that self-pacing was one of the most expendable components of PSI. Kulik et al. (1978) also

indicated that self-pacing could be curtailed without diminishing student achievement.

In summary, the effectiveness of PSI on achievement and retention has been well established. The literature also clearly demonstrates that this effectiveness is dependent upon immediate feedback and mastery for its success. In contrast, the value of self-pacing and the effectiveness of the personalization are not as well established. Furthermore, the literature suggests that personalization may not be a vital contributing factor to the effectiveness of PSI. Therefore, the investigator believes that computers could be used as proctors as long as the computers perform the administrative roles of the proctor and provide the immediate feedback that is essential to the effectiveness of PSI. An examination of the capacity of the computer to perform these functions follows.

The Ability of the Computer to Function as a Proctor in PSI

The idea of using computers as proctors in PSI, which seems to contradict the basic concepts of personalized and individualized instruction, is not new. For example, in

1968, Keller noted, with some reservations, that proctor functions could be carried out with computers.

One major argument against using computerized proctoring is that their use will limit the personalization of PSI courses and the effectiveness of the system will be reduced. For example, Keller (1968) felt that computerized proctoring would limit the personal advantages of the system. Moreover, he consistently emphasized the role of personalization in PSI courses. However, as presented in a previous section, the literature suggests that personalization may not be a vital contributing factor to the effectiveness of PSI and that the effectiveness of PSI is based on other components such as feedback and mastery. In addition, the literature does not support the concept that computers bring about depersonalization of instruction and, in many cases, the literature suggests that computers facilitate the individualization of instruction. For example, Cross (1976) could not find any evidence that students feel depersonalized by their sessions with the computer. In addition, in an evaluation of PLATO, Alderman, Appel and Murphy (1978) reported that PLATO students, when compared to non-Plato students in similar courses, thought that they had received individual attention to an equal degree. Furthermore, Bork (1979), indicated that computer

contact is highly individualized, humanizes education, provides a unique learning experience and allows for individual pacing.

The literature also suggests that technology has a vital role in personalized and individualized instructional systems. For example, in an introduction to seven reports on technology and personalized instruction, M^{C}Michael and Hinton (1978), noted that the reports demonstrate that "Technology, properly used, can enhance the effectiveness, the efficiency and the personalization of instruction" (p. 142). A similar attitude was expressed by Pennypacker (1978) who indicated that computers could provide custom-tailored materials to meet the momentary needs of the individual student. He emphasized that this ability was "An absolutely indispensible part of truly personalized instruction" (p. 147). He also indicated that the computers were "Fully compatible with the tenets and practices of PSI" (p. 150). Tyler (1981) provided additional support for this view when he suggested that the individualization of instruction would probably expand because of technology which included the microcomputer. He emphasized the computer's ability to provide a continuous record of individual progress, mastery, and diagnostic testing and prescriptive information.

There is also support in the literature that computers can increase the personal contact between faculty members and to students. For example, Kulik et al. (1980a), in their meta-analysis of 59 independent evaluations of the effectiveness of computer-based college teaching, concluded that instructional time with computers was about two-thirds that of conventional courses. This finding was consistent with those of Cross (1976), Edwards, Norton, Taylor, Weiss and Dusseldorp (1975), and Thomas (1979) who have reported that the use of the computer, usually in the form of tutoring or drill and practice, decreases the time needed for instruction. These findings suggest that the use of computers in PSI courses may increase the amount of time that students will be available to meet with the faculty. Other investigators have reported that computers have increased the amount of time that faculty members have available for students. For example, Summers (1984), in a description of a computer program called TESTOR, noted that the program freed the instructor from time consuming jobs and allowed the faculty to to use the time to deal with individual students. Furthermore, M^{C}Farland, Hallett, and Hunt (1983) also indicated that the use of computers in their PSI physics course allowed more time for the instructors to interact with students. A similar attitude

was expressed by Towle, Cohen, and Cohen (1973) and Roll and Pasen (1977).

Some proponents of computerized proctoring have indicated limits to the use of computers. For example, Pennypacker (1978) suggested that "Direct instructional contact should never be entirely supplanted by the computer" (p. 149). Furthermore, he asserted that human backups should be available because "there will probably always be certain motivational functions that are performed better by a warm, understanding human than by a cold impersonal machine" (p. 149). A similar attitude was expressed by Hursh (1976) who cautioned that "it may be of the utmost importance that the proctor be a person, who can do more than grade and give simple feedback on quiz performance" (p. 100). In the same analysis, Hursh called for additional research to determine the protor behaviors that contributed to the success of PSI.

An examination of the literature reveals that computers are extremely capable of meeting, and in many cases, exceeding the proctor requirements of PSI. Many examples of these capabilities are found in the descriptions and studies of computer managed instruction and in evaluations of PSI courses that involve computer applications.

The first example of computer managed instruction within individualized courses demonstrates the ability of the computer to generate paper quizzes and to provide highly individualized instruction that is based on the results of the quiz. Summers (1984) developed the TESTOR program that is used in the modularized introductory laboratory courses in the general biology program at the University of Missouri. These courses provide self-pacing within a ten day cycle and they have a mastery requirement of 70 percent and retakes are available. The program had been used for 4 semesters to serve 4,188 students and to provide them with over 45,000 quizzes. In this program, a computer is used to provide student evaluations and manage all records. The quizzes are taken in the Testing Center that is staffed by graduate assistants for a minimum of 30 hours per week. The TESTOR program, at the direction of a proctor, randomly generates 10 item quizzes from multiple choice item banks. Because the computer prints the quizzes on paper, the student does not interact directly with the computer. The printed quiz is corrected by the proctor who then provides the feedback to the student. If a retake is needed, TESTOR prevents students from retaking the quiz on the same day.

TESTOR also maintains student records on a daily basis and calculates grades. This information is provided via a video terminal or printed copy. To decrease the impersonableness of using the computer, the TESTOR program generates regular reports that alert teachers to students who are having problems. TESTOR also provides information on class performance and quiz statistics. The author indicated that the TESTOR program increased the amount of time that the faculty could deal with students.

Almost 91 percent of the students demonstrate mastery of the units and 95 percent of them demonstrate this mastery on the first or second attempt. Therefore, this program is effective in providing the quizzes and it does not seem to limit the students' achievement. Student evaluations of the program have been favorable. For example, two thirds of the students felt that the computer testing program was useful in helping them budget their study time while only 7 percent felt that it was of no use in this regard. In addition, 60 percent of the students felt that their final grade would be higher as a result of the computer testing program and 54 percent indicated that this form of evaluation reduced the anxiety they felt about taking major examinations in biology.

In summary, TESTOR is an effective and efficient program that provideds paper quizzes, maintains all student and class records, and generates quiz analyses. The program also identifies students who are having problems and it provides this information to the teachers. TESTOR increases the time that the faculty has available to spend with individual students because it performs many of the administrative tasks of personalized instruction. Therefore, the computer facilitates the personalized aspects of the course. Furthermore, the students are supportive of the TESTOR system.

The following example demonstrates the ability of the computers to generate quizzes that are made available to students who are remote from the campus. In addition, the quizzes are scored by the computer and the students do not interact with the computer. Kelly and Anandam (1978) described the computer-based communication and diagnostic system named Response System with Variable Prescription (RSVP) that was developed and operates at Miami-Dade Community College. RSVP, in conjunction with telephones, printed materials and audio-visual materials, is part of the Division of the Open College which offers from 12 to 15 courses and serves an average of 2,000 students each term. These students are remote from the campus and they proceed through courses at their own pace. The only time

that they have to be on campus is for midterm and final exams; however, they do have the option to go to the campus for additional help. The functions of the system are to: (a) maintain records of personal information and performance; (b) provide feedback in the form of quiz scores, diagnosis of student problems, personalized prescriptions; (c) prod students who are negligent with assignments; and (d) provide the instructor with reports that include, but are not limited to, item analyses and test statistics. In this system, the faculty develops multiple choice items that are incorporated into six to 15 RSVP surveys (quizzes) for each course. The surveys are made available to the students who respond to the survey items on computer-scorable cards which may be mailed to the appropriate faculty member. RSVP processes the cards and responds with personalized, individualized letters that contain pre-determined faculty responses to the student. The responses of the letters are based upon the answers provided by the students and student characteristics such as age, week of entry into the course and past performances. The authors indicated that:

> The personal, individual attention given to the students in RSVP letters is repeatedly claimed by them as the most rewarding and satisfying experience in college-level courses. Term after term

> statistical analysis has yielded a significant positive correlation between level of participation in RSVP surveys and performance in course examinations (p. 163).

In addition, the authors reported that, in a previous term, the students who used RSVP had lower attrition rate and higher levels of achievement than students who did not use the system.

Although the courses noted by Kelly and Anandam were not specifically described as PSI courses, this report demonstrates the viability of using computers within a PSI format. The authors concluded that:

> RSVP had great potential to improve upon the personal-social environment of PSI courses. RSVP can effectively provide consistent feedback to individual students that is customarily given by proctors in PSI. The added benefits RSVP provides for PSI are: 1) carefully developed feedback programs by the master faculty consistently implemented by RSVP, 2) the chores of record-keeping no longer requiring faculty or proctor time, 3) problems of time restraints and lack of trained proctors posing no threat to effective implementation of PSI, and 4) feedback to students not subject to proctor's misinterpretation or lapses of memory (p. 164).

Therefore, RSVP illustrates that computers can provide highly personalized instruction to large numbers of students.

In the following examples of computer management, the students have some type of interaction with the computer. One type of interaction involves the correction of an

answer sheet from a paper quiz, computerized record keeping and the generation of feedback by the computer. The other type of interaction involves on-line administration and correction of the quiz by the computer, computerized record keeping and the generation of feedback by the computer.

In 1978, Pennypacker, who had considerable experience with individualized instruction and limited knowledge of computer, described the effective use of computers in personalized courses at the University of Florida's Personalized Learning Center (PLC) and the Navy's system of computer-manager instruction (CMI) on a large scale basis. In this report he indicated that "Computers become a necessity whenever the target population exceeds the usual size of a typical college course" (p. 147). The report describes the following computer functions in personalized instruction: (a) materials production, (b) scheduling, (c) measurement and record keeping, (d) management, (e) quality control, and (f) research. However, only those functions that are proctor-related, i.e., materials production, measurement, and recording, and management, will be discussed.

Pennypacker indicated that the role of the computer in the production of materials at the PLC involved the generation of quizzes that were eventually corrected by

proctors. The computer selected quiz items, which were based on the individual need of the student, from large pools of stored items. He noted that this selection process was a function usually performed by proctors. In addition, he noted that systems with large enrollments, such as the PLC with over 1,000 enrollments per quarter and over 20 courses, could overwhelm unaided proctors.

Furthermore, Pennypacker indicated that a major requirement of PSI was the ability to provide immediate scoring, usually a function of the proctor, so that timely feedback could be provided to the student. To illustrate the way in which the computer could perform this grading and feedback function, Pennypacker described the scoring and record keeping capabilities of the Navy CMI system. He indicated that a centrally located computer had daily interactions with students located in various states. Each interaction involved the correction of an answer sheet, the storage of the quiz results, and the presentation of immediate feedback to the student in the form of remediation or a message to advance to the next assignment. The entire process of correction, storage and remediation took approximately 20 seconds and Pennypacker noted that this amount of time was "But a fraction of the human support time necessitated by proctor grading" (p. 148).

Pennypacker's experiences led him to the following conclusions: (a) computers can reduce the overall human requirements substantially, and (b) computers can relieve proctors of much of their administrative functions.

Pennypacker's report also illustrates the computer's capacity to provide highly individualized instruction and to process massive amounts of data. For example, Pennypacker indicated that the PLC has over 1,000 enrollments per quarter in up to 20 courses while the Navy's CMI system has one or more daily interactions with 7,000 students located in California, Illinois, Florida and Tennessee. He also noted that "Personalized, computer-based instruction on a mass scale has been found by the military to be at least as effective as, and far more efficient than, their former methods" (p. 148). Moreover, he indicated that this conclusion should be applicable to college instruction.

The final examples of computer management differ from the previous examples because the quizzes are taken on-line and they are corrected immediately without the aid of any type of answer card or course personnel. Bork (1978) indicated that an advantage of on-line quizzes was that no additional secretarial or instructor intervention was needed to process the quizzes.

The administration of on-line quizzes is variable and is dependent upon the type of computer equipment available. Although the first example of on-line quiz administration does not specify the particular type of interaction between the student and computer, it does illustrate the capabilities and effectiveness of on-line computer managed quiz administration. And, it also demonstrates the capability of the computer to administer and correct constructed response quiz items. This demonstration of the use of constructed response quiz items is critical because one of the arguments against using computerized proctoring is that it is limited to multiple choice quizzes. Kelley (1977) described the computer based Teaching Information Processing System, TIPS, that was developed at Duke and is used by over 40,000 students per semester in a variety of disciplines such as geology, economics, history, psychology, philosophy, and sociology. This system generates multiple choice and/or objective quiz items; the correction routines for the objective test items allowed for misspellings. The on-line quizzes, which take about 15 minutes to complete, are processed by a computer that produces individual printed reports for the students within hours of taking the quiz. The reports identify weaknesses and provide specific assignments that could be

used to overcome the indicated deficiencies. In addition, the reports identify areas of strength and provides activities that are based on these strengths. Furthermore, the computer generates summaries for the faculty and staff that could be used for the early identification of student who were having problems. The faculty could also use the information in these reports to modify their teaching. For example, the faculty could emphasize the areas that were difficult for the students and put less emphasis on the areas that the students had mastered. Kelley also indicated that research based on over 1,000 economics students revealed that:
1. achievement increased by a mean of 15 percent;
2. approximately equal gains in achievement were demonstrated on multiple choice, short answer, problem solving, and essay questions; 3. there was no significant hostility towards computers; and 4. the effect on achievement was maintained over a two year period.

Towle et al. (1973) described a PSI undergraduate psychology course that enrolled between 25 and 100 students per term and required the use of teletype. When the students are prepared to demonstrate mastery, they follow a simple sign-on procedure at the computer. The computer presents the quiz via teletype and the students respond to the questions by typing their answers. After

the computer processes the responses, it provides feedback to the student. All information is stored by the computer for item analysis, quiz statistics and grade calculations. In summary, the investigators indicated that "The computer acted as a test generator, test administrator, student evaluator, and data collector; and analyzed data necessary for the improvement of instruction and student evaluation of the course" (p. 138). Although the investigators indicated that the computer was not absolutely essential, they concluded that the computer was instrumental in providing individualized pacing and testing procedures and that the computer facilitated instruction.

Another type of on-line quiz administration, which is available on both minicomputer terminals and microcomputers, utilizes a cathode ray tube (CRT) that is similar to a television screen to present the quiz items. Bowles (1978) provided an illustration of this use when he described a PSI introductory computer science course at the University of California at San Diago. This illustration described a PSI format in which microcomputers were used to supplement proctors and thereby increase the amount of time that the proctors could provide individual attention to students. The students in this course had to complete a self quiz before

they could take the formal unit quiz and they could discuss these quizzes with the proctors who were also available to explain points of misunderstanding. The formal multiple choice quizzes were administered and corrected by the microcomputer. The computer also performed record keeping responsibilities to such an extent that it virtually eliminated all record keeping functions of the proctor.

The quiz programs utilized in the computer science course also demonstrated the versatility of the computer. For example, the computer presented the answer alternatives one at a time in a random sequence. The students had to determine whether each selection was correct or incorrect until the correct choice was displayed. The investigator indicated that this "concealed multiple-choice strategy" (p. 152) helped the students learn the material. Another advantage of these programs was that they would display the correct answer, along with an explanation, if the student responded incorrectly. The author indicated that "this immediate reinforcement was sufficient to clear up a misconception" (p. 153). In addition, the computer-generated explanations decreased the need for proctors.

Another example of quizzes in which the questions are displayed on a cathode ray tube was described by Sorlie, Essex, and Shatzer (1979). The authors described a computer-assisted examination program that was initiated at the School of Basic Medical Sciences at Urbana-Champaign. The curriculum is modularized and it is based on 13 medical science disciplines. The students, who proceed through the curriculum at their own pace, choose the sequence of the disciplines. After they complete each discipline, the students must take an objective, comprehensive examination. This computer program allowed the students to schedule computer time for their examinations. At the time of the appointment, the students sign-on to the computer and choose the appropriate examination. The questions are displayed by the computer and the students enter their responses directly into the computer. These responses are corrected immediately; however, no performance feedback is presented until the examination is completed. The students also have the opportunity to skip questions that will be repeated at the end of the examination.

In this system, the computer also provided the students with the opportunity to correct previous errors and to gain additional points on the examination. At the

end of the examination, the computer displays scoring information. Within one hour after the completion of the examination, a hard copy of the results is available along with test and class performance information. In addition, the students are provided with diagnostic information that includes individualized, remedial information.

