Development of an Online Course using a Modified Version of Keller's Personalized System of Instruction

by

Hope Q. Liu

Virginia Polytechnic Institute and State University

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Dr. David M. Moore, Chair
Dr. John K. Burton
Dr. Glen A. Holmes
Dr. Barbara B. Lockee
Dr. Ken R. Potter

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(ABSTRACT)

Keller's Personalized System of Instruction (PSI) uses small units of instruction, self-pacing, mastery learning, lectures for motivation, and proctors for immediate feedback. While highly successful in the early 1970's, PSI fell out of favor for a variety of reasons. This developmental dissertation resurrects Keller's system in its purest form and uses PSI for an online Master's program. Using Cold Fusion™ and Dreamweaver™ an online Keller experience was created. Experts of PSI reviewed the product to check for fidelity to Keller's ideas. Formative and summative evaluation showed that this system of instruction is viable for the online environment. Recommendations and implications for future use are discussed.

DEDICATION

For my parents, K. F. and Helen, who knew me better than I knew myself,

and

To C.J., for everything, always

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I dedicate this life achievement to the people who have been most important and instrumental in guiding my life both by their support and their example. Without my touchstones, I would never have reached this stage.

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Table of Contents

Table of Tables

Table of Figures

CHAPTER ONE

Introduction

Individualized instruction is "the adaptation of instructional procedures to the requirements of the individual learner"(Glaser, 1968), p. 227). Individualized instruction provides the ideal instruction for each learner. In the 1960's three approaches of individualized instruction were developed: Keller's Personalized System of Instruction (Keller, 1968), Postelthwait's Audio-Tutorial Method (Postlethwait, Novak, & Murray, 1970), and Bloom's Learning for Mastery (Bloom, 1971). Keller and Bloom advocated a mastery criterion, which means that learners must demonstrate a pre-set level of mastery of the instructional material before proceeding to the next lesson. Postlethwait did not have mastery as an integral part in his courses, although mastery learning was a component in his idea and development of mini-courses. Each of these approaches showed improvement in performance and student attitudes when compared to traditional, lecture-taught courses.

Distance education is increasing rapidly using the World-Wide-Web as its medium of distribution. There is an increase in the use of the World-Wide-Web to deliver instruction. The features of web-based instruction provide rich opportunities to develop individualized instruction for distance learners. Hypertext enables learners to branch to other or more types of instruction. By combining distance learner characteristics with the flexibility of web-based instruction, individualized instruction could be possible. There are computerized versions of Keller's personalized system of instruction in existence. However, there is no authentic version of Keller's system in use in web-based instruction.

Goal of this Project

This developmental dissertation uses Keller's Personalized System of Instruction (PSI) as the theoretical basis for the development and delivery of online instruction to Virginia Tech's Master's of the Arts learners in Instructional Technology. PSI has been shown to be a superior instructional method in a face-to-face setting. Recent attempts to deliver online instruction using PSI have lacked fidelity Keller's original conception of PSI because of major modification. This dissertation attempts to develop a more faithful modification of Keller's system to graduate students who are enrolled in an online,

distance education Master's program. There are four major components to this dissertation:

1. The review of literature to examine the theory behind putting PSI online
2. The design and development of the online version of PSI
3. The product, analysis and recommendations based on formative and summative evaluations
4. Discussion

The Theory Behind Putting PSI Online

Keller's Personalized System of Instruction

The Popularity of the Personalized System of Instruction

Fred Keller is widely recognized as the creator of a Personalized System of Instruction (PSI). PSI first began in the mid 1960's, but after Keller's 1968 publication of "Goodbye, Teacher…" interest dramatically increased (Sherman, 1992). This national interest in PSI led to conferences, research, and implementation across a wide variety of settings. Eventually, PSI research was centralized into the Center for Personalized Instruction at Georgetown University. This center sponsored conferences, workshops, and published research on PSI. At this time, there was large financial support at the state, national, and international level for PSI. This financial support from multiple agencies, including Carnegie Corporation, Sloan Foundation, and UNESCO, led to over 5000 PSI courses by 1979 covering a variety of disciplines. Unfortunately, in the early 1980's, the funding for PSI related research dried up. The Center for Personalized Instruction was disbanded and other more novel approaches were funded over PSI approaches (Sherman, 1992).

In addition to financial distress, Sherman cites three other factors contributing to the downfall of PSI: instructor reluctance, defining PSI, and the lack of information dissemination. Instructor reluctance to adopt PSI techniques hindered the acceptance of PSI. This is because instructors were threatened by PSI's independence of the instructor. Indeed, instructors using PSI were told not to use PSI any more because it was not viewed as teaching. Defining PSI became problematic because when variables were altered the high success rate of PSI altered as well, depending on the variables. This caused a rift amongst conservative PSI practitioners and more liberal PSI practitioners.

Finally, financial disputes led to the reduction of published information on PSI and therefore awareness decreased (Sherman, 1992).

Components and Characteristics of PSI

In his seminal paper "Goodbye, Teacher…" (Keller, 1968), Keller describes the five components of PSI, which are:

1. The go-at-your-own pace feature (self-pacing)
2. The unit-perfection requirement for advancement (mastery)
3. The use of lectures and demonstrations as vehicles of motivation
4. The related stress upon the written word in teacher-student communication
5. The use of proctors for feedback

The first feature of PSI allows a learner to move at his/her own pace through a course at a self-determined speed. The unit-perfection requirement means that before the learner can move to the next unit of instruction, he/she must complete perfectly the assessment given on the previous unit. Motivation for a PSI course is provided by a positive reward structure. Learners who have attained a certain level of mastery, as indicated by the number of completed units, are rewarded through special lectures and demonstrations. Communication, in classic PSI systems, relies primarily on written communication between learner and teacher. However, the proctor-learner relationship relies on both written and verbal communication, which provides valuable feedback for learners (Keller, 1968)

A PSI class is highly structured. All information is packaged into small, individual units. The learner is given a unit, reads the information, proceeds through the exercises, and then reports to a proctor for the unit assessment. After completing the quiz, the learner turns the answers into the proctor for immediate grading and feedback. If the score is unsatisfactory (as designated by the instructor), the learner is asked to re-examine the material and return for another assessment. After completion of a certain number of units, the learner's reward is permission to attend a lecture, demonstration, or field trip, which is instructor-led. At the end of the course, a final exam is given. The learner moves at his/her own pace, but is expected to complete all units by the end of the semester (Keller, 1968). PSI was widely used in the 1970's in higher education courses (Sherman, 1992). After the initial use of PSI became widespread, many studies focused on the effect

that these individual features have on the success of a PSI course.

The effect of pacing.

The emphasis on self-pacing has led some PSI practitioners to cite procrastination as a problem in their classes (Gallup, 1974; Hess, 1974; Sherman, 1972). In the first semester of a PSI course on Physics at the State University College, Plattsburgh, Szydlik (1974), reported that 20/28 learners received incompletes for failure to complete the requisite number of units. In an effort to combat procrastination, researchers started including some instructor deadlines with penalties (pacing contingencies) if the learners failed to meet the deadlines.

Semb, Conyers, Spencer, and Sosa (1975) conducted a study that examined the effects of four pacing contingencies on course withdrawals, the timing of learner quiz-taking throughout the course, performance on exams, and learner evaluations. They divided an introductory child development class into four groups and exposed each group to a different pacing contingency. Each group was shown a 'minimal rate' line that was a suggested rate of progress. The first group received no benefit or punishment for staying at or above the minimum rate. The second group (penalty) was punished if they were found below the minimum rate line, losing 25 points for every day they were below the rate line. The third group (reward 1) benefited from staying above the minimum rate line by earning extra points. The fourth group (reward 2) also benefited from staying above the minimum rate line by potentially gaining an extra 20 points overall. All learners were told that if they did not complete the course by the end of the semester they would receive an Incomplete and could finish the course later with no penalty. Learners could withdraw from the course at any point in the semester with a 'withdraw passing' grade (Semb et al., 1975).

The results of the course withdrawal and incomplete study showed that learners with no contingency pacing had the highest percentage (23.8%) of withdrawals and incompletes. The second group (penalty) had the lowest percentage of withdrawals and incompletes (2.4%). With regard to procrastination, learners in groups 2-4 maintained a relatively steady rate of progress while group 1 showed the traditional pattern of procrastination. No significant differences were found between any groups on performance on exams or quizzes. Nor were there any significant differences between

groups regarding learner evaluations (Semb et al., 1975).

In an almost exact replication of this study, Reiser (1984) again examined whether reward, penalty, or self-pacing was most effective in a PSI course. No difference between groups was found regarding performance on the final exam, and there was no difference in learner attitude. However, learners in the penalty group had significantly reduced procrastination. The reward group did not show a significant reduction in procrastination, which contradicts the findings by Semb et al. (1975).

Ross and McBean (1995) reported that multiple deadline contingencies led to more uniform test taking throughout the course. They concluded that self-pacing could be incorporated by imposing deadlines for the majority of tests and quizzes, but not for all of them. They also suggest that a deadline should be defined as the last date by which a unit of material must be mastered, and not attempted.

Self-pacing is one form of learner control. Studies on learner control when not in a PSI format show mixed results. Wilheim (1990) showed significantly higher achievement scores and less time spent on task when learners were given control of pacing in an interactive video lesson. Reiser (1980) has examined the importance of perceived locus of control of reinforcement in PSI courses. He compared performance between learners who believed that the locus of control of reinforcement was dependent on their behavior (internal locus) to that of learners who believed that reinforcement was externally controlled (external locus). The perceived locus of control had no effect on the learners' pace through the courses or on performance on the final exam (Reiser, 1980).

Using a microcomputer, Belland, Taylor, Canelos, Dwyer, and Baker (1985) examined the effect of self- pacing or external pacing on learner performance. They also compared the effect of unlimited cognitive processing time, measured by the amount of time the learner spent on instructional screens, to limited cognitive processing time, which was controlled by the computer. They concluded that allowing self-pacing results in poorer performance in terms of the amount learned and competency in the material. Moderate levels of external pacing improved overall learning. However, they caution against complete external pacing in a program, as learners who had limited processing time did not perform even as well as the self-paced students. It seems as though moderate pacing plus allowing time to process the material may prove most beneficial

(Belland et al., 1985). They also suggest that learners need to be forced into remediation by the computer program. This conclusion is supported by Tennyson (1980), who found that a program that provided learner advisement (diagnosis and prescription) yielded superior performance.