In summary, research demonstrates that the computer: (a) has the capacity to provide extensive, individualized feedback to the students; (b) can provide vital class and individual student information to the faculty; (c) has an extensive capacity to maintain records and calculate grades; (d) has the ability to produce constructed response quiz items; (e) can correct constructed response items and allow for misspellings; (f) can allow students to correct errors and gain points; (g) can produce and score paper quizzes; (h) can provide individualized, printed reports to the students; (i) can provide printed class and quiz reports to the faculty; (j) does not dehumanize or depersonalize instruction; and (k) can serve students who are remote from the campus. Therefore, the computer can either be used as adjuncts to proctors or they can replace the proctors.

The Effectiveness of Computer Based PSI Courses

The literature unambiguously demonstrates that computers are capable of performing many of the functions of the proctor. In the following sections, studies in which the effectiveness of computer based PSI courses were compared to the effectiveness of traditional courses will be described. The studies also demonstrate the ability of the computer to perform various proctor functions.

Towle et al. (1973) examined the final grades of students in a computer managed PSI undergraduate psychology course that enrolled between 25 and 100 students per term. They found that over 80% of all students completed the 10 course units and received a grade of A. In contrast, 22% of the students who took the course with a traditional lecture-quiz method during the previous five quarters with four different instructors earned a grade of A. In addition, they reported that the overall response of the students to the computer managed course was highly favorable. For example, 93% of the students had a positive reaction to the course while 89% indicated that they would like to take another course that

used the same technique. However, these results are not conclusive because they were confounded by comparisons of students who were not matched and between groups of students who had different teachers.

In another study, Burnard (1978) compared the final course grades of an equal number of students (327) who were exposed to the same subject matter in a regular biology section and a computer-managed instruction (Bio-CMI) section at Ohio State University. The Bio-CMI Group used a PSI format and took interactive computer quizzes that were presented on a cathode ray tube. The quiz items, which were generated from an item bank of over 4,000 items, were of the multiple choice and constructed response variety. The correction program would accept variable spelling for the constructed responses. The items were also based on three levels of difficulty and on six levels of Bloom's taxonomy of the Cognitive Domain. In addition, the quizzes also included review questions.

During the quiz, the questions appeared on the CRT individually and the student responded directly to the computer. The computer corrected the answer immediately and informed the student about the results; however, the correct answer was not given. The computer kept track of all missed questions and used the information to provide the students with prescriptive information at the end of

the quiz. The students were able to retake an equivalent quiz after a period of study. If the second grade were higher, it was recorded; otherwise, the first grade was was retained. Interestingly, if the student did not attain a grade of 70% or above on the first quiz, the computer would not allow the retake until the following day. In addition, if a grade of 70% was not achieved by the third attempt, the computer locked the student out until the student had a conference with the instructor. The instructor had access to the lock-out standing of the students and, if the student did not contact the instructor, the instructor contacted the student. The computer also generated student information and class information that was available to the instructor. In addition, the instructor was able to leave messages to the class or to individual students on the computer.

The traditional section of the Burnard study was evaluated with two midterms, two practical exams, three in-class quizzes and a comprehensive final exam. Although the data generated was inconclusive because of uncontrolled variables, the trend in final course grades was toward better performance by the computer group.

A significant finding collected from 327 Bio-CMI student evaluations indicated that 76% of the students

felt that they became less apprehensive about taking quizzes on the computer as the course proceeded; only 6% felt more apprehensive. These evaluations also indicated that the students had a positive attitude towards Bio-CMI. For example, 80% of them indicated that, if given a choice, they would choose intergrated lecture labs with the Bio-CMI philosophy of testing. In addition, only 15% would choose a traditional course that had the Bio-CMI philosophy of testing and only 1% would chose the traditional format. In summary, this study: (a) suggested that a computer based PSI format would produce results that were superior to results achieved with a traditional format, (b) demonstrated that proctors were not needed in order to maintain a PSI format, (c) illustrated the versatility of the computer in maintaining grades and records, (d) demonstrated that students are highly receptive to interactive computer-testing and feedback presentation, (e) indicated that student apprehension over computer quizzes diminished with experience, and (f) demonstrated that computer programs were able to provide personalized, individualized instruction. Significantly, this report also illustrated that computer programs were capable of administering and correcting quizzes that included constructive responses. This illustration was similar to the demonstration of the

use of objective quiz items provided by Kelley (1977).

Roll and Pasen (1977) conducted an investigation to determine whether the reported superiority of PSI over traditional courses could be obtained by using computers as proctors. Seventeen pairs of community college students in an introductory psychology course were matched for precourse knowledge and assigned to one of two sections in which they used the same text. The students in the computer managed instruction (CMI) section used a behavioral objective study guide along with their text, took interactive computer quizzes, worked at their own pace and had to meet a mastery requirement of 80% achievement on weekly quizzes before proceeding to the next unit. They also spent 40 minutes per week in a lecture-demonstration and 110 minutes studying, receiving individual help from the instructor and taking computerized quizzes. The computer randomly generated 10 item quizzes, corrected the quizzes and provided immediate feedback. The feedback included the student's score, a listing of the concepts that were not understood and references to the appropriate pages in the text.

The students in the traditional section did not have objectives and they attended 150 minutes of lecture per week. They took weekly, manual quizzes that contained items from the same pool of items used for the computer

quizzes. This section did not have a mastery level criterion or retake quizzes and the students received the same type of feedback as the students in the CMI section. Therefore, the study compared a typical PSI format with computer proctoring to a traditional lecture format with feedback available.

The CMI students performed significantly better on a common final examination than the traditional students. These results suggest that the computer managed PSI section achieved results that were superior to the results of the traditional section. However, the investigators indicated that the findings were confounded because different teachers taught the two groups. They also indicated that the questionnaire revealed that the CMI students did not feel that they learned more from their instructor than the traditional students. Based on this information, they concluded that the difference between the two groups on the final exam was not due to differential teacher effectiveness. Moreover, they concluded that the superiority of the CMI group was due to the effectiveness of the computer based PSI format.

These results, which are consistent with other PSI results reported in the literature, are significant because they were obtained without the help of any proctors. Therefore, these findings suggest that the

effectiveness of PSI may not be due to the presence of proctors per se, but to functions performed by the proctors or other PSI components.

Furthermore, the results of an anonymous questionnaire suggested that the CMI students felt that they acquired a better grasp of basic concepts and that they were able to get more individual attention from the instructor than the traditional students. The researchers noted that the computerized quizzes and record keeping allowed the instructor to spend more time with individual students. The CMI students also felt the computer quizzes were helpful and pleasant to take and they gave the course a higher overall rating.

A study was conducted by Herrmann (1982) to evaluate the use of a computer as a proctor/tutor in an introductory psychology course at the University of Guelph in Ontario, Canada. In this investigation, 219 students were given the option of choosing mastery quizzes to be administered by a computer or human tutor/proctor. Interestingly, more students chose the computer, 142 to 77. According to the investigator, some students were forced, with their concurrence, into the human proctor condition. As a result, half of the students received tutoring from experienced human tutors who were graduate students while the other half received it from an

interactive computer program. The tutors were available during 15 one hour time periods from Monday to Friday while the computer terminals were available 22 hours a day, 7 days a week. For security purposes, items were displayed for a maximum of 30 seconds and the entire quiz presentation was limited to 5 minutes. All of the feedback, which was based on missed materials, consisted of simple statements and was limited to the concept and its location within the written course materials. The students in both groups used the same text, mastery guide and study guide.

To measure the effectiveness of each type of tutor/proctor, Herrmann compared student performance on a common final examination. There was no significant difference in performance between the groups on the final examination. However, these results are not conclusive because the groups were not matched, some students were forced into the human proctor condition, and the proctors were available for different amounts of time and at different times of the day. In addition, the study was biased against the students with the computerized proctors because they had a time limit on each item and on the entire quiz whereas no time limit was indicated for the students with the human proctors and they did not have the same opportunity as the human group to review quiz

items. These confounding factors must be considered in future studies. Consistent with the research cited earlier, both PSI groups achieved results that were superior to those achieved in the traditional course.

To collect information about student behavior in relation to the PSI proctor, Herrmann administered an anonymous questionnaire at the end of the final examination. An analysis of the questionnaire results revealed the following factors that are germain to this study: (a) the female students usually chose the human proctor while the males chose the computer proctor, (b) each group liked its respective type of proctoring, (c) the computer group felt that the modular quizzes were difficult while the human group felt that the modular quizzes were fair, (d) the groups made the same number of attempts per module to demonstrate mastery, (e) in retrospect, each PSI group indicated that they would have preferred to take the course in the format that they experienced, (f) the computer group felt that the feedback they received was of little help whereas the students with the human proctors felt that the feedback was helpful, and (g) the students found the extensive details necessary to operate the computer to be simpler than the procedural

instructions necessary for the human proctor.

In summary, the results reported by Towle et al. (1973), Burnard (1978), and Roll and Pasen (1977) suggest that: a. computers can administer and grade quizzes, provide individualized feedback, and maintain student records; b. students have positive attitudes toward computerized proctoring; c. PSI courses with computerized proctoring are more effective than traditional courses; d. PSI courses do not require the presence of human proctors; and e. computerized quizzes can include constructed response questions. The Herrmann study (1982), suggests that computerized proctoring is as effective as human proctoring and that students felt that computers were easy to use. However, none of these investigations conclusively revealed whether there was any difference between the effectiveness of computerized proctoring and human proctoring on achievement and/or retention. Therefore, this study was initiated to compare computerized and human proctoring. It differed from the previously described studies because the comparisons were between students who were matched and had the same instructor, materials, instruments, and format. This study also based its examination of proctor preference on students who were exposed to both conditions.

C H A P T E R I I I

METHOD

Subjects

The subjects were 32 students in a Human Biology II course that was taught by the investigator at Quinsigamond Community College during the spring of 1984. The ages of these students ranged from 18 to 49 and their Quality Point Averages (QPA's), which were based on a 4 point scale, ranged from 1.62 to 3.86 and the number of college credits that they had attempted ranged from under 12 to over 60. Twenty-nine (91%) of the subjects were female. The characteristics of the subjects are summarized in Table 1.

Table 1

Student Characteristics

Ages	
Under 25	15
Between 26-35	11
Over 36	6
Mean Age	27.75
Program of Study	
Liberal Arts	17
Nursing	7
Dental Hygiene	8
Credits Attempted	
0-24	10
25-48	14
Over 49	8
Q.P.A.	
1.00 - 2.32	8
2.33 - 3.25	16
Over 3.30	8
Mean Q.P.A.	2.85
PSI Experience	6
Computer Managed Instruction Experience	4

One student took one quiz for the first module and then withdrew from the college. Because of this student's limited involvement in the study, her achievement on this quiz was not included in any calculations. Another student, who had completed three modules, withdrew from the college for medical reasons and another withdrew for personal reasons after completing two modules. A fourth student completed all modules but, for personal reasons, did not take the retention examination. Therefore, 31 students completed the first two modules, 30 students completed the third module, and 29 students completed the fourth, fifth, and sixth modules. Twenty-eight students participated in the retention phase of the study. The number of subjects participating in the study is summarized in Table 2.

Table 2

The Number of Subjects Participating per Module and in the Retention Study

Module #	1.	2.	3.	4.	5.	6.	Retention
Subjects	31	31	30	29	29	29	28

Setting and Personnel

The proctors, who had experience as PSI proctors in Human Biology, held all proctoring sessions in the Individualized Learning Center (ILC). The first part of the human proctoring session took place in the proctor's office and the quizzes were administered to the students at tables that were set aside for testing. These tables were adjacent to the proctor office and they were easily monitored by the proctors. The final phase of the session, which included quiz correction and remediation, occurred in the proctor's office. For the computerized proctoring, the students went to the proctor's office to pick up the appropriate disc and summary sheets that were necessary for the computerized session. Once they had the materials, the students went to the computer terminals that were located on tables that were easily monitored by the proctors. At the end of the session, the subjects returned all materials to the proctor.

In order to ensure that all computerized and human proctoring sessions were available for the same amount of time per week and at identical times, the proctors also had the responsibilities of overseeing the computerized proctoring sessions. In this capacity, the proctors

monitored the computerized proctoring sessions and they provided and collected all of the materials that were necessary for the completion of the computerized sessions.

Materials

Individualized Instruction Handout

This handout, which was developed by the invesigator, described the procedures for using the Keller Plan. A sample of this handout is in Appendix A.

Study Guides

Study guides, which consisted of an introduction, instructional objectives, study questions, and an assignment, were developed by the investigator for each module. The topics of the modules were: (a) An Introduction to Neuron Anatomy and Physiology, (b) Neuron Physiology, (c) The Synapse and Synaptic Transmission, (d) The Central Nervous System (with an emphasis on the anatomy of the spinal cord), (e) The Central Nervous System (with an emphasis on the reflex activity of the spinal cord), and (f) The Cerebrum. Each of these assignments covered from six to ten pages of text and they were based on Tortora and Anagnostakos's Principles of Anatomy and Physiology, 3rd ed., New York: Harper and Row, 1981.

Computer Operations Study Guide

This handout was developed by the investigator and it described the computer operations that were essential to this study. These operations were: (a) inserting and removing a disc into and out of the computer, (b) turning the computer on and off, and (c) responding to the computer via the keyboard.

Computer Keyboard Operations Program

This interactive program was developed by the investigator to be used in conjunction with the study guide described above. This program, which could be completed within 20 minutes, provided immediate, hands-on experience with the operations that were incorporated into the computerized proctoring programs described below.

Computer Proctor Programs

A master proctor program, which was written in Applesoft BASIC, was developed by the investigator for each module. The program performed the following proctor functions: (a) greeted the subject; (b) randomly selected a quiz for the first quiz attempt; (c) administered the quiz; (d) corrected the quiz; (e) recorded grade information; (f) displayed the quiz grade, and if appropriate, presented a congratulatory statement to the subject; (g) displayed the number of any questions that were answered incorrectly; (h) displayed the number of any

objectives that were not achieved; (i) displayed specific page assignments that covered the information that was necessary for each missed objective; and (j) provided a closing statement.

Proctor Guides

These guides, which were to be used by the proctors during each proctoring session, were prepared by the investigator for each module and they contained quiz answer keys and grade sheets on which quiz scores were recorded along with the quiz form. In addition, the guides also contained a list of the question numbers for each quiz and the corresponding objective on which each question was based. The list also indicated prescriptive information in the form of a specific assignment for each objective in the module.

Summary Sheets

These sheets, which were used with all the proctoring sessions, included space for the subject's name, the date, the number of the module, the form of the quiz, the amount of time that it took to complete the quiz, the grade, the number of incorrect responses, the number of any question that was answered incorrectly, the number of any objective that was missed, prescriptive information, and the type of proctoring. In addition, the subject was directed to

indicate whether: (a) the quiz was the first or second quiz for the module, (b) the subject previewed the quiz items, (c) the subject reviewed the quiz items, (d) the subject was taking a retake quiz. A sample of these sheets is in Appendix B.

Proctor Preference Sheet

This sheet directed the subject to indicate his or her name and proctor preference for the sixth module. It also indicated that it could not be completed in the presence of a proctor and that it had to be returned to the investigator. A copy of this sheet is in Appendix C.

Interview Schedule

This schedule, which requested the date and signature of the interviewee and the interviewer, described the purpose and format of the interview, and informed the interviewee that the interview could be terminated at any time. A copy of this schedule is in Appendix D.

Equipment

Apple II Plus Microcomputers

The Apple II Plus microcomputers were used for the computerized proctoring and to develop the computer programs for this study.

Statistical Analysis Software

This software package, entitled HSD Stats, was produced in 1981 by Human Systems Dynamics and was used for the t-tests and Chi-Square analyses in this study.

Correction Machine

A Scantron correction machine, model 3322, was used to score the retention items and to determine the accuracy of the modular quiz grades and the grading of the retention items.

Calculator

A Monroe Programmable Calculator, model 325 Scientist, was used to calculate a Pearson Product Moment Correlation between the proctor graded quizzes and the machine grade quizzes. The correlaton was used as an interscorer agreement index.

Instruments

Class Questionnaire

A demographic questionnaire was developed to ascertain the following characteristics: a. age, b. college credits attempted, c. experience with the Personalized System of Instruction, d. experience with computer managed instruction, e. gender, and f. program of study. A copy of this questionnaire is in Appendix E.

Readiness quiz

This 12 multiple-choice item quiz assessed the subject's knowledge of the Individualized Instruction Handout and the operations of the computer. Furthermore, it had to be passed with a minimum grade of 90% before the student could commence with the individualized modules.

Modular Quizzes

Two alternative forms of criterion-based quizzes were developed for each module and the quizzes contained one multiple-choice question, with four alternatives, for each objective in the study guide. These quizzes were printed and programmed into the proctor computer program for each module.

Attitudinal Questionnaire

A questionnaire was developed by the investigator to ascertain the subject's attitude toward each type of proctoring. The anonymous questionnaire contained 22 statements that were to be rated on an 11 point Likert-like scale that ranged from 0, which represented strong disagreement, to 10, which represented strong agreement. A 5 on this scale represented neither agreement nor disagreement. The statements focused on the following areas: taking quizzes with each type of proctoring, attitude towards machines, using the computer, accuracy of each proctor condition, trust in each type of proctoring, and personableness of each type of proctoring.

The questionnaire also contained three additional questions. Two items asked the students to compare their degree of comfort with the first and last session of each type of proctoring. The third question asked the students to compare their overall perceived level of difficulty for the quizzes administered with each type of proctoring. The questionnaire also asked the subjects to indicate their proctor preference for the sixth module and provided space for open-ended comments. A copy of this questionnaire is in Appendix F.

Retention Examination

The retention examination was given to all subjects in class as part of the usual midterm examination. It was announced a week in advance and did not have any time limit. The items in the retention section consisted of a stratified, random sample, (n = 61), of quiz items from the modular quizzes.

Design of the Study

This study used both a within and between subject, counterbalanced design to compare the effects of computerized proctoring versus human proctoring on achievement of remediated instructional objectives and the retention of successfully remediated instructional objectives. The subjects in the study were matched according to age (within five year classes), college credits attempted (within 12 credit classes), degree of experience with PSI, degree of experience with computer managed instruction, college program and gender. After the subjects were matched, they were randomly assigned to one of the two groups.

For five modules the proctor treatment in each group alternated between human proctoring and computerized

proctoring. For the sixth module, all subjects were provided with their preferred method of proctoring. Table 3 illustrates this design.

Table 3

Sequence of Experimental Proctor Conditions for each Group

Module #	1.	2.	3.	4.	5.	6.
Group 1.	H	C	H	C	H	preference
Group 2.	C	H	C	H	C	preference

Note: C = Computerized Proctoring, H = Human Proctoring.

Procedure

Preliminary Preparation

Prior to the experiment, the investigator developed the Computer Operations Study Guide, Summary Sheets, Computer Keyboard Operations Program discs and the Computer Proctor Programs. Fourteen students, who would not be included in any experimental group, and who had no knowledge of the impending experiment, used these materials in a pre-experimental trial. The investigator modified these materials according to the feedback

generated during this pre experimental trial.

In addition, the investigator also prepared the Individualized Instruction Handout; the demographic questionnaire; and the Study Guides, Proctor Guides, and quizzes for the first two modules. The quizzes were constructed so that each instructional objective was represented on the quiz. To determine whether this quiz specification was met, the quizzes were independently evaluated by two biology faculty members. For each quiz, the faculty members were given a module to be used as a checklist. In the evaluation, the faculty members compared the module to the quiz and they noted whether each instructional objective was represented. If the quiz contained an item for each instructional objective, it was graded as acceptable. If the quiz did not contain an item for each instructional objective, it was graded as unacceptable. These quizzes and all subsequent quizzes were graded as acceptable.

The faculty members also evaluated the appropriateness of the quiz items. The evaluation of each quiz item was based on the following criteria: 1. Did the item measure the intended instructional objective? 2. Was the item appropriate for the intended instructional objective? 3. Was the item stem clear?

4. Was the item stem concise? 5. Did the item contain only one correct response? 6. Was the item free of answer clues? If the response to any of these questions was negative, the item was to be re-written. However, none of the items for these quizzes or any subsequent quizzes had to be re-written.

During the first class of the experiment, the investigator told the students that in order to collect information on their personal and academic backgrounds, they would have to complete a demographic questionnaire. This type of data collection was practiced in most of the courses in the college.

The students were also told that they would use the Personalized System of Instruction format to cover the next six modules. At this time, the experimenter explained the system and indicated that they would receive a descriptive handout on the system within a week. During this explanation, the investigator emphasized the role of the proctor and also explained that because there was a shortage of human proctors, computers would be used as proctors.

At this time, the investigator provided the students with the Computer Operations Study Guide that described the general operations of the Apple II Plus computer that they would use. Furthermore, the subjects had the

opportunity to ask questions about using the computer. The students were also informed that the last part of the second class meeting would be in the Individualized Learning Center (ILC) so that they could meet the proctors, gain experience in using the computer, and demonstrate, to the investigator or proctors, their ability to use the computer.

At the beginning of the second class, the students had the opportunity to discuss the operations of the computer with the investigator. After the discussion, the class went to the Individualized Learning Center (ILC) where they were introduced to the two proctors and then used the Computer Keyboard Operations Program that was available from the proctors. If the students had difficulty learning the operations, they received individualized instruction on the techniques from the investigator or a proctor until they could perform those operations. By the end of the class, the subjects had to demonstrate, to the investigator or to a proctor, their ability to insert and remove a disc, turn the computer on and off, run a program and respond to the computer. In most cases, it took approximately twenty minutes for the students to learn the necessary operations and, by the end of the class, all students had demonstrated their ability

to use the computer. While in the ILC, the students were informed about the usual procedures for signing up for a computer and for making appointments for the sessions with the proctors.

During the third class, the students were given the Individualized Instruction Handout that explained the procedures of the Personalized Stytem of Instruction. A discussion of the individualized format followed the distribution of the handout. During this discussion, the investigator emphasized that the proctors were prohibited from providing correct answers and that they could not teach or discuss any questions. In addition, the discussion focused on the quiz passing level of 90% and the retake policy. This policy provided an alternative quiz if the student did not achieve the 90% passing level on the first quiz attempt for each module. The experimenter also emphasized that the retake quizzes, which were mandatory, were limited to one per module.

Furthermore, the subjects were told that before they could begin the individualized modules, they had to pass a 12 point "readiness" quiz that evaluated their understanding of the PSI format and computer operations. They were also told that the quiz would be given during the next class.

Prior to the fourth class, the investigator used the demographic information from the questionnaire to produce a matched pairs list of subjects. The subjects were matched according to: (a) age, within five year classes; (b) the number of college credits attempted; (c) QPA; (d) program of study; (e) experience with computers; and (f) experience with the Personalized System of Instruction. The investigator randomly assigned the subjects to either group 1 or group 2. There was no significant difference between the mean age of the groups, the mean QPA's of the groups or the mean number of college credits attempted by the groups. In addition, the investigator produced a list of subjects in each group; these group lists were used to identify the subjects in each group and they were also used as grade sheets.

Furthermore, the "readiness" quiz, which consisted of 12 multiple-choice items, was developed by the investigator. This quiz was also evaluated by two biology faculty members who were given copies of the Individualized Instruction Handout and the Computer Operations Study Guide. They also used the Computer Operations Program disc. These faculty members, who used the quiz evaluation procedure that was described previously, indicated that this quiz was acceptable and appropriate.

The "readiness" quiz was administered and graded during the fourth class meeting and all students demonstrated an understanding of the PSI format and operation of the computer. Additional discussion ensued, after which the students were given the study guide for the first topic and were directed to write and study their responses to the objectives and study questions of the first study guide. The investigator also indicated that this work could be completed in the student's usual place of study, such as at home or in the library. The students were also given the deadline within which they had to complete all quizzes for the first module.

At the end of this class, the subjects were given their proctor assignments. Group 1 subjects were told that they would have human proctors for the first module while the group 2 subjects would use the computer as a proctor. Furthermore, the subjects were told that in order to increase the time that they would have available for proctoring, classes would not be held while the course was using the individualized format. However, the investigator also indicated that he would be available during the scheduled class times and during the usual office hours.

After the fourth class, the proctors were given the proctor guides and modular quizzes for the first module, the group lists, and the summary sheets. In addition, the proctors received the discs containing the master programs for the first module. During the course of the experiment, the proctors were given the subsequent study guides, proctor guides, quizzes, computer programs, and summary sheets when they were required.

Human Proctoring Session

The following procedure was used for the human proctoring session during which the subject took the first quiz for each module. When the subject was ready for the quiz, he or she made an appointment with the proctor. At the appointed time, the proctor greeted the subject, took the subject's name and compared it to the list of those who should have a human proctor for the module. After verification of the subject's proctor condition, the proctor randomly selected a quiz and noted the specific form of the modular quiz that the subject received. The proctor gave the subject the quiz, an answer sheet and two summary sheets and directed the subject to a table that was easily monitored for quiz security. At the completion of the quiz, the subject returned the quiz and answer

sheet to the proctor. After providing the student with one more opportunity to see the questions and his or her answers, and possibly change the answers, the proctor graded the quiz and recorded the results, along with a pass/fail notation, on the grade sheet. The answer sheet was then filed for future examination.

If the subject achieved a grade of 90 percent or higher, the proctor offered congratulations and provided the quiz grade for the summary sheets. In addition, if there were any incorrect answers, the proctor used the modular proctor guide to determine the specific objectives that were not achieved and determined the appropriate prescriptive information for each objective. Then the proctor told the student which objectives were missed and provided the appropriate prescriptive information. If the information on the summary sheet was incorrect, the proctor told the subject to correct the misinformation. After completing the summary sheets, the subject kept one and gave the second sheet to the proctor who stored it for the investigator. At this time, the student was given the opportunity to examine the corrected quiz before it was filed. Then the proctor provided the next module and, along with a social closing statement, reminded the subject that the next proctoring session would be with a computer.

If the subject did not attain the 90 percent grade, the proctor followed the same prescriptive information procedure described in the previous paragraph. At the end of the session, the proctor and subject made arrangements for the retake quiz which was to be administered by a proctor and was available after an hour.

The human proctoring session for the retake quiz involved the same verification, quiz administration, grading, prescriptive information, and record keeping procedures as the first session. However, for this session, the proctor selected the alternative quiz form for the retake quiz. At the end of this session, the subject received the next module from the proctor and was reminded that the next proctoring session would be with a computer.

Computer Proctoring Session

The following procedure was used for the computer proctoring session during which the subject took the first quiz for the module. When the subject was ready for the quiz, he or she signed up for a computer in the ILC. At the specified time, the subject presented identification to the proctor who compared it to the list of students who were to use the computer as a proctor for the module.

After verification of the subject's proctor condition, the proctor recorded the date and provided a proctor program disc and two summary sheets to be completed during the proctoring session. The subject, who performed all computer operations, was directed to a computer that was easily monitored for quiz security by the proctor.

The program greeted the subject and described the way in which he or she should respond to the computer's question. At the same time, the computer also described the way in which typing mistakes could be corrected. This information was followed by a procedural direction that provided information that was necessary for the continuation of the program. The procedural directions, which accompanied all computer displays, consisted of short statements that directed the student to interact with the computer in a specified manner. For example, the computer directed the student to press the number one key and then press the return key. Whenever the subject responded to the computer, the computer would respond by clearing the screen and presenting a new display with its own information and procedural directions.

At the direction of the subject, the computer displayed a question that asked the subject to type in his or her first name. Then the program directed the student, by first name, to type in the his or her last name, the

date and whether this was the first or second proctoring session. After the last response, the computer displayed all of the personal information and directed the subject to confirm its accuracy. If it was not accurate, the series of questions and the confirmation sequence were repeated. If the personal information was accurate, the computer indicated that the subject should have a pen or pencil and two summary sheets and that the student should put any texts or notes away. Then the program randomly selected a quiz from the two forms.

At the beginning of the quiz, the subject had the option to preview the questions. If he or she wished to begin the quiz immediately, the quiz routine that is described below started. Otherwise, the first question was displayed on the screen. On direction of the subject, each subsequent question was presented individually. When all questions had been previewed, the quiz began.

During the quiz, each question was presented individually and the subject was directed to respond with the appropriate answer choice. After each answer was entered into the computer, the monitor cleared and the next question was presented. When all of the questions had been answered, the computer displayed a question that asked if the subject wished to review and possibly change his/her answers. If the subject answered no, the computer

scored the quiz and recorded the quiz results and form in the student's file on the disc.

However, if the subject wished to review, the computer presented him or her with the option to review all questions or to review some of the questions. If the choice was to review all items, each question was displayed individually with the original answer. The computer directed the subject to respond with a new answer choice if he or she wished to do so. However, if the student wished to retain the original answer, he/she pressed the enter key and the next question and answer would be displayed.

If the subject chose to review some items, he or she was directed to enter the number of the item to be reviewed. The question was displayed individually with the original answer and the procedure that was described in the previous paragraph was followed. After responding, the student was directed to enter the number of any other item and the process was repeated until all of the desired questions were reviewed. There was no limit to the number of times students could review each question and answer. After either of the two review processes were completed, the computer followed the grading and recording procedures described above.

The computer program determined whether the 90 percent grade had been achieved; and, if it had been reached, the computer displayed the subject's first name, a congratulatory statement, and the quiz grade. The congratulatory statement, which was randomly generated from five statements, flashed on and off. Furthermore, if there were any incorrect answers, the computer also displayed the number of the questions that were answered incorrectly along with a list of the missed objectives. The program also directed the subject to copy the displayed quiz information onto the summary sheets. However, if the subject achieved a grade of 100 percent, the computer provided the option to either see the quiz items and his or her answers again or to proceed to the end of the program. If the option to see the questions was chosen, each item was presented individually with the subjects response. Otherwise, the final phase of the program, which is described below, was presented.

However, if the subject had some incorrect responses, the computer began the prescriptive information component of the program. In the first phase of this routine, the computer program identified the incorrect answers, identified the objectives that were not achieved and

determined the appropriate prescriptive information for each missed objective. Then the computer indicated that the subject should copy the prescriptive information onto the summary sheets. In response to the subject's direction, the computer individually displayed the number of each missed objective along with the appropriate prescriptive information. This sequence was repeated until all prescriptive information had been provided. At the end of this sequence, the subject had the option to repeat it or to continue with the program. If the subject wished to review the prescriptive information, the process was repeated.

After the completion of the prescriptive information phase of the program, the subject had the option to sequentially view all of the quiz questions with his/her original answers. If the subject chose the review, the questions and answers were displayed individually. Otherwise, the program proceeded to the final phase of the proctoring session.

At the end of the proctoring session in which the passing level of 90% was demonstrated, the computer directed the subject to return the disc and a completed summary sheet to the proctor and to pick up the subject's ID. In addition, the computer directed the subject to obtain the next module from a proctor and indicated that

the next proctoring session would be with a human. Finally, the computer directed the subject to turn the computer off. Upon receipt of the summary sheet, the proctor examined the sheets for completeness and recorded the quiz grade and form on the grade sheets.

If the subject did not attain the 90 percent grade, the computer provided the same quiz information and followed the prescriptive information procedure that was described above for those subjects who reached the 90 percent achievement level and had some incorrect answers. After the prescriptive information was presented, the computer indicated that the subject must take another modular quiz and it also reminded her or him to reserve a computer for the retake quiz. Then the computer directed the subject to return the disc and a completed summary sheet to the proctor and to pick up the ID.

The proctoring session for the retake quiz involved the same verification, quiz administration, grading, feedback, and record keeping procedures as the first session. However, for this session, the proctor selected a disc that contained the alternative form of the quiz. At the end of the session, the computer indicated that the subject should get the next module from the proctor. In

addition, the student was reminded that his or her next proctoring session would be with a human.

Proctor Preference

The investigator hypothesized that student preference of computerized proctoring would be greater than student preference of human proctoring. Therefore, at the end of the proctoring session during which the subjects completed the fifth module, the proctor gave them the study guide for the sixth module and the proctor preference sheet. The proctors told the subjects that the preference sheet was to be completed in private and they directed the subjects to give this written notification of their proctor preference for the sixth module to the investigator. When this choice was known, the investigator noted each student's preference on the grade sheets for the sixth module. The proctor procedures for the sixth module were identical to the procedures described above. The significance of these preferences was assessed with a Chi-square analysis.

Measurement of Achievement

The investigator hypothesized that student achievement of remediated instructional objectives, as demonstrated on quiz items, would be greater with computerized proctoring than with human proctoring. However, before this determination could be made, the accuracy of the proctoring technique under each proctoring condition was assessed because the technique could influence student performance on retake quizzes and on the retention examination. In this assessment of proctoring, the accuracy of grading and the accuracy of the proctor prescriptive information were evaluated. In addition, the characteristics of the items and quizzes used in the study were established along with a control.