The effect of unit perfection for advancement.

Another requirement for a PSI course is that the content be broken into small, discrete, units. These units are then mastered individually by the learner. Several studies have examined the effect the number of units has on learner performance in a PSI course. Born (1975) took an introductory psychology class taught using PSI and divided it into three sections. One section had to master 18 quizzes over the 18 units. The second section had to master one quiz every two units. The third section was required to master one quiz every three units. Therefore, each section had the same 18 units, but the number of quizzes differed. Surprisingly, there was no difference between the three groups of learners in terms of performance on quizzes. However, section one learners spent a much shorter time on the quizzes than did section three learners (Born, 1975).

Another study examined the effect of breaking up course material into units of 30, 60, and 90 pages (O'Neill, Johnston, Walters, & Rashed, 1975). Learners performed worst in the first attempt on each unit quiz when they had learned the material from the large course unit. Learners exposed to a large unit also delayed starting the next unit. Also, more attempts at mastering the quizzes had to be made when learners were exposed to a large unit. Despite these effects, the size of the unit did not affect the final attempt to meet the mastery criterion. They also observed learner behavior and stated that the larger the unit the more time the learner spent studying. Learners with a large unit spent more time reading the unit, but less time: summarizing, taking notes, and other interactive behaviors (O'Neill et al., 1975).

One of the most studied aspects of PSI courses is the mastery component. A study by Abbott and Falstrom (1977) compared a lecture method that used a frequent testing component to a more traditional Keller-plan method. They treated the frequent testing component as a variable to isolate its effect on achievement. Both the lecture version and the Keller version of a statistics class were offered over two successive semesters. They both used the same text, professor, learning objectives, and the same criterion-referenced

grading scale. All content was offered in discrete units in both classes as well. The lecture method replaced the use of a proctor with professor office hours. The lecture method did not allow self-pacing, and did not require mastery of the content during the class. The lecture class offered 12 tests in the class during the semester and the Keller class required that 12 tests be taken. Thus they isolated the frequent testing component to test its effect on achievement (Abbott & Falstrom, 1977).

A total of 40 learners participated in the lecture version of their class and 25 learners participated in the Keller version. A comparison of the total points achieved between the lecture version and the Keller version showed no significant difference. Additionally, learners in both classes achieved, on average, a 'high' level of achievement based on total points earned. Abbott and Falstrom's (1977) results indicated that providing learning objectives, content in discrete units, and frequent testing opportunities led to the same level of high achievement reported in the Keller class, and that the other aspects of the Keller plan could be omitted. Therefore, mastery was not a required element in order to achieve the same level as a Keller course (Abbott & Falstrom, 1977).

It is interesting to note that the subject matter was statistics, a class that builds skill upon skill. This hierarchical nature of the subject matter could almost force mastery upon the learners that experienced the lecture version. If they did not master the skill on one test, they would not do well on the next test coming up in two weeks. In addition, the standard deviation within the lecture class was as high as 43.4, indicating a large range of achievement even though the mean achievement score was quite high. Also, one of the marked features of the Keller plan and other mastery programs is the success of learners who traditionally do not perform well (Austin & Gilbert, 1973; Born, Gledhill, & Davis, 1974; Kulik, Kulik, & Cohen, 1990). It is possible that with the omission of a mastery requirement and a proctor to monitor progress that these learners did not fare as well in the lecture class.

In another study attempting to isolate the most effective components of a PSI course, Goldwater and Acker (1975) compared the performance of learners in a 'mastery performance' (MP) class to a control group that received a traditional approach. The class was divided into two groups. One group received the MP class while the other group served as the control. During the second half of the semester, the groups were reversed.

Therefore, both groups experienced the MP class. The MP class was required to master the material on small units of the course as measured by weekly quizzes. Both courses were instructor paced with no proctoring and mass testing. The MP groups significantly out-performed the control group during the first term, but there was no significant difference during the second term. A follow-up quiz consisting of 18 questions was administered the next academic year and again, the MP first-term class performed significantly better than the control group. The authors conclude that the essential factors in increasing learner performance are a mastery criterion, weekly quizzes, and small units of instruction.

Another study that looked at the components of the Keller plan concluded that mastery was the essential requirement for all learners to perform at high levels (Caldwell, et al., 1978). They compared two introductory psychology classes at West Virginia University. One class labeled WVG was taught with a traditional group approach where learners met three times a week for 50 minutes. They were allowed two take two quizzes on the same material, with the highest score counting. The other class labeled WVI was taught using a Keller plan approach with a mastery requirement before proceeding. Both groups received a study guide with specified objectives, sample test questions, and pages of content. They also were tested using a common pool of multiple choice test items and the same multiple-choice final exam (Caldwell et al., 1978).

Using this methodology, they examined the overall effect of a PSI type course on learner performance. Their results agreed with previous studies (McMichael & Corey, 1969, 1971; Austin & Gilbert, 1973; Kulik, Kulik, & Cohen, 1979) that PSI courses yielded superior performance. Additionally, the average number of attempts a WVI learner made to master the quiz material was 2.5 times. The WVG learner was only allowed to take the quiz twice. They assert that the mastery requirement is what made the WVI learners more successful. If it was simply unlimited remediation that allowed improved scores, one would think that the number of times the WVI took the quiz would be significantly higher than the WVG learners (Caldwell et al., 1978).

The use of lectures and special demonstrations as motivators.

Another feature of PSI classes is the use of lectures and special demonstrations as motivators to combat the tendency to procrastinate and provide positive reinforcement for

progress. Interestingly, Born and Herbert (1971) reported that attendance at these events decreased steadily over the course, regardless of the type of event. They offered movies, lectures, and discussions as incentives and learners reported that the discussions were the least interesting of the three events. They concluded that since attendance did not have any effect on the learners' grades, learners did not see the reason for attending. Nelson and Scott (1972) reported similar findings for their course in psychology. In their survey, only 27% of the learners felt that the 'incentive' features aided progress and understanding, 53% reported that they provided some positive effect. Surprisingly, 20% of the learners reported that the incentives were of little or no value. Calhoun (1976) examined the importance of lectures in a PSI course and found that providing lectures did not improve performance. Supporting these findings are those of Brothen and Wambach (1998) who saw a similar pattern of decreased attendance in non-mandatory lectures and also noted no impact by lectures on performance.

Related to these studies are studies on motivation in PSI courses. Wittig (1974) reported that proctors can be important in motivating learners in a PSI composition course. According to her, proctors can provide a personal touch to learners who are unmotivated due to personal fears, such as failure and a feeling of anonymity. Ablin and Flammer (1974) support her contention that tutors increase learner motivation. They also assert that tests, which evaluate a learner's mastery of clearly stated objectives are motivating.

Learner self-pacing has been cited as one aspect of PSI that learners enjoy (Fernald et al., 1974). Therefore, it could be motivational. A study conducted by Reiser (1984) found that learners that proceeded through a class at their own pace, under a penalty system or under a reward system did not differ significantly in their attitude towards the PSI course. The attitude of all three groups toward the course was generally favorable (at least 63% responded positively). These results agreed with his conclusions of a previous study (Reiser, 1980). Another motivating aspect of PSI is the removal of the external locus of control. Because of the demand for perfection on each smaller unit, the grade distribution of PSI courses is skewed toward the higher grades, taking away the external locus of control provided by an emphasis on grades (Keller, 1968; Born & Herbert, 1971; Ryan, 1974).

The Emphasis on Written and Verbal Communication.

Written communication is the primary means of communication for PSI instruction and feedback. Naturally, this would be an unacceptable teaching strategy for learners whose writing skills are below average. If proctors are used, learners may express their knowledge verbally which may assist in improving the widespread application of PSI. The stress on the written word has not been widely examined as a research question. However, there have been studies conducted on the study guides in PSI courses.

Most PSI study guides provide an introduction to the unit material, provide unit objectives, recommend how to study the material, and then provide study questions (Kulik, Kulik, & Carmichael, 1974). The study guide provides almost all the communication between the learner and the teacher. In a study by Calhoun (1978), learners were either provided with a complete study guide (as defined above) or a study guide providing only study questions and an introduction to the unit material. He concluded that the complete study guide reduced procrastination as learners with the complete guide progressed through the course faster. Initially, learners with complete study guides performed better on the quizzes. Consequently, learners with complete guides had a higher percentage of A's as the final grade. Learners with complete study guides also had a more positive attitude to the course (Calhoun, 1978).

Another aspect of study guides is the study guide questions. Spencer and Semb (1978) reported that replacing the weekly quizzes with turning in study guide questions decreased learner performance by 5-10%. They noted that this decrease in performance was more marked when there was no mastery criterion in the course. More learners chose to turn in study questions than take a weekly quiz, suggesting that learners might not always know what method of instruction is best for them or that they need to further develop metacognitive skills. Interestingly, they also found that learners chose to take a course under a mastery criterion than under no criterion (Spencer & Semb, 1978).

The role of the proctor.

The proctor plays a pivotal role in a PSI course. There are actually two types of proctors in a Keller system. The first type of proctor is a “study hall proctor”. This proctor explains and assists the student prior to taking the quiz (Keller, 1974). According

to Keller (1974), this proctor stands between the materials and the student and is an interpreter and guide for the material. The other type of proctor (and the most researched) is the “grading proctor” (Keller, 1974).

Farmer, Lachter, Blaustein, and Cole (1972) analyzed the role of proctoring by quantifying the amount of proctoring that different sections of the course received. They randomly assigned a class of 124 undergraduates into five groups (0%, 25%, 50%, 75%, 100%) that received different amounts of proctoring on 20 units of instruction. One group received 0% proctoring, that is no interaction with a proctor at all. The group that received 25% proctoring interacted with the proctor on five units, and so on. They concluded that the amount of proctoring did not affect performance significantly as there was no significant difference between learners that received the different amounts of proctoring. However, no proctoring led to significantly lower scores when compared with the different groups of learners that had received proctoring (Farmer et al., 1972).