Computer Proctoring, Grading, and Prescriptive Information

To determine if the computer programs were implementing the appropriate proctor procedures, grading accurately, and providing the correct prescriptive information, they were independently evaluated by a faculty member who was experienced in computer managed instruction and programming. The faculty member examined

a printout of each proctor programs, (n = 6), and graded it on the following components: (a) greetings; (b) directional instructions; (c) request for personal, identifying information; (d) confirmation of the personal information; (e) random quiz selection; (f) quiz preview; (g) the administration of the quiz; (h) review routine; (i) grading accuracy; (j) grade calculation accuracy; (k) the display of the subject's first name; (l) the presentation of the grade; (m) the accuracy of the pass/retake status; (n) the presentation of the congratulatory feedback, if appropriate, (o) display of directions to complete the summary sheets; (p) accuracy of the ability to determine the objectives that were missed; (q) accuracy of the prescriptive information; (r) the presentation of the missed objectives; (s) the delivery of prescriptive information; (t) recording of quiz grade, quiz form, and missed objectives; (u) opportunity to review the questions and the student's answers; and (v) appropriate closing remarks. If the component was present, the program earned one point; if the component was absent, the program did not earn a point. Therefore, each program was scored on a 22 point scale. The number of points earned was divided by 22 and the results was multiplied by 100 for a program grade. The faculty member scored each of the six programs with a grade of 100.

In order to determine whether the program presented the components listed in the printout, the faculty member also ran each program and graded it on the 22 areas listed above. Using the same scoring procedures as described above, the evaluator scored each of the six programs with a grade of 100.

Because accurate scoring was essential to this study, two biology faculty members also independently assessed the accuracy of the scoring procedures and the grade calculations of the computer programs. These faculty members examined the printouts of the computer answer keys for 172 quiz items and they also took each of the 12 quizzes on the computer. They found two errors in the correction routine for one module 2A quiz; these errors were corrected before the subjects used the programs. The faculty members concluded that the answer keys for all other programs were accurate. A third check on the accuracy of grading was provided by the subjects who were taking the quizzes. In this capacity, the subjects uncovered five items that were eliminated by the investigator from the study. These items, which were in the quizzes for the third module, were removed because of contradictory statements in the textbook. Therefore, the total number of items on the quizzes for the six modules was 167.

The evaluative process described above established the accuracy of the computer programs in grading, in the presentation of the missed objectives, and in the presentation of the appropriate prescriptive information. However, the investigator wished to determine whether the information presented to the subjects was accurately transferred to the summary sheets. Therefore, a random sample (n = 20) of first attempt, computer records across all modules was examined for transfer accuracy. For this sample, the records from modules five and six were combined because of the limited number of computer quizzes for module six.

These computer records were examined by the investigator to determine the quiz grade. This grade was compared to the grade on the original summary sheet that was completed by the subject at the time of the proctoring session. In all of the comparisons, the grade had been transferred accurately.

In addition, these computer records were also examined to determine the objectives that were missed by the subject on the quiz. Once this information was known, the investigator examined the program to determine the prescriptive information that was provided by the computer. This information was compared to the information on the original summary sheet that was

completed by the subject at the time of the proctoring session. This comparison was used to calculate an interprescriptive agreement index by dividing the number of agreements for each record by the total number of objectives missed; the result was multiplied by 100. The indexes ranged from 25 to 100; the mean interprescriptive agreement index was 85.59 with a SD of 24.45. The quiz items, n = 21, that measured the objectives for which the subjects received inappropriate prescriptive information were eliminated from the study. A description of the way in which the human proctors were assessed for accuracy follows.

Human Proctoring

The proctors had been told that their proctoring technique would be evaluated. To evaluate the accuracy of human proctoring techniques, 13 human proctor sessions were randomly selected to be unobtrusively monitored by the investigator. During the sessions in which the student achieved a grade of 100%, the investigator determined whether the proctor: (a) greeted the student, (b) verified the proctor treatment, (c) selected the appropriate quiz, (d) provided the answer sheet and summary sheets to the subject, (e) admimistered the quiz, (f) provided a final review opportunity before correction,

(g) filed the answer sheet, (h) scored the quiz, (i) recorded the grade, (j) presented the score to the subject, (k) provided appropriate congratulatory feedback, (l) supervised completion of the summary sheet, (m) collected and stored a summary sheet, (n) provided the student with an opportunity to see the scored quiz with the student's answers, (o) filed the quiz, (p) provided the next module, (q) reminded the subject that his or her next proctoring session was with the computer, and (r) gave a closing statement. The proctor earned one point for each of these behaviors. In addition, the proctor earned one point for not providing any correct answers, and one point for not discussing any answers. Therefore, these sessions, n = 2, were evaluated on this 20 point scale.

If the subject achieved a grade between 90% and 99%, the session was also monitored for the presentation of the missed objectives and the presentation of the appropriate prescriptive information. Therefore, these sessions, $\underline{n}$ = 5, were evaluated on a 22 point scale.

If the subject did not achieve the 90% passing level, the session was also monitored for noting the form of the quiz that was used, and for making arrangements for the retake quiz. However, it was not graded on the presentation of congratulatory feedback, on the

presentation of the next unit or on the reminder about the next type of proctoring. Therefore, these sessions, n = 6, were evaluated on a basis of 21 points.

A proctoring accuracy index was calculated by dividing the total number of points earned during each session by the number of possible points and by multiplying the result by 100. The proctor accuracy indexes ranged from 93.3 to 100 and the mean index was 97.4. The investigator also analyzed the sessions for extraneous activities that could jeopardize the study. However, none of the proctoring sessions had any extraneous activities.

Human Grading

The accuracy of the human grading on the quizzes was evaluated with the following procedure. Each time the students took a quiz with the proctor, they put their answers on the quiz and on a separate, machine correctable answer sheet. During the proctoring session, the proctor graded the answers on the quiz and filed the answer sheet for further investigation. The proctors had been informed that this sheet would be graded by the investigator.

At the completion of the experiment, the answer sheets were corrected by the investigator with the Scantron correction machine. For the first five modules, there were two sets of answer sheets for each module. For the sixth module, each of the two quiz forms for each of the two groups was scored separately. Therefore, there were four sets of grades for the sixth module. For the 14 sets of quizzes a Pearson Product Moment Correlation between the scores on the answer sheets and on the original quizzes was calculated. This correlation was used as an interscorer agreement index. Overall, 14 interscorer agreement indexes were calculated and they ranged from .9524 to 1.00; the mean interscorer agreement index was .99 with an SD of 0.01.

Human Prescriptive Information

In order to determine whether appropriate prescriptive information had been presented by the proctors, the investigator examined a random sample (n = 18) of the first attempt, human proctor quizzes across all modules. During this examination, the investigator determined the questions that were answered incorrectly and then determined the appropriate

prescriptive information. This prescriptive information was compared to the original prescriptive information that was on the summary sheets completed by the subjects at the time of the proctoring session. The information from this comparison was used to calculate an interprescriptive agreement index. This index was determined by dividing the number of agreements between the prescriptive information provided by the proctor and the prescriptive information by the investigator for each quiz by the total number of of objectives missed; the result was multiplied by 100. The interprescriptive agreement index for the human proctors ranged from 77.69 to 100 with a mean of 96.86 and a SD of 7.37. The quiz items, $\underline{n} = 5$, for which the students received inappropriate prescriptive information were eliminated from the study.

Item Analysis

Because the results of the experiment were to be based on the achievement of remediated objectives and not the overall performance on the retake quiz, the individual characteristics of the quiz items that measured the achievement of the objectives on the modular quizzes had to be determined. Therefore, the investigator calculated the level of difficulty and the discrimination index of

each quiz item. These calculations, which were based on DeCecco (1968), were performed after all modular quizzes were completed. The classes of difficulty levels were: (a) easy, p = .75 and above; (b) moderate, p = .25 to .74; and (c) hard, p = .0 to .25. All classes of difficulty were corrected for chance. The modular quizzes contained items that were classified in all three levels; however, the hard items were not used in the study because of their limited number.

The discrimination index for all items in the modular quizzes ranged from - .3 to 1.0 and the indexes were classified according to the following three levels: (a) high, D = .75 and above; (b) moderate, D = .25 to .74; and (c) low, D = .0 to .24. Only those items that were within the same class of difficulty level and within the same class of discrimination index were used in the measurement of achievement on the retake quizzes and retention on the midterm examination. No items that had a low or negative discrimination index were used.

Student Attitudes

Questionnaires and interviews with students were used to ascertain student attitudes towards various aspects of

both types of proctoring and to determine the reasons for the students' proctor preference. The questionnaires were administered one week after the completion of the sixth module. To determine student attitudes toward each type of proctoring, the mean response and standard deviation to each statement on the questionnaire were calculated. Once this process was completed, the questionnaires were divided into two categories: one category contained questionnaires that were completed by the subjects who chose human proctors and the other category contained the questionnaires from those subjects who chose the computer. The mean response and standard deviation to each statement on the questionnaire were calculated for each preference group and independent *t*-tests between the means of the two groups for each statement were carried out.

After the retention test the investigator interviewed a sample of the subjects from each preference group. The investigator conducted interviews with 13 of the subjects who completed the study. Two of the interviews with students from the human preference group and one interview with a student from the computer preference group were used as pilot interviews. The responses elicited in these pilot interviews were used to generate additional questions for the remaining interviews; therefore, they

were not incorporated into the results. The pilot interviews were based on information that was generated from the completed questionnaires; the remaining interviews were based on the questionnaires and follow-up questions that were based on responses provided during the pilot interviews. As indicated on the interview schedule, the interview questions were based on the following questionnaire statements: 1, and 2; 3 and 4; 8; 9; 14, and 15; 18; 21 and 22. A sample of the interview schedule is in Appendix D.

Two factors that may have influenced proctor preference were each subject's level of quiz achievement and number of retake quizzes under each type of proctoring. Therefore, the investigator calculated the mean level of achievement of each subject under each proctoring condition before they chose a proctor for the sixth module. In addition, the investigator used independent _t_-tests to compare the mean levels of achievement of each preference group on the quizzes with computerized proctoring and on the quizzes with human proctoring.

The investigator also determined the mean quiz retake rate for the modules under each condition. These means were compared with a correlated _t_-test.

Student Characteristics

The investigator developed a profile of the subjects whose level of achievement of remediated instructional objectives was in the upper or lower 27% with each proctoring condition. These profiles, which were based on the subject's QPA, age, and program of study, were examined to determine whether there were any differences in the characteristics of the students who performed at the various performance levels with each proctor condition.

Follow-Up Study

In order to collect additional data on the time it took to complete the quizzes with computerized proctoring, a group of 18 students, who were in the same course in the subsequent semester, was exposed to computerized proctoring. These students had the same instructor, and used the same text, materials, and study guides. These students were evaluated with quizzes administered to all members of the class at one time and they were also exposed to computerized quiz sessions. During these sessions, which included all but the third module, these

students followed the same procedures as those students in the study.

The mean age of these students was 26 with an SD of 5.37. A correlated *t*-test indicated that this mean age was not significantly different from the students in this study, $t(47) = 0.736$, $p > .05$. Furthermore, the mean QPA of these students was 2.76 with an SD of 0.68. A correlated *t*-test indicated that this mean age was not significantly different from the students in this study, $t(47) = -0.415$, $p > .05$. Therefore, the students in the follow-up study were very similar to the students in the initial study.

In this follow-up study, the investigator examined 118 summary sheets for the computerized proctoring sessions to determine the mean amount of time it took for the quizzes.

C H A P T E R I V

RESULTS

Introduction

The purposes of this research were to: (a) compare the effectiveness of computerized proctoring and human proctoring on achievement of remediated instructional objectives within a modified PSI format, (b) compare the effectiveness of computerized proctoring and human proctoring on the retention of successfully remediated instructional objectives on a major examination within a modified PSI format, (c) determine student attitudes towards each mode of proctoring, (d) determine whether students prefer computerized or human proctoring within a modified PSI format, (e) ascertain the reasons for the proctor preference, (f) determine the characteristics of subjects whose level of achievement of remediated instructional objectives with each type of proctoring was high, and (g) determine the characteristics of subjects

whose level of achievement of remediated instructional objectives with each type of proctoring was low.

Achievement

It was hypothesized that student achievement of remediated instructional objectives, as demonstrated on quiz items, would be greater with computerized proctoring than with human proctoring. However, before any comparisons were made, the difficulty index and discrimination index of each quiz item were calculated. In addition, the investigator also determined the means and the standard deviations of the modular quiz grades. The quiz characteristics, which are summarized in Table 4, were based on all first time quizzes taken by all subjects.

Table 4

Quiz Characteristics

Module	Form[1]	n	Mean %	SD	Mean[2]	Mean[3]
2A.	A.	18	82.22	3.50	77.93	.253
	B.	13	81.43	4.67	78.47	.267
2B.	C.	15	87.16	4.79	83.67	.304
	D.	16	78.27	3.22	71.82	.274
3.	C.	14	78.85	3.20	81.25	.333
	D.	16	85.67	3.94	72.70	.283
4.	C.	19	84.91	3.22	80.03	.260
	D.	10	86.67	2.19	83.17	.167
5.	C.	19	90.53	2.16	87.17	.311
	D.	10	85.33	4.36	80.03	.173
6.	A.	12	79.59	3.07	73.96	.308
	B.	17	82.69	3.22	77.77	.208

Note: n The number of quizzes administered.
1 The alternative forms of the quizzes.
2 The mean difficulty level of the items in the quiz.
3 The mean discrimination index of the items in the quiz.

Achievement Control

To establish a control for the achievement items, the investigator examined each individual quiz record that was established whenever a subject took a retake quiz under each condition across all modules. These records, which were established for 41 computer proctored quizzes and 52 human proctored quizzes, enabled the investigator to ascertain the specific quiz items that were successfully answered on the first attempt quiz. Furthermore, because these items were answered correctly, the subjects did not receive any remediation on them. All items that were answered successfully on the first attempt quiz were classified as achievement control items. In this examination, the investigator determined the number of control items on the initial quiz for each module and determined the mean level of achievement of the equivalent items on the retake quizzes.

For the computer proctored quizzes, the investigator examined the 41 individual records and found that the mean performance level on 691 achievement control items was 89.22% with an SD of 9.57. For the human proctored quizzes, the investigator examined the 52 individual records and found that the mean performance level on 848 achievement control items was 88.87% with an SD of 9.45.

An independent *t*-test revealed that there was no significant difference between the means on these control items; $t(91) = 0.164$, $p > .05$.

Determination of Achievement

To determine student achievement of remediated instructional objectives, the mean percent of successfully remediated items on retake quizzes for each proctor condition was calculated. This calculation was determined for each subject who took retake quizzes by tabulating the number of incorrect items on the first modular quiz and the number of equivalent form items that was answered correctly on the retake quiz of each module. The number of items on which the students received remediation was 180 for computerized proctoring and 236 for human proctoring. The difference in the number of items was caused by the greater number of students who had human proctoring for the sixth module. The mean percent of successfully remediated objectives, as demonstrated by a correct response to equivalent items on retake quizzes, was 73.0% with a SD of 0.21 for computerized proctoring and 75.0% with a SD of 0.18 for human proctoring. A *t*-test for matched pairs indicated that the difference between the mean percentages of achievement was not

significant, t (20)= - 0 .327, $p > .05$.

Retention

The second hypothesis was that student retention of successfully remediated instructional objectives on a major examination would be greater with computerized proctoring than with human proctoring. The data for the retention study was based on the instructional objectives that were successfully remediated on the retake quizzes across all modules. To test this hypothesis, a stratified, random sample of quiz items, n = 61, from the modular quizzes was included on a criterion-based midterm examination. The sample contained three groups of items. Group 1 consisted of items from modules 2A and 2B, group 2 consisted of items from modules 3 and 4, and group 3 contained items from modules 5 and 6. Twenty items were chosen from each of the first two groups and twenty-one items were chosen from the third group. The mean discrimination index of these retention items, which represented 36.5% of all quiz items, was 0.52 with an SD of 0.16; the mean level of difficulty was 66.05% with an SD of 17.49. In addition, a control was established for the retention items.

Retention Control

To establish the control for the retention items, the investigator examined each quiz record that was established whenever a subject took a retake quiz under each condition. The investigator ascertained the quiz items that were successfully answered on the first attempt quiz and on the retake quiz; the subject did not receive any remediation on these items. All of these items that were on the retention test or were represented on the retention test by equivalent items, were classified as retention control items. The investigator calculated the number of control items for each subject under each condition for each module, and determined the mean level of achievement for each subject on the same or equivalent items on the retention test.

For the computer proctored quizzes, the investigator examined 33 individual records and found that the mean retention rate on 127 control items was 82.68% with an SD of 27.36. For the human proctored quizzes, the investigator examined 49 individual records and found that the mean retention rate on 237 control items was 74.24% with an SD of 21.15. An independent t-test revealed that there was no significant difference between the means on these control items; $t(80) = -1.571$, $p > .05$.

Measurement of Retention

To determine the level of retention, the mean percent of success on the retention items was calculated for each proctor condition. The results, which were based on 58 items from the computerized condition and 48 items from the human condition, were analyzed with a *t*-test for matched pairs. The mean percent of successfully retained objectives on the midterm for computerized proctoring was 52.74% with an SD of 0.37 whereas for the human proctoring the mean was 52.22% with an SD of 0.30. A *t* test for matched pairs indicated that the difference between the mean percentages of retention of items was not significant, $t\ (11) = 0.034$, $p > .05$.

Student Attitudes

One of the purposes of this research was to determine the attitudes of the students towards each type of proctoring. These attitudes were assessed with the attitudinal questionnaire and the interviews.

Many of the statements on the questionnaire focused on the quiz phase of each proctoring session. In response to statement 1, "I felt that it was easy to take the quizzes on paper," the mean response of the students was

8.27 with a SD of 1.66 while the mean response to statement 2, "I felt that it was easy to take the quizzes on the computer," was 5.69 with a SD of 2.35. A correlated *t*-test indicated that there was a significant difference between the means of these responses, $t(25) = 4.366$, $p < .000$.

Two statements measured student attitudes towards the capacity to review quiz questions with each type of proctoring. In response to statement 3, "I felt that it was easy to review the questions on the computer," the mean response of the students was 4.96 with an SD of 3.18 and their mean response to statement 4, "I felt that it was easy to review the questions on paper quizzes," was 8.73 with a SD of 2.13. A correlated *t*-test revealed a significant difference between the means of the students in their attitudes towards reviewing items on the quizzes, $t(25) = 5.103$, $p < .000$.

The questionnaire also measured the students' perceived degree of stress while taking quizzes with each type of proctoring conditions. The mean response of the students to statement 8, "I felt a lot of stress taking the quiz on the computer" was 5.38 with a SD of 3.51 and the mean response of the students to statement 9, "I felt a lot of stress taking the quiz with the proctor was 3.85 with a SD of 3.09. There was no significant difference

between these means, $t(25) = 1.725$, $p > .05$.

The level of confidence while taking the quizzes under each proctoring condition was also measured by the questionnaire. The mean response of the students to statement 10, "I felt very confident taking the quiz with the proctor," was 6.77 with a SD of 2.97 and the mean response to statement 11, "I felt very confident taking the quiz with the computer," was 4.42 with a SD of 2.94. The difference between the means on statements 10 and 11 was significant $t(25) = 3.052$, $p < .005$.

In addition to measuring the perceived stress level during quizzes, the questionnaire also measured perceived anxiety. The mean response of the students to statement 14, "I felt very anxious taking the quiz with the proctor," was 4.85 with a SD of 3.32 and the mean response to statement 15, "I felt very anxious taking the quiz with the computer," was 5.19 with a SD of 3.07. The difference between the means on statements 14 and 15 was not significant, $t(25) = -0.398$, $p > .05$.

Two statements, 16 and 17, assessed student attitudes towards the time it took to complete the quizzes. The mean response of the students to statement 16, "I felt that it took a lot of time to take the quiz with the computer," was 6.19 with a SD of 3.46 whereas the mean response of the students to statement 17, "I felt that it

took a lot of time to take the quiz on paper," was 3.62 with a SD of 3.21. The difference between the means on statements 16 and 17 was significant, $t(25) = 2.482$, $p < .019$. The responses to the quiz related questionnaire items are summarized in Table 5.

Table 5

Results of Quiz-Related Questionnaire Items-All Subjects

	M	SD	t(25) value
Ease of quizzes			
paper	8.269	1.66	$t = 4.366$*
computer	5.692	2.35	
Review			
paper	8.730	2.13	$t = -5.103$*
computer	4.961	3.18	
Stress			
paper	3.846	3.09	$t = 1.725$
computer	5.384	3.51	
Confidence			
paper	6.769	2.97	$t = 3.052$**
computer	4.423	2.94	
Anxiety			
paper	4.846	3.32	$t = -0.398$
computer	5.192	3.07	
Time			
paper	3.615	3.21	$t = 2.482$***
computer	6.192	3.46	

Note: *$p < .000$. **$p < .005$. ***$p < .019$.

Eight statements of the questionnaire assessed student attitudes towards proctor characteristics. The students' perception of proctor accuracy was assessed with four statements; statements 6 and 7 were based on accuracy of grading while statements 19 and 20 were based on the accuracy of the prescriptive information provided by the proctors.

The mean response of the subjects to statement 6, "I felt that the proctors were accurate in their grading" was 8.42 with a SD of 2.06 whereas their mean response to statement 7, "I felt that the computer was accurate in grading," was 5.85 with a SD of 2.95. The difference between the means on these statements was significant, $t(25) = 4.025$, $p < .000$.

In response to statement 19, "I felt that the proctors were very accurate with their prescriptive information," the mean response of all students was 7.04 with a SD of 2.75 and their mean response to statement 20, "I felt that the computers were very accurate with their prescriptive information," was 7.15 with a SD of 2.75. A correlated t-test of the means for these statements revealed that the difference between the means was not significant, $t(25) = 0.284$ $p > .05$.

Because one of the often cited responsibilities of the proctor in PSI courses is to provide personal contact

with students, two statements measured the personableness of the proctor conditions. The mean response of the students to statement 12, "I felt that the computers were very personal," was 3.19 with a SD of 2.87 and the mean response to statement 13, "I felt that the proctors were very personal," was 6.38 with a SD of 3.05. The difference between the means was significant, $t(25) = 3.75$, $p < .001$.

Two statements ascertained the degree of trust in each proctoring condition. The mean response of all students to statement 21, "I felt a lot of trust in the computer," was 4.04 with a SD of 2.49 and the mean response to statement 22, "I felt a lot of trust in the proctors," was 6.65 with a SD of 3.01. A correlated t-test between these means revealed a significant difference, $t(25) = 3.03$, $p < .005$. The responses to the proctor related statements are summarized in Table 6.

Table 6

Results of Proctor-Related Questionnaire Items All Subjects

	M	SD	t(25) value
Grading Accuracy			
human	8.42	2.06	t = 4.025*
computer	5.85	2.95	
Prescriptive Accuracy			
human	7.04	2.75	t = 0.284
computer	7.15	2.75	
Personableness			
human	6.38	3.05	t = - 3.746**
computer	3.19	2.87	
Trust			
human	6.65	3.01	t = - 3.03***
computer	4.04	2.49	

Note: *p < .000. **p < .001. ***p < .005.

Student Preference

The third hypothesis was that student preference of computerized proctoring would be greater than student preference of human proctoring within a modified PSI

format. To test this hypothesis, all subjects who completed modules 2A through 5, (n = 29) were given the opportunity to choose their proctor condition for the sixth module in the study. Twenty-two of the subjects (75.86%) who completed the sixth module chose the human proctoring while 7 (24.14%) chose computerized proctoring. A chi-square analysis indicated that this frequency was significant, x^2 (1, N = 29) = 7.759, $p < .005$. In addition, 74.1% of the female students chose the human proctors. A chi-square analysis indicated that this frequency was significant, x^2 (1, N = 27) = 6.259, $p < .012$. No additional analysis was performed on the male students because there were only two males in the study. In order to ascertain the basis for their preferences, the investigator analyzed the anonymous questionnaires and interviewed students from each preference group.

As indicated, the questionnaire results were used to compare the attitudes of students from each preference group toward computerized and human proctoring. To make these comparisons, the questionnaires were divided into those that were completed by the subjects who chose each type of proctoring. For the computer preference group, n = 6, and for the human preference group, n = 20. The mean response for the first 22 items was calculated for

each group; independent *t* tests were used to compare these means.

The results of the independent *t* tests revealed that there were no significant differences in the attitudes of the preference groups toward the following quiz related items: a. the ease of taking paper quizzes, b. reviewing the quizzes on the computer, c. the degree of perceived stress while taking the quizzes with the proctor, d. the level of confidence while taking the quizzes with the proctor, e. the degree of perceived anxiety while taking the computer quizzes, and f. the perceived amount of time required to complete the quizzes with the computer. The responses to these items are presented in Table 7.

In contrast to the items described above, there were significant differences in mean responses of the groups toward quiz related questionnaire items. The independent *t* tests indicated that the computer preference group, when compared to the human preference group, agreed, to a greater extent, with the following statements: a. I felt that it was easy to take the quizzes on the computer, b. I felt very confident taking the quiz with the computer, c. I felt very anxious taking the quiz with the proctor, and d. I felt that it took a lot of time to take the quiz on paper. These results are also summarized in Table 7.

Contrary to the results described above, the questionnaire revealed that the human preference group, when compared to the computer preference group, agreed, to a greater extent, with the following statements: a. I felt a lot of stress taking the quiz on the computer, b. I felt that it was easy to review the questions on paper quizzes, and c. I felt that it was too difficult to use the computer. These results are also incorporated into Table 7.

Table 7

Comparative Results of Quiz-Related Questionnaire Items

	Preference Group				
	Computer		Human		
	M	SD	M	SD	t(24) value
Ease of quizzes					
paper	7.83	1.47	8.4	1.73	t = - 0.725
computer	8.33	1.86	4.9	1.86	t = 3.963*
Review					
paper	6.67	3.08	9.35	1.31	t = - 3.159***
computer	5.67	3.72	4.75	3.08	t = 0.611
Stress					
paper	5.17	3.76	3.45	2.86	t = 1.202
computer	1.00	0.89	6.70	2.85	t = - 4.769*
Confidence					
paper	5.00	3.46	7.30	2.68	t = - 1.728
computer	7.00	3.52	3.65	2.32	t = 2.759##
Anxiety					
paper	8.83	1.47	3.65	2.72	t = 4.430*
computer	5.00	3.90	5.25	2.90	t = - 0.171
Time					
paper	6.50	3.27	2.75	2.71	t = 2.839#
computer	4.00	3.69	6.85	3.20	t = - 1.851

Table 7 Continued

	Preference Group				
	Computer		Human		
	M	SD	M	SD	t(24) value
Accuracy[1]					
Proctor	7.33	2.58	8.75	1.83	t = - 1.51
Computers	7.83	2.23	5.25	2.92	t = 1.99
Accuracy[2]					
Proctor	7.00	3.69	7.05	2.52	t = - 0.038
Computers	8.00	2.76	6.90	2.77	t = 0.853
Personableness					
Proctor	6.00	4.10	6.50	2.78	t = - 0.346
Computer	4.00	3.95	2.95	2.54	t = 0.779
Trust					
Proctor	6.0	3.79	6.85	2.81	t = - 0.60
Computer	6.5	2.43	3.30	2.03	t = 3.25**
Likeness of Machines	3.33	3.61	4.65	2.68	t = - 0.975
Ease of Computer use	1.50	1.87	4.05	2.84	t = - 2.055###

Note: 1. Grading Accuracy. 2. Prescriptive Accuracy.

*p < .000. ** p <.003. ***p < .004.

#p < .008. ##p < .01. ###p < .05.

The questionnaire included two questions that were based on the level of comfort perceived by the subjects on their first and last sessions under each type of proctoring. One question was:

Which of the following statements is most accurate?

A. I felt more comfortable with my first session with the computer.

B. I felt more comfortable with my last session with the computer.

C. I did not feel any difference in comfort between my first session and last session with the computer.

In response to this question, all members of the computer preference group chose option B and the results of a chi-square analysis, X^2 (2, $\underline{N}$ = 6) = 12.0, $\underline{p} < .003$, were highly significant. Sixty-five percent of the human preference group chose option B and the remaining 35% did not report any difference between the first and last sessions with the computer. The results of a chi-square analysis, X^2 (2, $\underline{N}$ = 20) = 12.0, $\underline{p} < .002$, were highly significant.

The other question was:

Which of the following statements is most accurate?

A. I felt more comfortable with my first session with the proctor.

B. I felt more comfortable with my last session with the proctor.

C. I did not feel any difference in comfort between my first session and last session with the proctor.

In response to this question, fifty-percent of the computer preference group chose option B and fifty-percent chose option C. The results of a chi-square analysis, X^2 (2, N = 6) = 3.00, $p > .05$, were not significant. Thirty-five percent of the human preference group chose option B and the remaining 65% chose option C. The results of a chi-square analysis, X^2 (2, N = 20) = 12.7, $p < .002$, were highly significant.

As indicated above, there was a significant difference in the attitudes of the preference groups towards the ability to review the paper quizzes and no difference in their attitudes towards reviewing the computerized quizzes. These results were supported by an examination of the summary sheets for each condition. For example, an examination of 127 of the summary sheets for the computer quizzes, revealed a mean review rate of 74.08% with a SD of 26.67. In addition, an examination of 141 of the summary sheets for the paper quizzes, revealed a mean review rate of 83.61% with a SD of 28.86. A correlated t-test revealed a significant difference

between the mean review rates, $t(30) = -2.240$, $p < .03$.

To determine whether there was a difference in the time it took to complete the quizzes under each proctoring condition, the investigator examined 131 computer summary sheets and 142 summary sheets from the human proctoring sessions. The mean amount of time for the computer quizzes was 25.13 minutes with a SD of 6.50 and for the paper quizzes it was 23.66 minutes with a SD of 6.90. A correlated t-test did not reveal a significant difference between the means, $t(271) = -1.81$, $p < .05$.

To measure the student's perception of quiz difficulty, they were asked the following question:

> Which of the following statements is accurate?
> A. I felt that the quizzes with the proctors were more difficult than the quizzes with the computers.
> B. I felt that the quizzes with the computers were more difficult than the quizzes with the proctors.
> C. I felt that there was not any difference in the difficulty level between the quizzes on the computer and the quizzes with the proctors.

In response to this question, 83.33% of the computer preference group chose option C and 17% chose option A. The results of a chi-square analysis of these responses,

$x2$ (2, N = 6) = 7.00, $p < .029$, were significant. Eighty-percent of the human preference group chose option C and 20% chose option B. The results of a chi-square analysis, $x2$ (2, N = 20) = 20.8 $p < .000$, were highly significant.

Results of the Interviews

The investigator conducted interviews with 13 of the 29 subjects who completed the study. Three of these interviews were completed on a pilot basis and the results of these interviews are not included in Table 8. The remaining 10 interviews were with the five subjects from the computer preference group who remained in the study and five subjects who were randomly chosen from the human preference group. The results of these ten interviews are in Table 8.

Table 8

Responses to the follow-up Questions

1. Do you feel that the response to the "ease of taking quizzes on paper" statement was due to experience with paper quizzes?					
Yes	100%	No	0%	Not Sure	0%
2. Do you feel that the response to the "ease of taking computer quizzes" statement was due to lack of experience with computer quizzes?					
Yes	90%	No	0%	Not Sure	10%
3. Do you feel that the response to the "easy to review on computer quizzes" statement was due to the delay of the review with computer quizzes?					
Yes	100%	No	0%	Not Sure	0%
4. Do you feel that the response to the "easy to review on paper quizzes" statement was due to the immediacy with which review could be carried out with paper quizzes?					
Yes	60%	No	20%	Not Sure	20%
5. Do you feel that the response to the "stress on paper quizzes" statement was due to the quiz being on paper?					
Yes	0%	No	100%	Not Sure	0%

Table 8 Continued

6. Do you feel that the response to the "stress on paper quizzes" statement was primarily due to the fact that the student was being quizzed?

Yes 100% No 0% Not Sure 0%

7. Do you feel that the response to the "stress on computer quizzes" statement was due to the quiz being on the computer?

Yes 50% No 30% Not Sure 20%

8. Do you feel that the response to the "stress on computer quizzes" statement was primarily due to the fact that the student was being quizzed?

Yes 80% No 20% Not Sure 0%

9. Do you feel that the anxiety of taking a quiz with a proctor was due to the proctor?

Yes 10% No 90% Not Sure 0%

10. Do you feel that the anxiety of taking a quiz with a proctor was due to the fact that the student was being quizzed?

Yes 100% No 0% Not Sure 0%

11. Do you feel that the anxiety of computer quizzes was due to the computer?

Yes 30% No 70% Not Sure 0%

Table 8 Continued

12. Do you feel that the anxiety of computer quizzes was due to the fact that the student was being quizzed?

Yes 90% No 10% Not Sure 0%

13. Do you feel that students lacked trust in the computer because students were afraid of making a mistake?

Yes 80% No 20% Not Sure 0%

14. Do you feel that students lacked trust in the computer because students did not know what happened to an answer once a key was pressed?

Yes 70% No 10% Not Sure 20%

15. Do you feel that students lacked trust in the computer because the student lacked experience with computers?

Yes 70% No 20% Not Sure 10%

16. Do you feel that students lacked trust in the computer because the computer may have had an undetected malfunction?

Yes 90% No 0% Not Sure 10%

17. Do you feel that students lacked trust in the proctor because the proctor was not a teacher?

Yes 30% No 40% Not Sure 30%

During the final phase of the interview, the interviewees were asked the following question: "What do you feel was the major factor that influenced the students to choose human proctors?" In response to this question, seven students reported that they felt that students preferred the humans because the quiz phase of the human proctoring session was easier to complete than the quiz phase of the computer proctoring session. The remaining three students indicated that they felt the human proctor preference was due to the preference of students to work with people rather than machines.