A second study by Caldwell et al. (1978) examined the role of the proctors. They did not use learner proctors in the traditional PSI sense. (That is, PSI proctors are used to administer test material). In this study, they prefer the term tutors, as learners were available for three hours each week to clarify or explain material to WVI learners. The tutors also gave limited feedback on quiz answers. Learners were not allowed to defend their answer and the tutor was not allowed to change the score on the quiz. The amount of tutoring was manipulated between three experimental groups. The first group was required to see a tutor if they did not master a unit after two attempts. The second group had tutors made available to them, but not required. The third group had no tutors (Caldwell, et al., 1978).

They compared the results of learners' performance on the final exam, the average number of tests taken per unit, the course grade point average, and their attitude toward tutoring. Interestingly, the learners with access to tutoring but no requirement scored highest on the final exam and on the course GPA. They also had the lowest average number of tests per unit (2.34). A previous study (Farmer et al., 1972) showed that proctoring reduced the number of tests taken. However, in that study, it could be that proctors were not as objective as the 'tutors' in this study. Proctors, in the traditional PSI sense, could have been influenced by the learner to change their grade because of the

learner's explanation. In the Caldwell et al. (1978) study, there was no personal rapport between the learner and the tutor, thus negating any personal bias that could alter grades.

In a cross-over experiment by Fernald, Chiseri, Lawson, Scroggs, and Riddell (1975) three instructional variables, learner pacing, the perfection requirement, and proctoring, were manipulated to see their effects on performance and learner preferences. Eight different combinations of the three instructional variables were formed. For example, one combination might have a learner interact a lot with a proctor, a perfection requirement, and use learner pacing. In this design, eight groups of learners were exposed to two combinations of 'opposite' instruction variables sequentially over a semester: a learner receiving much contact, perfection, and a teacher-paced section would next experience a little contact, no perfection, and learner paced section (Fernald et al., 1975).

The results of this experiment showed that learners performed best when exposed to a high amount of contact with a proctor and when it was self-paced. These results were unexpected because traditional PSI classes require mastery. The variable that had the greatest effect was the pacing variable. Learner pacing always enhanced performance on exams and quizzes. The mastery requirement was found to have no effect. However, the authors acknowledge that the perfection requirement might not have been challenging enough. They state that a mastery requirement may only have an effect on performance when the task is difficult enough to cause variation among learners (Fernald et al. 1975).

A study conducted by Robin and Heselton (1977) found that different amounts of feedback (social behavior, feedback, praise, and prompting) provided by the proctors did not influence learner performance. Perhaps it is merely direct and rapid feedback of any sort that is the benefit of proctoring. Another study by Conard and Semb (1980) examined the effects of self-grading. Learners' self-graded quizzes were compared to proctor graded quizzes and showed that learners were as accurate as proctors. Also, there was no difference in performance between groups that were graded differently (Conard & Semb, 1980). Proctors are supposed to have 'expertise' in the subject matter so that they can assess the learners' knowledge of the material. However, the Conard and Semb (1980) study showed that it doesn't matter if the feedback comes from an expert or from a novice.

Finally, Pennypacker (1978) has already removed the proctor component from

PSI and replaced it with computer feedback. Keller himself advocated the use of a computer in PSI (Keller & Sherman, 1974). It seems that using a computer to provide feedback is not a limitation or detrimental to the overall effect of PSI, which is to provide better learner performance.

Performance Results Using the PSI Method

A classic paper by McMichael and Corey (1969) reported on the use of PSI in an introductory psychology course at C.W. Post College, Greenvale, and N.Y. They examined whether a PSI course led to an increase in learning and improved course ratings by learners. They divided the entire class into four sections, three control sections that received traditional lecture-based instruction, and one experimental group that received PSI according to the guidelines outlined by Keller (1968). Comparison of test scores on the final exam between the control and experimental groups, showed that PSI learners had significantly higher test scores overall when compared to each control group. Similarly, the learners rated the quality of the PSI course higher than the traditional courses (McMichael & Corey, 1969).

A follow up study conducted by Corey and McMichael (1971) analyzed the retention of material for learners in a PSI course compared to learners taught traditionally. In this study, a random sample of 24 learners was taken from each teaching method ten months after the course was completed. The learners were asked to complete the same final exam that they had previously taken, and the mean test scores were compared between control and experimental group. Again, PSI was a significantly superior teaching method when compared to traditional methods on both the initial final exam and the final exam administered ten months later.

More evidence of PSI's superiority as a teaching method is provided by Austin and Gilbert (1973) from a study conducted in their course, Electricity and Magnetism offered at Michigan State. They compared the Keller Plan to a traditional, lecture-based course by administering a common final examination jointly prepared by the instructors of both sections. They also provided a retest two months after the course had ended to examine retention rates of the two methods. They concluded that PSI learners outperformed the traditional learners on the final exam by 10-15% better and that on the final exam PSI learners did 15-20% better. Of particular interest is that the PSI learners

completed more material than did the traditional learners. Another interesting point is that low ability learners seemed to benefit more from PSI than did high ability learners, although both groups still benefited significantly.

PSI has also been used in engineering courses at the University of Texas at Austin (Hoberock, Koen, Roth, & Wagner, 1972). Five engineering subjects were offered using PSI. Learners reported that they spent above average effort in the PSI courses and also reported that they viewed the PSI course as above average or one of the best courses that they had taken. Over 85% of the learners that took PSI courses in engineering reported that they would take another course taught using PSI.

A meta-analysis by Kulik, Kulik, and Cohen (1979) examined 75 comparative studies about PSI usage. Their conclusion was that PSI produces superior learner achievement, less variation in achievement, and higher learner ratings in numerous college courses. Another meta-analysis on PSI conducted more recently by Kulik et al. (1990) found similar results. In this analysis, mastery learning programs (PSI and Bloom's Learning for Mastery) were shown to have positive effects on learners' achievement and that low aptitude learners benefited most from PSI. They also concluded that mastery learning programs had long-term effects even though the percentage of learners that completed PSI college classes is smaller than the percentage that completed conventional classes (Kulik et al., 1990).

Attitudes and Characteristics of Learners in PSI Courses

Generally, learners rate PSI courses as favorable or equally favorable to traditional lecture courses. Commonly cited reasons for this favorable attitude are the self-pacing and the interaction with the proctors (McMichael & Corey, 1969; Born & Herbert, 1971; Hoberock, 1971; Kulik et al., 1979). An interesting study conducted by Newman, Young, Ball, Smith, and Purtle (1972) examined initial attitude differences in a PSI course between successful learners, procrastinating learners, and learners who withdrew in a statistics class using PSI. They concluded that learners who procrastinated in the course, initially entered a statistics course with a feeling of anonymity. It is possible then that the prevailing attitude of a learner toward a subject could determine their success in a PSI course and that the lack of social contact inherent in the PSI system does not determine success (Newman et al., 1972)

The withdrawal rate of learners in PSI courses was examined again by Born and Whelan (1973). They found that, when compared to traditional lecture methods, there were three to five times more withdrawals (incompletions) in a PSI course. They examined the grade point averages of learners in both a lecture class and a PSI class and found that learners with a record of poor academic performance withdrew from the PSI course. Learners who historically were academically superior remained in the PSI course. The learners who were doing the worst in the class were consistently behind the pace and progress of academically superior learners. They also found a pattern of procrastination in that the learners who performed the worst delayed taking the unit tests according to a 'normal' progress chart. They asserted that learners with a record of poor performance might have difficulty pacing themselves through a PSI course and that the tendency to procrastinate leads to withdrawal.

A review of literature by Semb, Glick, and Spencer (1978) supported the idea that learners who withdrew from PSI courses is positively correlated with a history of inferior academic performance. They also stated that learners who start work early in PSI courses and traditional courses would be more successful in a PSI course. They suggested that helping all learners plan their progress through a PSI course would help them complete the course successfully.

Extending this research, Abbott and Falstrom (1978) conducted an aptitude trait interaction study in an elementary statistics class. They found that past grade-point average positively correlates with success in a traditional classroom, but that the correlation is not as strong with a PSI course. They also found that providing a PSI course compensates for time constraints outside academic life, such as working a job and other personal problems, like family responsibilities. Learners with these problems do not do as well as learners without these problems when taught by the traditional method. Finally, they concluded that learners with personality traits that do not favor success (as measured by Edwards Personality Inventory, as cited by Abbott & Falstrom, 1978) in a traditional academic setting were compensated for these deficiencies when exposed to a PSI course.

Criticisms of PSI Studies

One criticism of PSI is the interpretation of research results regarding

performance of PSI courses to traditional courses. While PSI courses do show significant improvements in performance, the actual difference in learners' scores might not be that great. For example, Sheppard and McDermot (1970) reported that on their final examination, PSI learners scored 73.1 on average, while the control group scored 66.8. While these results are statistically significant, the standard deviation for the PSI learners was 12.1 and the control group was 11.9, indicating significant overlap of scores between groups. Other studies (McMichael & Corey, 1969; Kulik, Kulik, & Milholland, 1974) report similar overlaps in performance scores. Finally, Billings (1974) reported that the differences between PSI learners and lecture taught learners on the Test of Understanding in College Economics were not significantly different.

Another explanation of the apparent improved performance of PSI learners is the attrition rate. PSI courses have a large percentage of learners who drop out of the course. It is possible that because learners are receiving constant feedback that unsuccessful learners would drop out, leading to an inflation of successful performers in a PSI course (Ryan, 1974). However, Kulik et al. (1979) reported that attrition rates were not significantly lower than attrition rates in a traditional lecture course, thus disputing the idea that PSI courses have greater attrition.

Ainsworth (1979), in a very bitter diatribe, described using a modified PSI format in two introductory psychology classes that resulted in remarkable failure. One section of the modified PSI class had 41% of the class with failing (F) grades even after adjusting the grading scale to be more lenient. Ainsworth concluded that failure was due to a lack of remedial skills, such as reading. Citing grade inflation and less rigorous admission requirements, he asserted that only those learners who are capable of good work regardless of the teaching approach should be offered PSI courses. He also stated that not all learners are capable of doing the *best* quality work and that these lower ability learners would not be suited to a PSI format.