Two factors that may have influenced proctor preference were each subject's quiz achievement and retake rate under each type of proctoring. To determine whether performance may have had an influence on proctor preference, the investigator calculated the mean level of achievement of each subject under each proctoring condition before they chose a proctor for the sixth module. The subjects who chose the computer proctoring condition had a mean level of achievement of 81.09% with of SD of 16.58 on the quizzes with computerized proctoring and mean level of achievement of 82.17% with a SD of 12.33 on the quizzes with the human proctoring. A correlated t-test indicated that there was no significant difference between these means, $t(7) = -0.343$, $p > .05$.

In addition, the subjects who chose the human proctoring condition had a mean level of achievment of 83.11% with a SD of 11.77 on the quizzes with computerized proctoring and a mean level of achievement of 85.11% with a SD of 9.68 on the quizzes with the human proctoring. A correlated *t*-test indicated that there was no significant difference between these means, $t(22) = -1.437$ $p > .05$.

In addition, the investigator compared the mean levels of achievement of each preference group on the quizzes with computerized proctoring. An independent *t*-test revealed that there was no significant difference between these means, $t(27) = 0.357$, $p > .05$. Similarly, the investigator also compared the mean levels of achievement of each preference group on the quizzes with human proctoring. According to an independent *t*-test, there was no significant difference between these means, $t(27) = 0.657$, $p > .05$.

Furthermore, the investigator determined the mean quiz retake rate for each module under each condition. The mean quiz retake rate, across all modules, with human proctoring was 55.82% with an SD of 14.32 and with computer proctoring it was 55.35% with an SD of 12.93. A correlated *t*-test revealed that the difference between the means was not significant, $t(5) = 0.078$, $p > .05$.

Student Characteristics

The 6th and 7th purposes of the study were to determine the characteristics of the subjects whose level of achievement of remediated instructional objectives under each type of proctoring was high and to determine the characteristics of the subjects whose level of achievement of remediated instructional objectives under each type of proctoring was low. Therefore, students who were not required to take retake quizzes were not included in this phase of the study. The characteristics that were examined included age, QPA, field of study, and number of college credits attempted. The characteristics of those subjects whose level of achievement was either in the upper or lower 27% of achievement under each type of proctoring were examined. For each level of achievement in each proctoring condition, the number of students examined was 6.

For the group of students whose level of achievement with computerized proctoring was high, the ages ranged from 19 to 47 with a mean age of 31.5 and a SD of 8.5; and, the mean number of attempted credits was 23 with a SD of 11.09. The mean QPA for this group was 2.72 with a SD of 0.67 and the mean level of achievement was 88.89% with a SD of 0.08. Two students were in each of the following

programs: Nursing, Dental Hygiene, and Liberal Arts.

For the group of students whose level of achievement with computerized proctoring was low, the ages ranged from 20 to 49 with a mean age of 28.00 and a SD of 10.79; and their mean QPA was 2.62 with a SD of 0.59. The mean number of attempted credits was 21.17 with a SD of 6.84. In addition, they had a mean level of achievement of 48.33% with a SD of 0.13. None of these students were in the Nursing program while two were in Dental Hygiene and four were in Liberal Arts.

The investigator found that the difference in the mean QPA between the upper and lower computer achievement groups was not significant, $\underline{t}(10) = 0.275$, $\underline{p} > .05$. In addition, there was no significant difference in the mean number of attempted credits, $\underline{t}(10) = 0.3145$, $\underline{p} > .05$. Furthermore, there was no significant difference in the mean ages between the groups, $\underline{t}(10) = 0.569$, $\underline{p} > .05$. The major difference between the groups was that the lower achievement group was composed of 67% Liberal Arts students while 33% of the upper group consisted of Liberal Arts students. The characteristics of the students in the upper and lower computer achievement groups and the results of the comparisons between the characteristics are summarized in Table 9.

Table 9

A Comparison of the Characteristics of Students in the Upper and Lower Computer Achievement Groups

	Upper		Lower		
	M	SD	M	SD	t(10) value
Age	31.50	8.50	28.00	10.79	t = 0.570
Q.P.A.	2.72	0.67	2.62	0.59	t = 0.275
Achievement	88.89	0.08	48.33	0.13	t = 6.013*
Credits	23.00	11.09	21.16	6.84	t = - 0.315
Field of Study					
Nursing	2		0		
Dental Hygiene	2		2		
Liberal Arts	2		4		

Note: * p < .0005.

For the group of students whose level of achievement with human proctoring was high, the ages ranged from 19 to 36 with a mean age of 27.33 and a SD of 6.42. The mean QPA for this group was 2.65 with a SD of 0.33 and the mean number of attempted credits was 26.17 with a SD of 10.59. Moreover, the mean level of achievement was 96.07% with a

SD of 0.56. One student was in the Nursing program, one was in Liberal Arts and four were in Dental Hygiene.

For the group of students whose level of achievement with human proctoring was low, the ages ranged from 18 to 47 with a mean age of 27.00 and a SD of 10.23. Their mean QPA was 2.29 with a SD of 0.64. The mean number of attempted credits was 25.33 with a SD of 8.73 and the mean level of achievement was 54.35% with a SD of 0.09. One student was in the Nursing program and five were in Liberal Arts.

Additional investigation revealed that the difference in the mean QPA between the upper and lower human achievement groups was not significant, $\underline{t}(10) = 1.197$, $\underline{p} > .05$. In addition, there was no significant difference in the mean number of attempted credits, $\underline{t}(10) = -0.136$, $\underline{p} > .05$. Furthermore, the mean age of the groups was not significantly different, $\underline{t}(10) = 0.617$, $\underline{p} > .05$. The major difference between the groups was that 87% of the lower achievement group was composed of Liberal Arts students while only 13% the upper group consisted of Liberal Arts students.

Table 10

A Comparison of the Characteristics of Students in the Upper and Lower Human Achievement Groups

	Upper		Lower		
	M	SD	M	SD	t(10) value
Age	27.33	6.42	27.00	10.23	t = 0.062
Q.P.A.	2.65	0.33	2.29	0.64	t = 1.197
Achievement	96.07	0.56	54.35	0.09	t = 9.048*
Credits	26.17	10.59	25.33	8.73	t = - 0.136
Field of Study					
Nursing	1		1		
Dental Hygiene	4		0		
Liberal Arts	1		5		

Note: * $p < .0005$.

To determine whether there were any differences between the QPA's, attempted credits and ages of the students in the achievement groups under each condition, the investigator performed independent t-tests of the means for these characteristics. These independent t-tests did not reveal any significant difference between the mean QPA's, $t(10) = - 0.235$, $p > .05$; the mean attempted credits, $t(10) = - .462$, $p > .05$; or the mean

ages, $\underline{t}(10) = 0.8746$, $\underline{p} > .05$ of the upper group in each condition. In addition, the mean level of achievement with each type of proctoring was not significantly different, $\underline{t}(10) = -1.616$, $\underline{p} > .05$. These results are summarized in Table 11.

Table 11

A Comparison of the Characteristics of Students in the Upper Achievement Groups

	Computer		Human		
	M	SD	M	SD	t(10) value
Age	31.50	8.50	27.33	6.42	$\underline{t} = 0.875$
Q.P.A.	2.72	0.67	2.65	0.33	$\underline{t} = -0.235$
Achievement	88.89	0.08	96.07	0.56	$\underline{t} = -1.616$
Credits	23.00	11.09	26.17	10.59	$\underline{t} = -0.462$
Field of Study					
Nursing	2		1		
Dental Hygiene	2		4		
Liberal Arts	2		1		

The investigator also compared the mean QPA's, ages, and attempted credits of the low achievement groups. There was no significant difference between the mean

QPA's, $t(10) = -0.9167$, $p > .05$; or the mean ages, $t(10) = -0.150$, $p > .05$; or the attempted credits, $t(10) = -0.840$, $p > .05$ of the lower group in each condition. Furthermore, the difference between the mean level of achievement with each type of proctoring was not significant, $t(10) = 0.8496$, $p > .05$. These results are summarized in Table 12.

Table 12

A Comparison of the Characteristics of Students in the Lower Achievement Groups

	Computer		Human		
	M	SD	M	SD	t(10) value
Age	28.00	10.79	27.00	10.23	$t = -0.150$
Q.P.A.	2.62	0.59	2.29	0.64	$t = -0.917$
Achievement	48.33	0.13	54.35	0.87	$t = 0.850$
Credits	21.17	6.84	25.33	8.73	$t = -0.840$
Field of Study					
Nursing	0		1		
Dental Hygiene	2		0		
Liberal Arts	4		5		

Additional Results

To obtain more information on the amount of time it took to complete the computerized quizzes, the investigator examined the summary sheets for 118 computerized quizzes taken by 18 similar students in the subsequent semester. This examination revealed that the mean amount of time per quiz was 17.49 minutes with a SD of 5.92. As indicated, the mean amount of time for 142 human proctored quizzes in the initial study was 23.66 minutes with a SD of 6.90. An independent t-test revealed a significant difference between these means, $t(258) = -7.655$, $p < .000$.

CHAPTER V

DISCUSSION

Introduction

This chapter is subdivided into the following sections: a) a discussion of the results, b) the implications of the results, and c) conclusions supported by the study. Suggestions for additional research are included throughout the various sections of this chapter.

Student Performance

It was hypothesized that student achievement of remediated instructional objectives, as demonstrated on quiz items, would be greater with computerized proctoring than with human proctoring. This hypothesis was rejected because a *t*-test demonstrated that there was no significant difference between the mean levels of achievement.

In addition, the second hypothesis, which was that student retention of successfully remediated instructional objectives on a major examination would be greater with computerized proctoring than with human proctoring, was rejected because a *t*-test demonstrated that there was no significant difference between the mean levels of retention.

These results, although unexpected, are not suprising because the only difference between the conditions was the way in which the proctoring was carried out. For example, the proctoring sessions were held at identical times in the same learning center and the quizzes and prescriptive information were identical for each condition. The feedback for each condition was also the same; however, there was a difference in the timing of the feedback. For example, with the computerized proctoring session, the feedback was presented as soon as the quiz was completed, whereas with the human proctors there may have been a delay of about 5 minutes. This 5 minute delay in the presentation of the feedback was "immediate" in the sense that was well within time limits often labelled "immediate" in the literature and it did not seem to have an adverse effect on achievement or retention. Both conditions had the same pacing and passing requirements and the students also used the same texts and modules

with each type of proctoring. Furthermore, each condition was highly individualized; i.e., the feedback was based upon each individual's responses to the quiz items. The essential difference between the proctoring conditions was that the humans performed the proctor functions in one treatment while computers functioned as proctors in the alternative condition.

Although there was no difference between the mean levels of retention under each proctoring condition, there was a difference in the levels of retention of the control items and the experimental items. This difference may have been due to several factors. For example, the control items were items that had been answered successfully by the subjects on two occassions while the experimental items had been answered correctly only once. Therefore, the students received more feedback for the correct responses to the control items than for the experimental items. This difference in positive feedback may have decreased retention of the experimental items and it may have increased the probability for extinction of the material that had been learned. A second factor was that the experimental items were usually tested about one hour after the failure on the initial quiz. This limited time span did not allow sufficient opportunity to perform some of the activities that increase retention, i. e.,

practice, spaced review, rehearsal, and overlearning of the subject matter. In contrast, the subjects had more opportunity to perform these activities with the control items. Future research could determine whether these activities are performed. The third factor that may have limited retention was interference from learning the material for the next module shortly after studying the remediated materials. In contrast, there was more time between learning the material for the control items and the new subject matter. Therefore, the probability of interference was reduced.

The rate of student progress, as measured by retake rates, is another way in which student performance is measured in PSI courses. The results of this study demonstrated that there was no significant difference in retake rates under the two conditions. Similar results were reported by Herrmann (1982). Additional research could determine whether this "no difference" condition is maintained throughout a complete course. Future research could also determine whether there is any difference in retake rates between students who are exposed to computerized proctoring and students who are not proctored.

The results, which suggest that exclusively personalized contact with a human proctor is not critical to achievement or retention within a PSI format, are

consistent with the views of numerous researchers. For example, Barton and Ascione (1978), Caldwell et al. (1978), Fernald et al. (1975), Gaynor (1975), Kulik (1978), Kulik and Jaska (1977), and Kulik and Smith (1976), investigated the effect of personalization in PSI and concluded that it was not vital to the success of PSI. These results also add support to the findings of Semb (1981) who concluded that the proctors, per se, are not necessary to the success of PSI provided that the other components of PSI, such as feedback, are maintained.

In addition, the results are the same as those obtained by Herrmann (1982) in a similar investigation that compared the effect of computerized and human proctoring on student performance on a common final examination. However, this comparison must be viewed cautiously because Herrmann's study had some confounding variables that favored the students with the human proctoring. For example, the computer programs displayed each multiple choice item for a maximum of 30 seconds and each quiz had to be completed within 5 minutes. In addition, the computerized quizzes could not be reviewed. Despite these restrictions, which did not apply to the quizzes with the proctors, there was no difference in performance on a common final examination.

In contrast, the results do not support the views of Keller (1968), Keller (1981), Schiller and Markle (1978), and Taveggia (1976). These investigators have indicated that the personal contact with proctors contributed to the positive influence of PSI on achievement.

As indicated, there was no difference in student achievement or retention as measured on multiple choice items. Future research might replicate this study over a larger number of modules and/or the use of constructed response quiz items. In addition, the effects of computerized proctoring could also be compared to PSI systems that used internal proctoring. Additional investigation could also examine retention after a longer period of time.

During the experiment, 131 proctoring sessions were conducted with the computer. These computerized sessions, which included the administration and grading of a quiz, the presentation of feedback, and the recording of grades, reduced the personnel needs of the course. This reduction is consistent with the results reported by Bork (1978), Bowles (1978), Kelley and Anandam (1978), McMichael and Hinton (1978), Pennypacker (1978). Although the benefits of this reduction in personnel were not measured in the present study, the investigator did have individual

conferences with many students throughout the experiment.

Furthermore, in studies that did investigate the influence of using computers on the time course personnel spent with students, Bowles (1978), McFarland et al. (1983), Robin (1978), Roll and Pasen (1977), and Summers (1984) reported that computer use does increase the amount of personal contact between instructors and students.

Student Attitudes toward the Proctoring Conditions

One of the purposes of this study was to determine student attitudes toward each type of proctoring. This information provides particular insight into some features that might be incorporated into computer proctor programs.

None of the results indicated any extremely strong attitudes toward or against the components of computerized proctoring. For example, positive attitude towards machines, attitudes toward computer accuracy in grading and prescriptive information, ease of computer use, ease of taking quizzes, quiz review, and levels of trust in the computer were all moderate. As the subjects took the computerized quizzes, they expressed moderate levels of confidence and perceived moderate levels of stress and anxiety. The levels of stress and anxiety may have been

due to the challenge of being quizzed and adequacy of preparation. Another possible cause was the novelty of PSI and proctoring: the majority of students had never been exposed to computers or to PSI. These levels of anxiety and stress, which were not significantly different from the levels experienced with the human proctors, were consistent with the findings that Postlethwait (1978) indicated would accompany changes from familiar to unfamiliar procedures.

The investigator believes that the limited degree of confidence while taking the computerized quizzes and the perceptions of stress and anxiety are possibly due to the fear of making a mistake in the operation of the computer. On the other hand, the limited trust in the computer and the moderate attitude towards computer grading accuracy were probably due to the lack of understanding the way in which the computer works. For example, the students did not know what happened to an answer once a key was pressed. They also had a fear of undetected computer malfunctions, such as marking correct answers as incorrect. In addition, the level of trust may have been influenced by the lack of tangible evidence that the answers they put into the computer were the answers upon which their grades were based. Each of these factors indicates issues that could be investigated in future

research and that should be addressed when computers are introduced into PSI courses.

In general, the students felt that the computers were easy to use. This perception, which was similar to that reported by Herrmann (1982), was probably due to the preliminary preparation for using the computer and the nature of the computer proctor programs. The initial preparation for the study was based on the completion of a study guide on the computer operations that would be necessary to run the proctor programs. Successful completion of this module required that the students demonstrate their ability to perform the necessary computer operations. In addition, the students had to achieve a grade of 90% or better on a readiness quiz that contained some questions on the operation of the computer. This brief introduction, which required only 20 to 30 minutes, seems to have been effective.