It is interesting to note that Ainsworth's (1979) classes varied considerably from a true PSI format. There was no mastery requirement. No proctoring was offered. There were no clearly defined learning objectives either. In addition, because there was no mastery required, learners' grades were based on the average of two test scores. The only similarities between this course and a PSI course were self-pacing, using small units, and

frequent testing. Interestingly, Caldwell et al. (1978) previously stated that the mastery component was the essential requirement for a PSI type course. Ainsworth's conclusion that learners of high ability only benefit from PSI has also been disproven countless times with learners of lower ability showing the greatest gains (Caldwell et al. 1978; Kulik et al., 1990). If Ainsworth had followed Keller's original plan, learners' achievement might have been more aligned with traditional PSI results.

Learner attitudes towards PSI courses are consistently positive, but Ryan (1974) cautions against believing that this positive nature is due solely to PSI. He asserts that the effect of novelty could account for many of the positive attitudes. Another problem with PSI studies is a lack of rigor in experimental design (Ryan, 1974). Many PSI studies do not compare PSI methods to any control group and thus fail to account for the effect of any novel instruction method on performance (i.e., Green, 1971; Hoberock et al., 1972; Nelson & Scott, 1972). Finally, Ryan (1974) states that the lack of reported failures of PSI could be due to journal editors' inherent dislike of reporting failed experiments.

Another oft cited criticism is that PSI courses only teach basic cognitive skills such as memorization and do not address higher order skills such as synthesis and application (Meek, 1977). However, Reboy and Semb (1991) contend that PSI does not determine content of a course. The responsibility to develop content that develops higher order skills lies upon the instructor. They also state that learners in a PSI format always outperform learners in a lecture-discussion format. Therefore, they will have a larger knowledge base from which to develop higher-order skills. Since PSI has been implemented successfully in many different subjects, such as cancer education (Medio & Hersh, 1978), engineering courses (Hoberock, 1974; Koen, 1974), and chemistry (Leo, 1974), it seems erroneous to state that all PSI courses teach lower level cognitive skills.

Badia, Stutts, and Harsh (1978) also stated that an often overlooked methodological weakness of PSI studies that compare a traditional lecture course to a PSI course is that the PSI instructor is also an experimenter. They asserted that this could lead to instructor bias. They stated that the experimenter/instructor would spend much more time preparing the best PSI course possible, but that the lecture course would suffer. In their study, they controlled that variable by assigning 18 instructors with equal teaching experience to 18 sections of introductory psychology, and then randomly assigning each

section to be taught by a standard PSI format or a lecture method. The variables they examined included performance of PSI learners to lecture taught learners. At the conclusion of the study, learners in PSI courses still out-performed learners in lecture taught courses on exams. However, there was no significant difference in critical thinking skills as measured by the Watson-Glazer scale (Badia et al. 1978).

Distance Education

Distance education has been around since the late 1800's, but is currently growing rapidly. The United States Department of Education reports that from 1995-1998, there has been an 11% increase in the percentage of higher education institutions offering distance education courses. During that same time period, the number of distance education courses offered has doubled in higher educational institutions (Greene & Meek, 1999). In addition, 80% of community colleges as of 1994 reported offering a form of distance education (Parrott, 1995).

As distance education evolved from correspondence courses to more sophisticated class formats, such as web-based courses, the definition of distance education has changed as well. Distance education is a form of education where there is separation of teacher and learner, two-way communication, separation of learner and the learning group, industrialization of education, an educational organization that influences the education, and a technological medium to connect teacher and learner (Keegan, 1986, p. 43-48). Distance education uses a variety of media including printed material, video, CD-ROM, audio, multi-mode packages, and Internet instruction (Greene & Meek, 1999).

Distance education can be easily organized based on location and time. Figure 1 shows examples of different types of instruction based on whether they occur synchronously or asynchronously in time and their geographical location with respect to members of the learning community. Generally, if instruction occurs synchronously, the course is instructor-led, whereas if the instruction occurs asynchronously, the course is self-paced (learner-paced) (B. Lockee, personal communication, Spring 2001).

	Same Location	Different Location
Same Time	Classroom	Chat, video
Different Time	Computer assisted instruction	Online learning Virtual learning

Figure 1. Model of distance education *(*From B. Lockee, personal communication, Spring 2001.)

Computer-mediated communication (CMC) describes different systems used by people to communicate to other people by means of computers and networks. It includes computer conferencing, electronic mail, discussion lists, and bulletin boards Characteristics of CMC include highly interactive communication, multi-way communication, and synchronous/asynchronous communication. It is interesting to note that computers allow both types of temporal communication and that the instructor determines (based on course needs) which mode will be used (Romiszowski & Mason, 1996).

Characteristics of Distance Learners

Distance learners are a distinct population of learners with distinct characteristics. Fields (as cited in Keegan, 1986, p.170) studied the learners at the Open University of the United Kingdom. Four characteristics differentiated distance learners from traditional learners. These were experience, aspirations, study milieu, and investment.

Distance learners at the Open University were older than traditional learners. Seventy-five percent of distance learners were aged 30-55 years old, whereas traditional learners were less than 25 years old (Keegan, 1986). Parrott (1995) reported that distance learners in the United States were younger than Keegan reported, with the average age being 26 years old. Most of the distance learners had a wealth of diverse experience regarding family, community and work. They also have experience with the concepts of evidence, analysis and accuracy. Because they come with pre-conceptions, many learners

have to unlearn first, before learning (Keegan, 1986).

Traditional learners often find them in higher education because of family and other social expectations. The aspirations of distance learners are different. Distance learners often place family and work ahead of school. Traditional learners view job and family as results of the learning process. Distance learners are experiencing those demands while learning (Keegan, 1986; Galusha, 1998). Fields (as cited in Keegan) also stated that some distance learners do prioritize learning over other aspects of life, while other learners also stated that they view learning as enhancing their existing work. Distance learners are also highly motivated and goal-oriented (Parrott, 1995).

Wilkes and Burnham (1991) investigated the relationship between motivation and satisfaction in an electronic distance education course. They measured the motivation of learners enrolled in a distance education course and found that they were significantly more degree oriented than a control group of on campus learners. However, there was no relationship between motivation and satisfaction with the course. That is, a high level of motivation did not yield a high level of satisfaction. They concluded that participant satisfaction is independent of the initial internal motivation of adult learners in an electronic distance education environment (Wilkes & Burnham, 1991).

Distance and traditional learners also differ in their study environment. Traditional learners have easy access to a variety of learner support mechanisms, such as the library, professors, and other academic facilities. Parrott (1995) reported that learners select distance learning because they are unable to attend traditional courses. Finally, financial investment of distance learners can be more of a personal burden that their family has to share. Traditional learners do not have the expense of a family and generally they have less of a financial burden to bear from attending school (Keegan, 1986).

Another characteristic of distance learners when enrolled in a distance learning program, is a high attrition rate. Keegan (1986) stated that providing good learning materials and adequate learner support services can reduce attrition rates. He further postulated that the more integrated a distance learner feels with the learning environment the more likely the attrition rate will be reduced (Keegan, 1986; Galusha, 1998). Cookson (1989), in a review of literature, states that there are multiple reasons for dropouts in

distance education. These include lack of learner support systems, personal/domestic problems, insufficient time for studying, conflicts with work, and/or the teaching method (Cookson, 1989; Galusha, 1998).

Wilkinson and Sherman (1990) examined learner procrastination in a telecommunications-based distance education program by asking the educators. Ninety-five percent of respondents identified procrastination as a problem, but only 37.5% indicated that it was frequently or always a problem. However, 61% of distance educators reported that 10% or less withdrew or were dropped from the course. Therefore, they concluded that procrastination is not actually linked to non-completion of the course.

Biner, Bink, Huffman, and Dean (1995) investigated personality traits of learners enrolled in televised-courses and traditional courses to see if any differences existed. They also examined these personality traits to see if any could be used as predictors of success in a televised course. Using the Sixteen Personality Factor Questionnaire (16PF) (as cited in Biner, Bink, Huffman, & Dean, 1995) they found that the personality of televised course learners was significantly different from traditional course learners. Telecourse learners were found to be more intelligent, emotionally stable, trusting, compulsive, passive, and conforming when compared to traditional college learners (Biner et al., 1995).

In addition, Biner et al. (1995) also found that self-sufficient and introverted learners perform better in telecourses, than group-oriented and extroverted learners. Interestingly, they also found that the more undisciplined learners performed better than the disciplined learners. However, telecourse learners were found to be more compulsive overall than traditional learners, so that even a lax telecourse learner could be more disciplined than a traditional learner. They also noted that higher grades were associated with greater expediency for telecourse learners. That is, the faster they could work, the better the grade. They characterize successful distance learners as resourceful, decisive, introverted, self-indulgent to a certain extent, and responsible in an efficient, expedient manner (Biner et al., 1995).

Because more and more distance learning courses are being offered using the World-Wide-Web (Greene & Meek, 1999), distance learners must know how to use this technology. Marshall (2001) reports that fear of technology can impact learner

communication in the distance education setting. He studied 92 learners in three different distance courses for classroom communication apprehension. He concluded that learners who fear technology do not vocalize their thoughts in class as much as learners who are comfortable with technology. He recommends this 'technophobia' be alleviated by providing instruction on how to use the technology (Marshall, 2001).

Another characteristic that have been studied in learners is the concept of field dependence/independence. Using videotapes to distribute training in agriculture, Miller (1997) compared attitudes of field dependent and field independent learners to the distance education experience. He concluded that there were more field independent learners enrolled in the distance education course than would be normally expected. However, both groups of learners were equally satisfied with their learning experience (Miller, 1997).

Distance Education and Tutors

Because integration with the academic environment and learner support systems are important factors in learner success (Keegan, 1986; Cookson, 1989), many distance education programs try to provide learner tutors to their distance learners. Moore and Kearsley (1996) stated that the primary reason for having tutors in distance education is to individualize instruction. They also asserted that having tutors available in a distance education course generally improves learner completion rates and achievement (Moore & Kearsley, 1996).

Functions of tutors in distance education are diverse and encompassing. They include discussing course material, providing feedback in terms of progress and grades, assisting learners in planning their work, motivating the learners, keeping learner records, and supervising projects. However, providing feedback is critical for a good learning experience (Moore & Kearsley, 1996). Pace (1999) stated that the most important functions of the tutors are to provide objective feedback and grades and use good model answers. Holmberg (1977) stated that learners profit from comments from human tutors provided within 7-10 days of assignment submission.

The Open University has historically used human tutors in many different roles, including counselor, grader, and consultant (Keegan, 1986). The Open University's learner support system has included regional face-to-face tutorial sessions and a personal

(usually local) tutor for grading purposes. Teaching at the Open University has been primarily through these tutor marked assignments. Summative and formative evaluation by the tutor has occurred though the postal system, the telephone, or face-to-face sessions. Despite the extreme success of this system (>70% retention rate), recently the Open University has begun moving to the Internet for its learner support services (Thomas, Carswell, Price, & Petre, 1998).

The Open University is using the Internet for registration, assignment handling, learner-tutor interactions, and exams. The new electronic system for handling assignments addresses many limitations of the previous postal system such as, turn-around time for feedback and reduced reliance upon postal systems. The tutor still grades the assignments, but now the corrections are made in a word processing tool that makes it easier to read (Thomas et al., 1998).

The Open University is also using the Internet for tutor-tutee contact. Previously, tutors held face-to-face sessions where learners could interact with each other and the tutor. However, the cost of maintaining facilities where these sessions could take place was expensive and the organization of tutor groups and schedules was complex. Additionally, one of the reasons learners choose distance learning is the freedom from traditional school hours. The face-to-face sessions were difficult for some learners to attend. The Open University has moved to computer conferencing, which integrates with administrative components to reduce the complexity of managing tutors (Thomas et al., 1998).

Carswell, Thomas, Petre, Price, and Richards (2000) examined the effects of this new Open University experience on learner performance and attitudes. In a course in Computer Science all learners were taught using electronic communication only. They compared a group of Internet learners to a group of conventionally taught distance learners. An interesting finding is that more Internet learners reached the exam phase than conventional learners (final phase of the course), but proportionately fewer learners achieved the highest grade possible. However, in general the pattern of performance was the same for both groups. Attrition rates were comparable between groups. In addition, learners liked the electronic submissions because the turn around time was faster and they felt that it was more convenient (Carswell et al., 2000).

Internet learners contacted their tutors and peers more often than the conventional learners. Internet learners felt that both asynchronous and synchronous tutorials were motivating. Another interesting finding regarding the Internet tutorial sessions was that learners who would not have attended face-to-face tutorials, attended Internet sessions. Indeed, conventional learners wanted the electronic tutorials in their instruction. Internet learners felt that their questions were answered faster by email and that they got to know their tutor better. In summary, the Internet experience was positive (Carswell et al., 2000).

Traditionally, distance education programs use individuals who are independent of the learning process. However, Coldeway (1980) implemented the use of peer tutors in a distance education program at Athabasca University. One peer tutored ten learners in a distance course in English. Other learners received no peer tutoring, but regular tutoring. Coldeway compared the results of performance between peer tutored learners and learners who received traditional tutoring. All tutoring occurred using the telephone to communicate. He concluded that there was no difference in performance between the two groups, or between the peer tutor and the other tutors (Coldeway, 1980).

Rowe and Gregor (1999) developed a computer based learning system that uses the World Wide Web for delivery. Integral to the system are question-answer tutorials and programming tutorials. The question and answer tutorials were multiple-choice and graded instantly after submission. The programming tutorials required the learners to provide short answers to questions. These questions were checked by the computer and if necessary, sent to a human tutor for clarification. After using this format for two years at the University of Dundee, the computer based learning system was evaluated by a small learner focus group with representatives from all the levels of academic achievement in the class. Learners were asked about the interface, motivation, and learning value (Rowe & Gregor, 1999).

Learners enjoyed the use of the web browser for distance learning, especially when colors were used in the instruction. With regards to the tutorials, learners wanted to see the question, the learner's answer, and the correct answer on the screen at the same time, along with feedback as to why the answer was wrong or right. Some learners wanted to email answers to a human tutor because of the natural language barrier. Since

the computer based learning system was used as a supplement to lecture and lab sessions, learners found it to be motivating. They found that the system fulfilled gaps in knowledge and could learn in their own time and at their own pace. They especially liked the interactivity of the web. Learners did not feel that they learned more with the computer-based system, but that their learning was reinforced (Rowe & Gregor, 1999).

Computers as Tutors

Tutors have been used to improve learning since Socrates. However, there are limitations on the availability of tutors to distance learners. Holmberg in 1977 stated that some distance education programs use pre-produced tutor comments and received favorable feedback from learners on this method. However, advances in available technology have further developed the microcomputer as a possible tutor. Bennett (1999) asserts that using computers as tutors has multiple advantages, including self-pacing, the availability of help at any time in the instructional process, constant evaluation and assessment of the learner, requisite mastery of fundamental material, providing remediation. In addition, he states that computers as tutors will reduce prejudice, help the disadvantaged, support the more advanced learners, and provide a higher level of interest with the use of multimedia components (Bennett, 1999). In addition, the rapid feedback provided by computers is beneficial and enjoyable to the learners (Holmberg, 1977).

Halff (1988) identifies three roles of computers as tutors:

1. Exercising control over curriculum by selecting and sequencing the material,
2. Responding to learners' questions about the subject,
3. Determining when learners need help in developing a skill and what sort of help they need.

Cohen, Kulik, and Kulik (1982) examined 65 school tutoring programs and showed that learners receiving tutoring out-performed non-tutored learners on exams. Tutoring also affected learner attitudes. Learners who received tutoring developed a positive attitude towards the subject matter (Cohen et al. 1982). Since tutors have positive effects on learning, they are a desirable component to have in an instructional experience. Crowderian branching was originally designed to mimic a tutor's behavior. That is, based upon the response of the learner, the next question was provided. More recent advances

in technology have led to the use of computers as tutors. An Intelligent tutoring system (ITS) attempts to mimic human tutors using computers. Anderson (1988) further identified three uses of an ITS. These are to satisfy robustness in a knowledge area, to establish prerequisite knowledge, allowing human interaction to focus on more complex skills, and finally, to teach part of a skill.

GED instruction has been approached using computer instruction. PLATO IV was developed on a national basis to help adult learners prepare for the GED. This online system provided branching, dialogue, self-pacing, feedback, as well as kept a record of the learner (Elliott & Videback, 1973). Other computer tutor systems exist such as SCHOLAR, GUIDON, GUIDON2, WEST, and SOPHIE (Steinberg, 1991). These systems are widely known. However, in the interest of conciseness, the reader is referred Steinberg, 1991 for greater depth on these particular systems.

In an interesting study, Wood and Wood (1999) examined the effect of a contingency-based computerized tutor in algebra. A contingent tutor provides help when the learner is struggling. When the learner succeeds, the tutor's help is decreased. In their tutoring program, QUADRATIC, the program only knows that the learner is struggling when the learner seeks help from the program. This program offers five levels of help each level is a different depth of help. The type of help that the learner receives is contingent upon the learner's prior answer to a question. For example, if a learner had succeeded at a problem after receiving level 3 help, the next time he/she asked for help he/she would receive less help (level 2) (Wood & Wood, 1999).

They compared the performance of a group of 14-15 year olds with high prior knowledge of algebra to a group of 14-15 year olds with low prior knowledge of algebra after receiving QUADRATIC. They concluded that novice learners (those without prior knowledge of algebra) sought help from the tutor more often. They also found that the effects of contingent help were similar for both groups. Help increased the chances of all learners to perform at a similarly high level. Benefits of receiving tutoring help were greater for the low prior knowledge group (Wood & Wood, 1999).

Characteristics of Web-based Instruction

Specifically, there is a movement within postsecondary education institutions in the United States to increase the number of distance education courses offered by

asynchronous Internet instruction or web-based instruction (WBI). The National Council for Education Statistics reported that 82% of institutions planned to start or increase their use of asynchronous Internet instruction. Of the 2580 reporting institutions, 60% planned to start or increase their use of synchronous Internet instruction (Greene & Meek, 1999).

Owston (1997) states that three characteristics of web-based instruction are a broader appeal to learners' preferred learning styles, greater flexibility in learning, and a new kind of learning. Computers permeate a child's environment and, consequently, young children gain early computer skills and feel quite comfortable with computers. More children are visual learners now than previous generations because of their visual environments. Therefore, the web, which is rich in visuals, is a good method for instruction (Khan, 1997; Owston, 1997).

In addition to appealing to a younger generation's learning styles, the web provides flexible learning. Not only can learners access information without being on-campus, but also instructors can enhance their on-campus courses by providing information through the web. Their learners can continue learning outside of class, but remain in contact with the instructor or peers. For example, online chat rooms and threaded discussion boards are ways that learners can explore class information, but also do it on their own time (Khan, 1997, Owston, 1997).

Finally, Owston (1997) asserted that web-based instruction provides opportunities for new kinds of learning. Jonassen and Reeves (1996) stated that computers and their applications can be used as cognitive tools to facilitate critical thinking and higher-order learning. Owston elaborates on that idea further by saying that the web can allow learners to weigh evidence, construct understanding, and analyze and synthesize the large amount of information available. Learners can also participate in collaborative learning through the Internet and increase writing skills through communication programs, such as e-mail and chat rooms (Khan, 1997; Owston, 1997).

Additional advantages of web-based learning are that learning occurs 'anywhere, anytime, any place,' synergy occurs, learning is learner centered, there is a level playing field, and increased access to resources. Web-based courses are asynchronous which means that they can reach learners who could not participate in an on-campus course because of scheduling problems or physical distance. Web-based courses are accessible at

all times. This allows learners to access information and participate in the class at any time. It also allows learners to reflect and review the material more if needed. (Khan, 1997; Strengths of Online Learning, 2000).

Depending on the format, web-based courses can have a high level of interaction between learners and instructor and among learners. By sharing resources and ideas, synergy can be effected, leading to a more complete learning experience. Because the possibility of multiple conversations exists, web-based learning can be more learner-centered. Learners can choose to participate in discussions based on their needs. This individualizes instruction (Khan, 1997; Strengths of Online Learning, 2000).