In addition, the computer proctor programs were based on the following premises: a. the students had little or no prior experience with computer proctor programs, b. the program should function as a human proctor and create an interaction that resembles that between a student and a proctor, and c. the administration of the computerized quiz should be as similar as possible to the administration of paper quizzes. Therefore, the program

was designed to: a. be highly interactive, b. gain and hold the students' attention, c. limit the presentation of material to three or four lines of text so that all of the material could be displayed simultaneously, d. provide concise procedural directions to guide the students through the program, e. request simple responses that were usually limited to pressing 1 or 2 keys, and f. provide appropriate social comments and refer to the students on a first name basis when appropriate. In addition, the duration and rate of presentation of materials was always under the control of the student.

The results indicated that the students felt that the computerized quizzes were easy to take. This finding is similar to one reported by Roll and Pasen (1977) who reported that students felt that computerized quizzes were easy to take. The positive attitude towards taking quizzes was due to the factors described above and to the way in which the quizzes were administered. For example, the quiz provided the students with the opportunity to preview the questions before answers were required. Interestingly, an examination of the summary sheets revealed that the students reported similar preview rates with the computer quizzes and with the paper quizzes. In addition, the quiz items, which were always accompanied by procedural directions, were displayed in their entirety

and they were always presented individually. Furthermore, the student also controlled the rate at which the items were presented because the question would be displayed until the student responded. Therefore, the computer quiz was similar to paper quizzes.

The student ratings of the ability to review some or all of the items on the computer quizzes ranged from low to moderate. The major concern about the review procedure was not the process itself but that it occurred at the end of the quiz and could not be completed whenever the student wished to make changes in his or her answers. The timing of this process prohibited immediate review and contrasted greatly with paper quizzes. Therefore, the timing of the review procedure seems to have been a limiting factor of the computerized proctoring. The implications of this result are discussed in a subsequent section.

Although there was dissatisfaction with the review process on the computers, it was used at a rate similar to that on the paper quizzes. For example, an examination of the summary sheets revealed that the proportion of quizzes that were reviewed was 78.34% with the computers and 81% with the paper quizzes.

The students ranked the personableness of the computers low and this ranking was the least positive

attitude expressed. However, none of the subjects ever indicated that they felt any depersonalization from using the computers and this finding is consistent with that of Cross (1976). And, although the computers were not very personable, they did provide extensive, highly personalized contact via the individualized quiz administration and feedback. This individualization has been noted by several investigators, such as Alderman et al. (1978), Bork (1978), and Pennypacker (1978), as one of the assets of computers in education.

The results suggest that the students felt that the computer quizzes took a moderate amount of time to complete. This assessment of time was supported by an analysis of 131 computer summary sheets that revealed a mean amount of 25.13 minutes with a SD of 6.50 for the entire proctoring sesssion.

An overwhelming majority of students felt more comfortable during their last computerized proctoring session than with their first session. This result, which suggests that as the students gained experience with the computers their apprehension about computers diminished, is similar to the finding of Sorlie et al. (1979). The implications of this finding are discussed in a subsequent section. Future research could attempt to determine the threshold number of computerized proctoring sessions that

would produce the increased level of comfort.

In essence, the students expressed a generally favorable overall attitude toward the computerized proctoring. These results were consistent with the findings of Sorlie et al. (1979), Burnard (1978), Kelley (1977), and Summer (1984) when they measured student attitudes toward using computers. Additional research could investigate whether additional exposure to computerized proctoring sessions promotes more positive attitudes toward the sessions.

In general, the overall attitudes towards human proctoring were highly positive. They were similar to the attitudes reported in numerous PSI studies including Born and Hebert (1974), and Johnson and Ruskin (1977). In addition, the attitudes and ratings of the various proctoring components were also favorable. For example, student attitudes toward the ease of taking and reviewing the quizzes were strongly positive. These attitudes were not unexpected because the students have been exposed to this type of quiz throughout their academic experience. In addition, the paper quizzes could be scanned easily and quickly and this scanning could provide information foranswering quiz items. However, if constructed response items were used, this advantage of scanning would diminish. These quizzes were also tangible and provided

the student with substantiation of their answers.

The students also felt that the proctors were more accurate than the computers in their grading. However, the quiz interscorer agreement index revealed extremely high levels of accuracy for each proctor condition. One possible explanation for the difference in attitudes is that the students could watch the proctors use an answer key to correct their quizzes. More importantly, they could see that the answers being scored were the answers that they had indicated. This ability to observe the proctor correct the answer differs dramatically from the correction routine used by the computer and it seems to have had a positive influence on the students' rating of proctor grading accuracy. In addition, the students may have been predisposed to a favorable attitude towards grading accuracy because of their familiarity with human grading of their quizzes.

The level of trust in the proctor was moderate. This level did not seem to be influenced by grading accuracy because the students had given this proctor component a high rating in grading accuracy. However, this level of trust may have been influenced by the novelty of the system. Additional research could determine whether the levels of trust varied with the extent of the experience with proctors.

While the students took the paper quizzes they reported feeling moderate levels of anxiety and stress no different from those levels experienced with the computerized quizzes, and, the anxiety and stress was probably due to the same causes: that is, being quizzed, quiz preparation, and the newness of PSI and proctors. The degree of perceived confidence during the quizzes was also moderate and it was probably influenced by the amount of preparation and the novelty of the system. Therefore, some stress and anxiety, accommpanied by limited confidence, was not unusual.

Thirty eight percent of the students felt more comfortable with their last proctoring session with the human than with their first session. None of the subjects felt less comfortable and the remaining students did not report any change in comfort. Although the actual degree of comfort was not measured, the expressed levels of confidence, stress and anxiety suggest that the level was at least moderate. Additional research could examine the actual levels of comfort and whether the levels of confidence, anxiety and stress become more favorable.

The students felt that the proctors were only moderately personable. This attitude was probably influenced by major restrictions that were imposed on the proctors. For example, the proctors were directed not to

reveal any correct answers at any time and they were restricted from providing information and teaching during the proctoring session. Furthermore, the investigator's unobtrusive observations of the proctors suggest that the proctors maintained strict adherence to these restrictions. The subjects were also told about these restrictions at the beginning of the experiment. However, a few subjects reported that the proctors were uncooperative because they would not reveal the answers or provide information. In addition, the time lag of no more than five minutes between the completion of the quiz and its correction and subsequent remediation may have adversely influenced attitudes towards the personableness of the proctors.

The students felt that the paper quizzes took a moderate amount of time to complete. This perception was supported by an examination of the 142 summary sheets that revealed the mean amount of time for each quiz was 23.66 minutes with a SD of 6.90.

Although the attitudes of the students toward each type of proctoring were favorable, the overall rating of human proctoring was more positive. The results on achievement and retention suggest that this overall difference in attitudes did not influence student performance because there was no difference in performance

under each condition. However, the results suggest that the different attitudes influenced proctor preference.

Student Preference

The third hypothesis was that student preference of computerized proctoring would be greater than student preference of human proctoring within a modified PSI format. This hypothesis was rejected because a significant majority of subjects, as revealed by a chi-square analysis, chose the human proctor condition. This finding is similar to the results of studies by Barton and Ascione (1978) and Fernald et al. (1975) in which students chose the condition that provided the most human contact when given the choice between treatments with different amounts of human contact. In addition, a significant majority of the females also chose the human proctoring condition. Herrmann (1982) described similar results. Additional research could determine whether these preferences for human proctors is maintained after longer periods of exposure to each proctoring condition.

In an attempt to determine the basis for proctor preference, the investigator made several comparisons between the preference groups. Comparative results indicate no significant difference between the attitudes

of the preference groups toward a. machines, b. the common proctoring functions of grading and prescriptive accuracy, c. the ease of taking paper quizzes, d. the degree of perceived stress and the level of confidence while taking the quizzes with the human proctors, e. the degree of trust in the human proctors, f. reviewing the computerized quizzes, g. the degree of perceived anxiety while taking computerized quizzes, or the perceived amount of time required to complete the computerized quizzes. These results suggest that the factors listed above did not influence preference.

In addition, the questionnaires did not reveal any significant difference between the ratings of the preference groups toward the personableness of the proctoring conditions. Furthermore, none of the interviewees indicated that the computers were not preferred because they were impersonal and only 3 of the 10 interviewees indicated that the human proctors were preferred because students prefer to work with people rather than with machines. These findings suggest that the personal qualities of the proctor were not vital factors in the choice of proctors. In addition, these findings also suggest that personal contact may not be critical to the success of PSI and they add support to the findings of Caldwell (1978), Gaynor (1975), Kulik et al.

(1976), Kulik and Jaska (1976), and Semb (1981).

A significant percentage of the members of each group felt that the level of difficulty of the quiz items under each condition was not different. This perception was supported by the students' quiz performance that indicated no significant difference between the mean level of achievement under each condition. In addition, the modular quizzes under each condition were made up of the same items. Moreover, there was no significant difference in the quiz retake rates under each condition. Furthermore, intra-group performance under each condition for the first five modules was not significantly different. These results suggest that the difficulty level of the quizzes, achievement on the quizzes, retake rates, and intra-group performance did not influence preference.

Comparisons between the preference groups revealed significant differences in their ratings of many proctoring components and perceptions under each condition. These comparative results indicate that proctor preference was based on a combination of positive attitudes towards some features of one type of proctoring and less favorable, although not negative, attitudes towards some features of the other type of proctoring. For example, the computer preference group had little

difficulty with using the computers and they had moderate to high levels of trust in them. During the quizzes, which they felt were moderately easy to extremely easy to take, these students had moderate to high levels of confidence and they perceived exceptionally low levels of stress. In contrast, the human preference group felt that computers were only moderately easy to use and the computer quizzes were moderately easy to take. In addition, they perceived moderate to high levels of stress and they had low to moderate confidence while they took the computerized quizzes. Furthermore, their level of trust in the computers was also low to moderate. The higher degree of confidence, along with the perceptions of less stress and anxiety characteristic of the computer preference group, seems to have developed from their ability to use the computers and their trust in the computer. The implications of these findings are discussed in a subsequent section.

On the other hand, the computer preference group indicated that the paper quizzes were only moderately easy to review and they perceived an extremely high level of anxiety as they took the quizzes. In comparison, the human preference group felt that the quizzes with the proctors were extremely easy to review and they also felt moderate anxiety when they took the quizzes. The

questionnaire and follow-up questions of the interviews were not sufficiently sensitive to determine the cause of the differences in anxiety and the attitudes towards reviewing.

The computer preference group felt that the paper quizzes took a moderate amount of time to complete while the human preference group felt that the paper quizzes took a limited amount of time. As indicated in a previous section, the mean reported time for the computerized quizzes was 25.13 minutes with a SD of 6.50 and 23.66 minutes with a SD of 6.90 for the paper quizzes. These mean times were not significantly different. However, the interviews revealed that the students based their responses to the time question on the summary sheets on different criteria. For example, the students based their answer to the time question for the computer summary sheets on the entire proctoring session. Therefore, the mean amount of time for the computerized quizzes was less than the reported figure and the mean of 25.13 minutes was for the entire session. In contrast, the answer to the time question for the paper quizzes was based only on the quiz and it did not include the time for the remainder of the session. Therefore, the time for the entire proctoring session with the human proctors was greater than the 23.66 minutes. Because of this discrepancy, no

comparison can be made on the actual amount of time spent with each type of quiz or proctoring session. However, the amount of time per quiz and/or proctoring session under each condition was probably similar.

Although there was probably no difference in the actual amount of time for each type of proctoring, the perception of time differred significantly for the paper quizzes and this perception may have influenced proctor preference.

In order to determine whether there was an actual difference in the amount of time necessary for each type of quiz, a follow-up study was conducted in the subsequent semester. The students in this study were very similar to the students in the initial study; they were enrolled in the same course with the same instructor, they were matched for age and QPA, they has similar academic backgrounds, and they were in the Nursing and Liberal Arts programs. They were also exposed to the same preliminary preparation for the computer and they used the same programs. The follow-up study revealed that the mean amount of time per computerized quiz was 17.49 minutes and that this value was significantly less than the time needed by the students in the initial study for the paper quizzes. This finding must be viewed with caution because the follow-up study was not an exact replication of the

initial study. However, the finding suggests that computerized quizzes take less time than paper quizzes, and this reduction in the time adds support to the findings of Cross (1976), Edwards et al. (1975), Thomas (1979), and Kulik et al. (1980) who have indicated that the use of computers in various types of computerized instruction reduces the time requirements of the course. Future research could determine whether this time reduction is maintained over an entire course and it could also determine the way in which the students used this time.

As indicated in a previous section, there was no significant difference between the attitudes of the preference groups toward the ease of taking the quizzes with the proctors. This "no difference" finding, which was probably due to the extremely high rating both groups gave to this questionnaire item, could be misleading. For example, the impact of this factor became apparent when 70% of the interviewees identified it as the major determining factor in proctor preference. Therefore, the ease with which the paper quizzes could be completed had a major influence on preference.

These results suggest that proctor preference was based on the following factors: a) the ease of taking the quizzes, b) the ease of using the computers, c) the degree

of perceived stress while using the computer, d) the degree of trust in the computer, e) the degree of confidence while using the computers, f) the ability to review the paper quizzes, g) the degree of perceived anxiety with the paper quizzes, and h) the perceived amount of time to complete the paper quizzes.

The investigator believes that one factor that may have influenced proctor preference would have been greater availability of the computers. For the purposes of the study, the computers and proctors had to be available at the same time and for equal amounts of time. However, this time restriction eliminated one of the major advantages of computers; namely, their availability. The investigator believes that if the computers had been as available as they would be during the typical school day, rather than only when proctors were available, additional students would have chosen computer proctoring. Future research could investigate the influence of computer availabilty on proctor preference.

Student Characteristics

Two of the purposes of the study were to determine the characteristics of the subjects whose level of achievement under each proctoring condition was high and

to determine the characteristics of the subjects whose level of achievement under each proctoring condition was low. An examination of the results revealed no significant differences in the mean Quality Point Averages(Q.P.A.'s) between the students in the upper and lower achievement levels under each proctoring condition. This finding differred from the results reported by Roberts and Meier (1978) who found that grades from prior college courses, as indicated by grade point average, were indicative of success in PSI courses. In addition, there was no difference in the mean number of attempted credits. This finding was similar to that of Roberts and Meier (1978) who reported no relationship between the number of points earned in a personalized course and year in college. In addition, there were no differences in the ages, or attempted number of credits between the students in the upper and lower achievement levels under each proctoring condition. Furthermore, none of the students in either group had had experience with computers or with PSI. Moreover, there were no significant differences in these factors when the comparable achievement groups under each condition were compared.

The only observable diffference between the students in these achievement groups was the academic programs with which they were affiliated. For example, 67% of the upper

achievement computer group and 87% of the upper achievement human group were in the Nurse Education or Dental Hygiene programs while the remaining members of each group were in Liberal Arts. In contrast, 33% of the lower computer achievement group and only 13% of the lower human achievement group were in Allied Health. The remaining members of each lower achievement group were in Liberal Arts. Therefore, the majority of students in the upper achievement groups were Allied Health students while the majority of students in the lower achievement groups were in the Liberal Arts program.

The unequal representation of students from the various programs may have been due to factors that were not discernable in this study. However, they may also reflect the overall academic ability of the students in each of the indicated programs. For example, both of the Allied Health programs are highly competitive and they only admit highly qualified students. In contrast, the Liberal Arts program has an open door policy that admits most, if not all, applicants. Allied Health students, who usually have better academic credentials, consistently outperform Liberal Arts students in this course and their higher levels of achievement in this study are not uncommon. The type of proctoring does not seem to have had any influence on the unequal distribution of students.

Implications

Because there was no difference in the levels of achievement and retention under each proctoring condition, these results demonstrate that computers can be used effectively as proctors within a modified PSI format for at least a portion of a course. The decision to use computerized proctoring must be based on other criteria. Factors that must be considered include, but are not limited to, the availability of proctors and computers; source of programming; program functions; cost effectiveness; and the way in which the students are introduced to the computers.

If the proctoring within a course is meeting all proctoring needs then there is no need to use computers as proctors. However, if proctors are not available, and computers are, then, the use of computers as proctors, as implemented in this study, is a viable alternative.

As indicated above, the decision to use computers could only be made if computers are available. The type of computer is not critical because proctor programs can run on both microcomputers and larger computers. Both types have advantages and disadvantages. For example, if the larger type of computer fails, then all computer

activity stops. However, if one microcomputer stops functioning, the others will still be available. In contrast, the main frame computers are easier to use logistically and they also seem to offer more quiz and record security and can simultaneously service extremely large numbers of students who may be in diverse locations. For example, with the larger computers, the only administrative involvement of the students is to log onto the computer terminal. An excellent example of the widespread student use of computerized proctoring was presented by Pennypacker (1978) when he described the Navy's computerized system.