Web-based courses also remove discriminating factors such as gender, socio-economic indicators (dress, physical appearance, etc), race, and age because of the anonymity that the web offers. Instead, the focus is on intellectual skills. This creates an open learning environment, and learners, who otherwise might feel uncomfortable participating in class, feel more comfortable in voicing their thoughts. As previously noted, there is increased access to resources by linking documents, other sites, and other information to a website. In addition, other professors could be invited to participate in chat rooms or discussion boards (Khan, 1997; Strengths of Online Learning, 2000)

Web-based instruction is also more dependent on written materials than in a traditional classroom. Information is displayed as text on a computer screen with links to more text material. The instructor takes the role of facilitator by leading learners through the material. Web-based instruction can accommodate video and audio formats as well (Khan, 1997; Powers, 1998) which can appeal to a variety of learning styles.

One important component of Web-based instruction is hypertext. Hypertext is an "electronic representation of text that takes advantage of the random access capabilities of computers to overcome the strictly sequential medium of print on paper,"(Marchionini, 1988, p.8). Hypertext consists of nodes (information units) and links (connect the nodes). Basically, hypertext potentially allows learners unlimited branching in all directions using an electronic format, similar to Crowderian branching. This creates problems for learners because they can get disoriented and distracted (Marchionini, 1988).

Disorientation can be caused by the large amount of information available to the learner and the ability to get "lost in the web". Learners forget where they are in the

material and can feel overwhelmed if they are not properly oriented. Distraction is caused by the high level of learner control in hypertext. Learners decide where to go and thus, what to learn. Their decisions might not lead to effective learning if there is a particular goal in mind (Marchionini, 1988).

Jonassen (1989) states that there are three ways to structure hypertext: unstructured, structured, or hierarchical. Unstructured hypertext provides random access to any node that is linked to it. Structured hypertext conveys the structure of the subject by the links that are provided. In structured hypertext, there are small clusters of information units that are linked together. These clusters are linked to other clusters, but individual information units in one cluster are not linked to individual information units in another cluster. Hierarchical hypertext breaks general concepts down into detailed concepts. The hierarchical relationship is evident in the links that are used (Jonassen, 1989).

Lanza and Roselli (1991) examined learner performance under two instructional conditions: backwards branching at the learner's discretion and a hypertext program developed in HyperCard. Both conditions used personal computers. Learning was assessed using a short test after instruction. Learners' attitudes were also measured by a brief survey. The backwards branching group scored on average 53.33 on the exam while the hypertext group scored 49.67. However, this difference was not significant. The authors also noted that the hypertext group had a wider range of scores (standard deviation=32.21) than did the backwards branching group (standard deviation=15.16). This indicates that the hypertext approach could benefit some learners more than others. Seventy-six percent of learners in the hypertext group found their program to be stimulating and attractive compared to 37 percent of the control group. However, 40% of the hypertext learners suffered disorientation (Lanza & Roselli, 1991).

A study by Shin, Schallert, and Savenye (1994) provided second graders with a HyperCard program that was presented either in an unstructured approach or in a hierarchical approach. Learners were either given advisement or no advisement. Advisement is simply guidance to help learners make good choices. Learners either had high prior knowledge or low prior knowledge of the instructional subject. Immediate and delayed posttests were used to measure learning, as well as an attitudinal questionnaire to

see which method learners preferred.

Not surprisingly, learners who had high prior knowledge out-performed learners with low prior knowledge on the posttests. High prior knowledge learners functioned equally well under both instructional modes while low prior knowledge learners benefited significantly more from the hierarchical approach than the unstructured approach. Learners in the unstructured approach significantly preferred advisement, but learners in the hierarchical approach showed no preference for advisement. Finally, low prior knowledge learners completed the lesson significantly faster without advisement than with advisement (Shin, et al., 1994).

Hannafin's (1984) earlier article on computer-aided instruction provides further recommendations on how branching can best be used for different groups of learners. His review of the literature states that older learners perform better when they control their movement through instructional material (internal locus of control). Younger learners perform better when the lesson's structure is pre-determined (external locus of control). More able learners perform best when moving through material under their own control, but less able learners do not perform well when given choice of what material to explore. Hannafin also states that the instructional task should dictate whether learners are given control of moving through the material or if the movement through material should be pre-determined. For example, lesson control is preferable for tasks, which have an established mastery criterion. Also, learners should be provided guidance to make informed decisions as to where to go next. He acknowledges that ineffective learners in the learner-controlled mode should be identified and assisted (Hannafin, 1984).

Examples of PSI and Computer/Web-based Instruction

PSI and the World-Wide-Web seem to be ideally suited for each other. Both rely on learner self-pacing through the instructional material. Both rely on the development of primarily text-based instructional materials. Both use the instructor as a facilitator, but not as the primary instrument of instruction. In addition, the increasing use of web-based instruction means that this medium will be more accessible to more learners. Indeed, Keller himself recognized that PSI could use a "programmed text, a teaching machine, closed-circuit television, or a computer" (Keller & Sherman, 1974, p.19).

Crowell, Quintanar, and Grant (1981) developed PROCTOR using the PSI

format. Even though it was not designed for distance education, PROCTOR is one of the first applications of PSI to computers. PROCTOR allows the learner to view general class information, individual unit test statistics, and overall performance and progress in the course. The learner logs in to take a test and multiple-choice questions are displayed on the screen. If the instructor has designated mastery to be a requirement, the learner must pass a certain number of items correctly. The learner has three tries to master the unit. If the learner still fails, the learner must see the instructor.

If the instructor has not selected mastery, then the learner can progress to the next unit regardless of his/her performance. PROCTOR provides three levels of feedback: an immediate correct or incorrect response, a posttest summary of lesson performance in terms of objective mastery diagnosis (learning objectives), and a graph showing the learner's progress in the course. Two observers monitored all testing sessions and only computers in one lab were set up to run PROCTOR (Crowell et al., 1981).

Pear and Kinsner (1988) used a computer based PSI instructional method to teach several courses at the University of Manitoba on-campus as well as to distance learners. They developed a computer-aided personalized system of instruction (CAPSI) that incorporated Keller's PSI principles into a computer delivery system. They used CAPSI to teach a variety of courses on and off-campus, including Introduction to Psychology and Behavior Modification Principles/Applications.

In order to maintain the immediate feedback and positive reinforcement that PSI employs with proctors, Pear and Kinsner (1988) developed an ingenious solution. Each learner in the course who has mastered a unit (by passing it) can proctor another learner on that unit. They received additional course credit for this activity since it provides added practice on course material. This could help keep learners moving through the material as being a proctor helps their final grade. Pear and Kinsner (1988) also said that each exam that was not graded by the instructor had to be graded by two proctors for quality control purposes.

CAPSI used email and a 'talk' command that enabled streaming conversation. The program was put onto a mainframe computer and learners accessed the mainframe via their personal account. The program can tell learners what their grade is for each activity (tests, proctoring etc) if the learner desires or the learner can log directly into the

program. The computer searches to see if the learner has been selected to be a proctor. If the learner has been chosen to be a proctor, the learner must log in within 24 hours to proctor the exam. That way immediate feedback can be generated. The program also asks if the learner needs a test to be generated. If the learner selects 'yes', then the computer randomly generates a test from a databank of questions. The learner then writes the answers in essay form and submits it to the proctors or instructor (if no eligible proctors are available) via email. The learner also has the option to cancel the test if he/she feels the test results would not demonstrate mastery (Pear & Kinsner, 1988).

As a proctor, the learner has to mark the exam and electronically mail it back to the learner. Then the learner enters the results into CAPSI, either pass, conditional pass, or restudy. A pass is mastery of the unit. A conditional pass means the learner made minor errors, but corrected them. A restudy is when the learner made several minor errors or any major errors. Either proctors or the instructor must enter a pass or conditional pass in order for the learner to move to the next unit of instruction. If the learner receives a restudy, he/she must wait at least one hour before CAPSI will allow them to take the exam again. Proctors must retain all tests and feedback for examination by the instructor (Pear & Kinsner, 1988).

With regards to course statistics, the results of the CAPSI programs are as varied as traditional methods. Completion of the course with a passing grade (C or better) ranged from 69% of the enrolled class to 98%. Overall, learners reacted favorably to the teaching method. Most negative comments focused on technical problems, absence of class discussions and lecture, and the amount of work required for the class (Pear & Kinsner, 1988).

Pear and Novak (1996) evaluated the effectiveness of CAPSI courses in two undergraduate psychology courses. They asked learners about their satisfaction with the course, problems they had with the course, and work habits with the course (where they worked on the course, when they worked on the course). They also measured the participation of learners, as measured by the amount of proctoring they did, and achievement, as defined by the final exam grade. They also asked about computer

experience, demographic information, and grade point average (GPA) (Pear & Novak, 1988).

The majority of learners had experience with computers and felt comfortable using a computer. In fact, the primary motivation (68%) for taking CAPSI was the opportunity to use a computer. Learners liked the convenience aspect of CAPSI the best and disliked the testing method the most (weight and structure of the exam). Most dissatisfaction was derived from technical difficulties using the computer. Only 20% said that they would prefer a traditional lecture course and 77% said they would take a future CAPSI course (Pear & Novak, 1996). Additionally, Pear & Novak (1996) found that predictors of success (through regression analysis using the final exam grade) in a CAPSI course were GPA, experience with computers, and a positive attitude towards computers.

Rae (1993) used videos, an interactive videodisc, and computer delivered tutorials in a discrete mathematics course that used PSI format. Each learner had two hours of tutorial per week, but these sessions were not mandatory. In order to prevent procrastination, a mid-term exam was used to keep learners at a pace that would enable completion of the course. The videos, videodisc, and tutorials were used to reduce the number of human proctors needed and also to provide learners the opportunity for repetition by rewinding videos. He found that many learners who would have otherwise failed this course successfully completed it using PSI (Rae, 1993).

Another application of PSI using computers was developed by Crosbie and Kelly (1993) for an applied behavior analysis class. In this class, only the testing was conducted using computers. The small, constructed response tests were scored by the learners on the computer. For example, the learners were shown their answer and the correct answer for each question and then asked to type in if they had gotten it correct or incorrect. This method required monitoring of the computer sessions to discourage cheating. This program did not provide any feedback. Rather, feedback was delivered when the learner turned in the answer sheet. The instructor went over the material at that time with the learner to clarify misconceptions.

They had a very high retention rate with 49 out of 51 learners completing all

units. Another interesting feature of this PSI application was the use of four review tests that were used to prevent procrastination. Crosbie and Kelly felt that, when compared to other classes they taught without these review tests, the pace of this class was much more consistent. Learners also had positive feelings towards the class and the negatively skewed grade distribution typical of PSI courses was seen, with more A's and B's then a traditional course (Crosbie & Kelly, 1993).

Brothen (1996) used a computer-assisted version of PSI in a course on introductory psychology. He used 40 networked computers in one classroom to facilitate the development of self-regulated studying. This self-paced course recommended a schedule for taking quizzes and used programmed instruction via computer exercises to teach terminology. Other features of the course included objectives, chapter quizzes with the highest grade out of five attempts counting as the final grade, written reports, and a final exam. The computer network kept records and provided feedback while teaching personnel provided personal contact (Brothen, 1996).

Brothen (1996) noted that 75.9% of the learners enrolled in the course passed the course, which was slightly higher than the college mean (70%) for passing a course for the term. Therefore, this method did not impact learner performance negatively. He then looked at learners who received F grades (non-performers) and then compared them to learners who received A grades (high-performers). High performers took an average of 71.54 quizzes over all 20 units. Low performers took an average of 22.80 quizzes over 8.10 units. High performers also took advantage of being able to re-take the quiz up to five times. High performers took a quiz an average of 3.58 times while low performers took a quiz an average of 2.81 times. He further noted that non-performers' final scores on quizzes still did not reach a passing score (5.96/10). He concluded that high performers worked harder towards mastery than non-performers. Brothen reviewed the academic history of non- and high performers and found that the ACT scores did not differ significantly between groups. However, high performers had a significantly higher high school grade point average (Brothen, 1996).

Brothen and Wambach (1998) evaluated the impact that lectures have in

conjunction with a computer-based PSI course. They used the computer course as Brothen (1996) and developed a non-mandatory lecture session to accompany the computerized sessions. They found that attendance in the lecture sections was very low after the first lecture. They also found no significant correlation on learner attendance in lectures and the final exam. Finally, the rating of the instructor was not significantly impacted by lecturing. Lecturing did not influence learner ratings of instructors. They concluded that lectures do not contribute much to learning in a technologically rich environment (Brothen & Wambach, 1998).

Brothen and Bazzarre (1998) extended this research using the same computer system as Brothen (1996) and examined the effect that personal intervention had on procrastinating learners in an introductory psychology course. Learners who had not completed any of the mandatory quizzes after four weeks were either personally contacted by a teaching assistant, or served as controls. The teaching assistant tried to get a commitment from each procrastinating learner to take the quiz. They concluded that personal contact and getting a commitment led learners to increase the amount of time working in the course, and therefore, out-perform the control learners (Brothen & Bazzarre, 1998).

More recently, Pear and Crone-Todd (1999) moved the CAPSI system to a local area network. The functions of CAPSI in cyberspace were essentially as the mainframe version. These were to deliver the unit tests and exams, assign work to proctors, and keep track of all course data. Course materials for the psychology courses, such as study guides and textbooks were available at the bookstore. Interestingly, 32% of their learners withdrew before they experienced the program. These learners were not interested in this course format. The majority of the remaining learners completed the course and proctored exams. Performance on exams was average, but 90% of the learners felt satisfied with their experience (Pear & Crone-Todd, 1999).

Price (1999) used the World-Wide-Web to distribute his Online Communications and the Internet course at Texas Tech University. He used PSI as his theoretical model. In this system, provides the syllabus, course description, course objectives, and other

materials via the Web. Completed assignments are emailed to instructors, graded, and emailed back. Final exams are taken in the presence of a supervisor. He used a listserv and email to maintain a sense of interaction within his course. It is worth noting that there is no mastery criterion used (Price, 1999).

Davis, Feltrop, Petrikovitsch, and Ragsdell (2000) developed web-based instruction using PSI. They designed six engineering courses for Internet delivery using a variety of software including ToolBook™, Dreamweaver™, Powerpoint™, Flash™, RealSystems™, and other tools. Instruction is provided via text based web pages, simulations, chat rooms, video delivered via Internet, and audio. Homework problems were graded by the computer and content was arranged in small units. They used WebCT to manage testing, grading, and chatrooms. However, there was no designation of mastery before proceeding to the next unit and no description of feedback. They assert that the Keller Plan is an ideal format for the distance learner, especially when given the variety of learning styles that the Web environment can accommodate (Davis et al, 2000).

Summary

Because PSI courses have consistently shown increased performance in higher education courses and have received extremely favorable learner evaluations, it is a method of individualized instruction that should be modernized by developing on online course. When considering implementing individualized instruction on the web, it becomes clear that Keller's PSI could be adapted fairly easily to the Web. Keller's plan has few personnel required, is self-paced, and relies primarily on written text (Keller, 1968). The fewer people required to instruct reduces the cost of development. Self-pacing can easily be accommodated by web-based instruction, as the Web allows access anytime, anyplace. Web-based instruction occurs easily with written text and the addition of hypertext can allow for branching to occur (Khan, 1997).

When designing PSI for the web, another feature to consider is the proctor. Proctors (in the PSI sense) operate primarily to provide rapid feedback and clarify errors in learners' thoughts (Keller, 1968). The use of a computer as a proctor could further adapt PSI to the web. Computerized tutors have increased learner performance (Fletcher

& Atkinson, 1972; Knight, Acosta, & Anderson, 1988; Wood & Wood, 1999). More recently, the Open University has successfully demonstrated the use of only electronic communication between tutors and tutees (Carswell et al., 2000). Learners were very receptive to this method. While tutors have a distinct role from proctors, it is possible to use humans as proctors even when geographically separated (Pear & Kinsner, 1988). While development of a computerized proctor could be time-consuming, the rapid feedback provided by the proctor is integral to the success of PSI (Farmer et al., 1972; Calhoun, 1976).

The characteristics of successful PSI learners and distance learners should be compared to ensure compatibility before proceeding with design. Distance learners have many responsibilities outside of school that are time consuming (Keegan, 1986). PSI compensates for these (Abbott & Falstrom, 1978) by allowing time and place independence. Successful distance learners are motivated and goal oriented (Keegan, 1986). Successful PSI learners are also motivated (low procrastination) and historically academically successful (Born & Whelan, 1973; Semb et al., 1978).

Motivation, in a traditional PSI course, has been provided by special demonstrations or lectures as a reward for completing work (Keller, 1968). However, these have been found to be of minor interest to learners and have generally been excluded from PSI courses (Born & Herbert, 1971; Nelson & Scott, 1972; Calhoun, 1976). Attrition in distance education is a problem and has been a problem within PSI courses as well. However, careful use of pacing methods could reduce attrition. Moderate external deadlines with a penalty for missing the deadline appears to be the most successful as they allow learners some control, but also keeps them on task (Semb et al., 1975; Reiser, 1984; Ross & McBean, 1995).

Other researchers have attempted to computerize PSI because PSI is so adaptable to the computer. These attempts are shown in Table 1. None of these attempts have used a true PSI format delivered on the Web. While CAPSI (Pear & Kinsner, 1988, Pear & Crone-Todd, 1999) come closest to replicating a true PSI course with the use of learner proctors online, they have not delivered their course using the World-Wide-Web. The

other courses fail to meet even four criteria for a Keller course.

Many of the existing computerized PSI courses lack true mastery. Crosbie and Kelly (1993), PROCTOR (Crowell et al., 1981), and Price (1999) all recommend that the learner attain mastery, but there is no barrier to proceeding should the learner not

Table 1

Comparison of existing computerized versions of PSI to the five elements of PSI

	Small units/mastery Criterion	Self-pacing	Use of lectures for motivation	Emphasis on verbal/written communication	Use of immediate feedback
PROCTOR (Crowell et al., 1981)	-	+	-	+	+
CAPSI (Pear & Kinsner, 1988, Pear & Crone-Todd, 1999)	+	+	-	+	+
Crosbie/Kelly (1993)	-	+	-	+	+
Brothen & Wambach (1996) Brothen & Bazarre (1998)	-	+	-	+	+
Price (1999)	-	+	-	+	+
Davis et al. (2000)	-	+	-	+	-

demonstrate mastery. Pear and Kinsner (1988) only prevent further progress in the course by making the learner wait one hour before taking the re-test.

Clearly, PSI and web-based delivery are suited for each other. The wealth of literature on PSI has shown that it works and that it can be replicated. PSI is even superior to other individualized instruction methods. The characteristics of distance learners and successful PSI learners are compatible, with PSI even compensating for external time constraints.

Future Directions

According to the literature, PSI is a superior instructional method when compared to traditional instructional methods. Distance education is rapidly growing and this is primarily due to the World Wide Web. Because PSI has been proven successful in a face-to-face setting, it would be interesting to see if PSI could be successful in an online environment. This is not a novel idea as several other researchers have tried to replicate PSI online. However, the modifications made by most researchers leave doubt as to the authenticity of their programs to PSI as Keller envisioned it in his original writings. Therefore, developing a more faithful version of PSI for online distribution could determine how successful PSI is in an online environment, and as a system of instruction overall. This project will:

1. Develop an online prototype of a PSI course
2. Evaluate the product
3. Discuss the development and evaluation results

CHAPTER TWO

Project Overview

In order to develop a Personalized System of Instruction (PSI) course for an online environment, the goal of this developmental dissertation was narrowed. The logistics of adapting Keller's PSI tenets to an online environment were identified and explored. Finally, the PSI units were developed and evaluated.

Project Goal

The primary goal of this project was to develop a dynamic, database-driven system for a personalized system of instruction to be delivered in an online environment. This primary goal is supported by several secondary goals:

1. Incorporate Keller's PSI tenets into an online environment with minimal modification
2. Develop a database driven system that will manage aspects of the course, such as mastery, grading, and feedback
3. Evaluate the product for fidelity to Keller's concept of PSI and learners' perceptions of effectiveness and enjoyment

The Context for PSI Online Delivery

In 1998, the Virginia Tech Instructional Technology faculty began offering a distance learning Master's instructional program. The first iteration (1998) of the Instructional Technology Master of the Arts program (ITMA) was originally designed for K-12 practitioners in Virginia. Some of the ITMA courses involved face-to-face meetings between learners and instructors. The next ITMA iteration in 2000 reduced the number of face-to-face meetings and learners were also Virginia K-12 educators. Instruction was primarily online. Both ITMA 1 and ITMA 2 used geographically based cohorts that all moved through the program at the same pace. In addition, since all learners took the same three credit hours per semester, only three credit hours of instruction were required per semester.