In contrast, with the microcomputer, the student must handle the disc which could be damaged with improper handling. Moreover, discs could also be misplaced, stolen or copied. And, as the number of students in the class increases and/or the number of modules with computerized proctoring increases, the logistical problems intensify. In addition, off-campus students cannot be served because microcomputer use is usually limited to the college campus. This limitation could be overcome by allowing the students to take discs from the campus; however, this procedure would also magnify the problems associated with the discs.

The larger computers also offer an advantage in the collection of data. For example, all student records for all modules can be stored together and this type of storage enables the instructor to have immediate access to all files at the same time. In contrast, if the individual student files are stored on several floppy discs for each module, then the instructor must use each disc individually to get the same information. All records, whether they are established on the larger computers or the microcomputers should be backed up on other discs and on paper to safe guard against damage and/or loss.

Another critical factor that must be considered is that the programming of the proctor programs requires an extensive knowledge of programming and the expenditure of time and effort. As indicated, the proctor programs were based on Applesoft Basic. Additional research could examine the feasibility of using other languages, such as LOGO, PILOT, and PASCAL. If the faculty member plans to do the programming, he/she must consider the time and energy that would be expended in learning a programming language or using an authoring system. In addition, the faculty member must consider the time it would take to develop the programs. However, if an experienced programmer were available, the amount of faculty time put

into the development of the programs would be reduced, but not eliminated. For example, the faculty member would have to provide the programmer with explicit details of the program requirements and, more importantly, would have to make sure that the resulting program is academically sound. The investigator believes that faculty involvement is essential to the success of the programs. The functions of the computer proctor programs will depend upon the proctor requirements. However, the basic program should be easy to use and it should perform the following proctor functions: a. greet the student; b. request identification information from the student; c. verify that information; d. select and/or generate modular quizzes; e. administer the quiz and allow for preview and review; f. score the quiz and record the grade in each student's individual file; g. provide immediate feedback in the form of appropriate comments, grade, and prescriptive information; and h. provide an appropriate closing statement.

One of the most critical sections of the program is the review procedure. This program sequence should permit answers to be changed when and as often as the student wishes. The program in the present study permitted students to review answers only at the end of the quiz. Although answers could be changed as often as desired

during this review, the students' attitudes towards this capacity was only moderately favorable. To improve this review procedure, the program could direct the students to press a particular key to indicate the desire to review. Once the key was pressed, the computer could keep track of those items to be reviewed and they could be presented automatically at the end of the quiz. Or, the program could permit unlimited review at any time.

The proctor programs in this study visually displayed feedback on the monitor to the student. The results suggest that a computer generated printed copy of the feedback would improve this section of the program and it would promote trust in the computer.

The basic program described above could be enhanced by incorporating some of the features described in the literature. For example, it could be modified to lock out students who have low levels of achievement and to notify the instructor about these students (Sorlie et al., 1979). Or, it could also be programmed to provide item analyses Towle (1973) and enhanced explanations Bowles (1978).

In addition to deciding the functions of the program, the teacher must also determine the way in which the students will learn how to use the programs. This task is not as formidable as it seems because the students only

have to be able to turn the computer on and off and operate the keyboard. It should be noted that the student does not have to develop any programming skill to use the programs. These computer operations can be taught with commercially available or faculty developed teaching packages. In either case, the introductory program should permit some hands-on experience and/or practice quizzes. The amount of time needed to teach these computer skills is minimal. For example, the subjects in this study were using an interactive program developed by the investigator after less than one half hour of instruction. These results are similar to those reported by Hermann (1982) who indicated that students reported that computer operations were simpler to follow than the procedural instructions for human proctors.

Although the students found that it was relatively easy to use proctor programs, this investigation revealed that they were afraid of making mistakes on the computer and that they lacked a basic understanding of the way in which computers function. These limitations had many ramifications because the results suggest that they influenced student trust in the computer; attitudes towards computer grading; and levels of confidence, stress, and anxiety while taking computer quizzes. Therefore, these limitations are major obstacles that

should be reduced as much as possible. To reduce these limitations, the instructor could: a) provide programs that are easy to use, b) provide simple procedural directions in the program, c) provide the opportunity for extensive hands-on experience and practice time, d) tell the students that the program has been programmed by the instructor or under the instructor's supervision (thereby building on the trust that may have been previously established), e) discuss the phases of the program in English and not in computer jargon, f) demonstrate that the program does what the student tells it to do, g) emphasize the importance of following directions, h) emphasize that it is <u>almost</u> impossible to break the computer, i) indicate that any errors made by the student or computer can be rectified, and j) provide a study module on computer use and the way in which a computer works. The instructor could also administer a computerized readiness test, which uses the same quiz procedure that is incorporated into the proctor programs, to evaluate the students' ability to use the computer and their understanding of the ways in which computers work.

During this investigation, the investigator observed a sharp decrease in the level of anxiety as the students gained experience with the computer. This decrease was evident in most students after only one or two twenty-five

minute proctor sessions. In addition, the results revealed that the level of comfort increased with computer experience. Therefore, it seems that anxiety levels could be reduced and comfort increased by providing additional practice sessions with the computer.

The discussion in the previous sections was based upon the assumption that no proctors were available and that all of the proctoring would be performed by computers. However, computerized proctoring may also be desirable under other circumstances. For example, they may be used in combination with proctors whereby some modules utilize the computer as a proctor and other modules are proctored by a human. Or the proctors could use computers to perform some functions during the proctoring session. In this combined proctoring session, the degree of computer use would depend on local needs and resources. In both of these circumstances, the use of the computers would reduce the amount of training required by the proctors. In addition, the personnel needs of PSI would decrease and the social aspects of PSI would be maintained. This combination would be in keeping with investigators, such as Keller (1967) and Johnson and Ruskin (1977), who maintain that the social aspects of PSI are critical to the success of PSI. The motivational potential of the proctors, as recommended by Pennypacker

(1978), would also be preserved in a system that included proctors and computers.

Summary

The results of this study, in which the subjects were exposed to the same instructor, study guides, quizzes, and feedback, indicated that: a. there was no significant difference in achievement of remediated instructional objectives under each type of proctoring, b. there was no significant difference in the retention of successfully remediated instrucional objectives under each type of proctoring, c. there was no significant difference in the student rate of progress as measured by retake rates, under each type of proctoring, d. the students overwhelmingly chose human proctors, e. student attitudes towards computerized proctoring was positive, f. student attitudes towards human proctoring was highly positive, g. computers were used effectively and efficiently as proctors within a modified PSI format, h. computers provided highly individualized contact, i. computers decreased the personnel needs of the modified PSI course, and j. students learned to use computers within a relatively short period of time.

Conclusions

a. Computers effectively functioned as proctors within an individualized instruction format,

b. Computerized proctoring served as a supplement to human proctoring,

c. Computers decreased the proctor requirements of the individualized instruction and increased the time available for student-teacher contact,

d. The students displayed generally positive attitudes toward computerized proctoring,

e. Students easily learned to use computers,

f. Students became more comfortable and less anxious with the computers as they gained experience with them, and, when given the choice between computerized and human proctoring, preferred human proctors.

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APPENDICES

A. Individualized Instruction Handout

B. Summary Sheet

C. Proctor Preference

D. Interview Format

E. Class Questionnaire

F. PREFERENCE QUESTIONNAIRE

Appendix A. Individualized Instruction Handout

Human Biology
Prof. Paul Chamberlin

Name_____
Date_____

The Keller Plan

Some of the units on the nervous system will be covered sequentially on an individualized basis and they must be completed according to the schedule that will be posted. You must take a quiz on each unit. The quiz will be given to you, individually, by a proctor in the Individualized Learning Center (ILC), Room 169A. The proctoring will be performed by a person or a computer. Fifty-percent of the class will begin with a person as a proctor for the first module and will use the computer for the second module. The other 50 percent use a computer as a proctor for the first module and will have a person for the second module. I will tell which type of proctoring you will have for the modules.

If you do not achieve a grade of 90 percent or better on your first quiz, you will take a second quiz on the unit. The proctors will not give you the correct answers to the questions; however, they will provide you

with prescriptive information that will direct you to the assignment that contains the material that you did not learn for the first quiz. After you have studied this material for at least one hour, you can take your second quiz. After you have completed your quiz on one unit you will proceed to the next unit.

The following procedure will be used for these units.

1. Make an appointment with a proctor or for a computer after you have completed the unit.
2. Bring a pencil and two summary sheets (available in class and in rooms 302S and 421A-my office.

The proctoring session-proctor.

Identify yourself to the proctor and indicate which unit you want a quiz on.

The proctor will give you the appropriate quiz. When you have completed the quiz, bring it back to the proctor for correction.

The proctor will show you your grade and indicate whether you must take a re-take. The proctor will also indicate which questions you missed and will indicate where the correct information can be found. The proctor cannot tell you the correct answers to the questions. At this time you will complete both summary sheets. You will keep one

sheet and give one to the proctor. If you must take a re-take quiz, you will be reminded to make an appointment for it.

The proctoring session-computer.

Obtain the appropriate disc from the proctor and start the program. The program will describe the way you should respond to it and it will also describe the way in which you should correct typing errors.

After the computer asks you to identify yourself, the quiz program will begin. You will have the opportunity to preview your questions before you take the quiz. After you take the quiz you will have the opportunity to review your questions and answers before they are graded. When the computer completes grading your quiz, it will display your grade and indicate whether you must take a re-take. It will also indicate which questions you missed. At this time you will complete both summary sheets. You will now have the option to review all of your questions or to continue with the program.

At this time the program will indicate which questions you missed and the objectives the questions were based on. It will also describe the location of the correct information.

At the end of the program, the computer will remind you to keep one summary sheet and to return the other one to the proctor. It will also remind you to make another appointment for the computer if you need a re-take.

Appendix B. Summary Sheet

Summary Sheet

1. Name the Unit. 1._____

2. Indicate the quiz form: A B C D 2._____

3. Is this for your first or second quiz? 3._____

4. Indicate your grade. 4._____

5. How many questions did you get wrong? 5._____

6. How long did the quiz take? 6._____

7. Please circle the incorrect answers:

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30

8. Please circle the objectives that you got prescriptive information on:

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30

9. Indicate the pages you must restudy:

10. Did you preview the questions? 6._____

11. Did you review the questions(to change answers) before the quiz was graded? 11._____

12. Are you taking a retake? 12._____

13. Indicate the type of proctoring that you received.

a. Computer

b. Human

Appendix C. Proctor Preference

BI 156 Human Biology Name_____

Prof. Paul Chamberlin Date_____

Subject: Proctor Preference for Unit 6.

This form must be completed after you have taken your quiz/quizzes on unit 5 and before you take your quiz on unit 6.

Please indicate the type of proctoring that you wish to have for unit 6.

A. Human

B. Computer

This form must be returned directly to Prof. Chamberlin or you can bring it to his office, Room 421A, and slip it under the door. The proctors cannot accept these forms.

The due date for unit 6 is 2/24/84

Name_____

Date_____

Appendix D. Interview Format

Interview Format

Purpose

The purpose of this interview is to discuss the reasons why you and your classmates have agreed or disagreed with statements number 1, 2, 3, 4, 8, 9, 14, 15, 18, 21, and 22 that were on the questionnaire.

General Information

All numerical references are based on the same scale that was on the questionnaire. The scale reanges from 0 to 10; 0 represents strong disagreement with the statement whereas 10 represents stong agreement. The number 5 represents neither agreement nor disagreement.

The term computer group refers to the students who chose to use the computer for the sixth proctoring session while the term human group refers to the students who chose to have a proctor for the sixth proctoring session.

All information discussed in this interview will be held in absolute confidentiality and your anonymity will be protected. In addition, you may terminate this interview at any time. Please let me know when if this interview may be taped.

After you have read this information, please read statements number 1, 2, 3, 4, 8, 9, 14, 15, 18, 21, and 22 on the questionnaire that I have provided. Please note the numerical notations that are indicated for the statements listed above. The green notations indicate the mean values of the responses for the computer group while the blue responses represent the means of the responses for the human group.

Please let me know when you are ready to begin the interview.

Your signature in the space below indicates that you have read and/or discussed the information presented above with the interviewer.

Date of the interview_____

Signature of the Interviewee_____

Signature of the Interviewer_____

Appendix E. Class Questionnaire

Human Biology
Prof. Paul Chamberlin

Name.....
Date.....

Class Questionnaire

Directions. Please answer the following questions in the spaces provided.

1. Please indicate your sex: M or F. 1.....

2. Please indicate your age:
   a. under 20 b. 21-25 c. 26-30 d. 31-35 e. 36-40
   f. 41-45 g. 46-50 h. over 50

   2.....

3. Please indicate your program of study:
   a. liberal arts b. nursing c. dental hygiene
   d. other (if other, please specify

   3.....

4. Indicate the number of college credits that you have earned at QCC and at other colleges:
   a. 0-12 b. 13-24 c. 25-36 d. 37-48 e. 48-60
   f. other(if other please specify) 4.....

5. Have you had college experience with the Keller Plan (also known as the personalized System of Instruction)?
   a. yes b. no 5.....

6. If you answered yes to question # 5, please indicate the amount of time you used the plan:
   a. 1-2 courses b. 3-4 courses
   c. over 5 courses 6.....

7. Have you used a computer in any course.
   a. yes b. no 7.....

8. If you answered yes to question # 7, please indicate the amount of time you used computers: a. 1 course
b. part of 1 course c. 2 courses
d. part of 2 courses e. other-describe. 8.....

9. Please name your lab instructor for this course.
9. _____

10. Did you take the math placement exam at this school?

a. yes b. no

10.....

page 2.

11. Please indicate the year you took Bi 155 and your grade.

11.....

12. Please indicate the chemistry courses that you have had:

A. Chemistry 100 a.....
B. Chemistry 151 b.....
C. Chemistry 152 c.....
D. other d.....
E. If you had chemistry in another college, please indicate the name/s of the course/courses.

E.....

Section II. Directions. Please answer the following questions in the spaces provided.

1. Briefly describe your attitude towards taking your quizzes individually with a computer as a proctor.
1.....

2. Briefly describe your attitude towards taking your quizzes individually with a person as a proctor.
2.....

Appendix F. PREFERENCE QUESTIONNAIRE

BI 156 HUMAN BIOLOGY Date_____

PREFERENCE QUESTIONNAIRE

PURPOSE. The purpose of this survey is to ascertain how you feel towards being proctored by humans and by computers.

DIRECTIONS. Please indicate the degree to which you agree or disagree with the following statements by drawing a circle around the number that represents your feelings. Do not put your name on this survey.

Scale: 0 = strongly disagree (SD)
5 = neither agree or disagree (N)
10 = strongly agree (SA)

1. I felt that it was easy to take the quizzes on paper

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

2. I felt that it was easy to take the quizzes on the computer

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

3. I felt that it was easy to review the questions on the computer

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

4. I felt that it was easy to review the questions on paper quizzes

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

5. I do not like machines

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

6. I felt that the proctors were accurate in their grading

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

7. I felt that the computer was accurate in grading

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

8. I felt a lot of stress taking the quiz on the computer

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

9. I felt a lot of stress taking the quiz with the proctor

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

10. I felt very confident taking the quiz with the proctor

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

11. I felt very confident taking the quiz with the computer

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

12. I felt that the computers were very personal

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

13. I felt that the proctors were very personal

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

14. I felt very anxious taking the quiz with the proctor

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

15. I felt very anxious taking the quiz with the computer

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

16. I felt that it took a lot of time to take the quiz with the proctor

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

17. I felt that it took a lot of time to take the quiz on paper

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

18. I felt that it was too difficult to use the computer

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

19 I felt that the proctors were very accurate with their prescriptive information

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

20 I felt that the computers were very accurate with their prescriptive information

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

21. I felt a lot of trust in the computer

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

22. I felt a lot of trust in the proctors

0. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

(SD) (N) (SA)

23. Which of the following statements is most accurate?

A. I felt more comfortable with my first session with the computer.

B. I felt more comfortable with my last session with the computer.

C. I did not feel any difference in comfort between my first session and last session with the computer.

24. Which of the following statements is most accurate?

A. I felt more comfortable with my first session with the proctor.

B. I felt more comfortable with my last session with the proctor.

C. I did not feel any difference in comfort between my first session and last session with the proctor.

25. Which of the following statements is accurate?

A. I felt that the quizzes with the proctors were more difficult than the quizzes with the computers.

B. I felt that the quizzes with the computers were more difficult than the quizzes with the proctors.

C. I felt that there was not any difference in the difficulty level between the quizzes on the computer and the quizzes with the proctors.

26. Please indicate your preference for unit 6.

A. Proctor

B. Computer

27. Additional comments. Please feel free to add any comments about your experiences with the sessions with the proctors and/or with the computers.