However, in Fall 2001, the ITMA program was made available for nationwide enrollment to any interested persons. Now there are approximately, 125 learners from 23 different states, Spain and Japan, enrolled in courses and more learners are being

admitted each academic semester. This has led to program modifications. One of these is the elimination of iterations and cohorts that move through the program together. Current ITMA admittees can enter and move through their program at their own pace. Additionally, instead of being restricted to three credit hours per semester, ITMA learners can take up to nine credit hours per semester. This requires availability of more instruction per semester and also the availability of more graders per semester. Finally, the learner population has more diverse backgrounds, with learners from K-12, as well as industry professionals.

As the ITMA program continues to grow, there is a need to balance the increasing and diverse learner population with the services that can be provided. Using a different method of instruction, such as PSI, could alleviate the demands on the ITMA staff, as well as help the learners succeed in ITMA. Each course in ITMA has a grader to mark learners work and provide feedback to the learners. With objective-referenced, computer-graded quizzes possible, ITMA graders could have their grading workload reduced substantially because the computer would grade the quizzes. Since the quizzes would be developed from objectives, quiz questions would be specific and unambiguous. Many times ITMA graders have spent substantial amounts of time revising incorrect questions on existing quizzes created by the textbook publisher, (A. Kellogg, personal communication, March 2003).

Since PSI has been shown to compensate for outside demands on learners' lives (Abbott & Falstrom, 1978), learners could benefit from this method of instruction. For example, ITMA learners are adult, distance learners, with 99% of them employed full-time. Abbott & Falstrom (1978) noted that the use of PSI compensates for outside demands such as having a family and being employed, leading to increased performance in the PSI course when compared to the same course in a lecture format. Thus, distance learners in ITMA could benefit from PSI since they also have outside demands.

Also, learner attitudes toward PSI have been consistently positive (McMichael & Corey, 1969; Hoberock, 1971; Kulik et. al., 1979). Learners enjoy the PSI format. Additionally, PSI does produce better performance overall (Kulik et al., 1979). However, there are some constraints of the PSI approach that should be addressed when trying to adapt it to a different environment and delivery method.

Adapting the PSI Model to the ITMA Online Environment

This developmental dissertation uses Keller's PSI as its theoretical basis. Because some components will be modified to use PSI in an online environment, the components of PSI will be reviewed and summarized with regard to the necessity of each component based on the literature.

The PSI Model Components

The five components of PSI, as stated by Keller (1968) are:

1. The go-at-your-own pace feature (self-pacing)
2. The unit-perfection requirement for advancement (mastery)
3. The use of lectures and demonstrations as vehicles of motivation
4. The related stress upon the written word in teacher-learner communication
5. The use of proctors for feedback

Although some studies show that self-pacing leads to more withdrawals and incompletes in a PSI course (Semb et. al., 1975; Reiser, 1984), learners perceive the self-pacing component as one of the most enjoyable components in a PSI course (McMichael & Corey, 1969; Born & Herbert, 1971; Fernald et al., 1974). The mastery requirement has also been intensively researched (Born, 1975; Goldwater & Acker, 1975; Caldwell et. al., 1978). Mastery learning yields higher performance, when compared to traditional methods of instruction, especially for learners who do not traditionally perform well (Kulik et. al., 1979; Kulik et. al., 1990).

Originally, Keller envisioned additional lectures and demonstrations as stimulating to learners while also providing extra information not covered in the self-paced portion (Keller, 1968). However, studies by Born and Herbert (1971), Nelson and Scott (1972), Calhoun (1976), and Brothen and Wambach (1998) have shown that learners do not perceive these activities as motivating and do not enhance performance. Regarding lectures, Keller (1974, p.19) states, "[Lectures] could be eliminated entirely without serious damage." Verbal and written communication, the fourth aspect of PSI, was represented in the written study guides and the verbal discourse between learner and proctor. This aspect has not been extensively researched.

The use of proctors is the fifth characteristic of a PSI course. The study hall proctor serves to clarify learner knowledge and provide guidance. Most research attention

has focused on grading proctors. Grading proctors, as described by Keller (1968), are learners who have developed expertise with the course material. Research on this topic has been confounding. Farmer et al. (1969) reported that grading proctoring leads to better performance. Fernald et al. (1975) also found that high amounts of proctoring led to better performance. However, Caldwell et al. (1978) asserted that personal contact between proctor and learner can lead to proctor bias and alter grades. Caldwell (1985) also cites cheating as common when learner proctors are used.

Proposed Modifications of PSI for the ITMA Online Learning Environment

Using PSI for the ITMA program requires a trade-off between purity of the system and practical implementation barriers. Every aspect of PSI, except the emphasis on the written word, has been intensively researched. However, in order to use PSI online efficiently, in terms of development time and personnel costs, some modifications should be made. Table 2 depicts each PSI component, suggested modifications, and the justification for the change.

One key feature is modified: the use of human proctors to provide feedback. Because of the modifications, the roles and duties of the proctor, as envisioned by Keller, should be reviewed. The role of the study hall proctor is to provide clarification and guidance to the learner prior to taking the quiz (Keller & Sherman, 1974, chap.3). The role of grading proctors, as explained by Keller, was to elucidate the learner's knowledge by interacting with the learner after administering a quiz (Keller, 1968). During this interaction, learners would explain their answer. If the proctor felt that the learner had mastered the information, the learner was allowed to move to the next unit.

Keller (Keller & Sherman, 1974, chap.3) later expanded on this concept of the proctor with a practical description of the role of a grading proctor. He states that the grading proctor scans the test quickly and grades the answers. If there are too many wrong answers (> three wrong), then the learner must re-study and take the exam again at a later time. This quiz grade would not count. If the learner answers two or three questions incorrectly, the learner can defend the answers to the grading proctor. The grading proctor determines if the learner has made an adequate defense. If the defense is adequate (the grading proctor determines the learner has mastered the material), the proctor re-scores the exam and the learner is allowed to move to the next unit. If the

Table 2

PSI components, modifications and justifications

PSI Component	Modification	Operationalize	Justification
The go-at-your-own pace feature (self-pacing)	None	ITMA learners are allowed to proceed through the lessons at their own pace.	Learners enjoy the self-pacing feature (Fernald et. al., 1974). This feature aligns with ITMA's self-paced nature.
The unit-perfection requirement for advancement (mastery)	None	Lessons will be presented linearly, contingent upon successful mastery of the previous lesson.	Mastery learning improves performance (Caldwell et. al, 1978; Kulik, Kulik, & Cohen, 1979).
The use of lectures and demonstrations as vehicles of motivation	Omitted	Omitted	Lectures and demonstrations are not motivating (Born & Herbert, 1971; Nelson & Scott, 1972; Calhoun, 1976)
The related stress upon the written word in teacher-learner communication	None	ITMA instruction will be primarily text based.	No real research conducted on the role of the written word.
The use of proctors for feedback	Modified	The computer program will automatically generate feedback to fulfill the role of study hall proctor and grading proctor.	There have been many cited problems with grading proctors (Caldwell et. al., 1978; Robin and Heselton 1977; Conard and Semb 1980). In addition, providing feedback is critical for a good learning experience (Moore & Kearsley, 1996; Pace, 1999).

defense is inadequate, the learner is advised on which material to re-study and is told to take the exam again at a later date. If the learner has mastered the material (≥90%), the learner is congratulated and permitted to move onto the next unit (Keller, 1974). Since this is Keller's vision of grading proctors, the above description of the grading proctor's

role that will be used for this project.

Development of the Course

PSI is a complex instructional system that requires many decisions to be made by the developer. Sherman (Keller & Sherman, 1974, chap.4) states that, "sometimes local considerations of subject matter, learner background, university policy, or even the physical space of the classroom will determine a choice." (p. 26). He asserts that careful consideration of decisions regarding materials, course policy, and implementation should be made based on all of these factors. Sherman's (Keller & Sherman, 1974, chap.4) recommendations for these decisions are summarized in Appendix A and will be addressed in the design steps for this project.

Development of the Course Policy

Sherman (Keller & Sherman, 1974, chap.4) recommends that a course policy be developed that explains the grading policy, final exam policy, incomplete policy, unit test rules, defining what a pass means, proctor assignment, internal proctor, class hours, and special announcements. Because this is not a complete course, the course policy was modified to include a statement on procedures, pacing, unit tests, and the concept of mastery. (See Appendix A, under Course Policy for the recommendations that were followed). Specific instructions were given about how to proceed in the online environment and the course policy was developed using Dreamweaver™ 4.0.

Development of the Study Guides

The content was developed for ITMA's Instructional Media, Part I. This course relies heavily on the textbook, *Instructional Media and Strategies for Learning, 7th Edition*, by Heinich, Molenda, Russell, and Smaldino (2002). As this class currently exists, learners purchase a textbook and then proceed to the text's website to access the quizzes. However, there have been problems with the existing testing system and the need to tailor content for the ITMA learners has also been noted (K. Potter, personal communication, 2001). Three chapters of the textbook, Chapters 1, 3, and 5, were used as the primary content for eight PSI units. (Appendix A under “Materials” further details the guidelines that were used to develop the unit materials). Chapter 1 was divided into two units. Chapter 3 was divided into four units. The remaining two units covered the

material in Chapter 5. Units were made by using logical breaks in the textbook content. For example, in Chapter 3 which covered the ASSURE model, an entire unit was created on writing objectives.

Each unit has a study guide that includes an introduction, unit objectives, study questions, and a procedure (Keller & Sherman, 1974, chap.4). The introduction introduces the new material and allows the instructor to emphasize sections of the text that are more important or correct out-dated information in the text. It also captures the interest of the learners to continue to read the assignment (Keller & Sherman, 1974, chap.4). The next section, objectives, is crucial to the success of a PSI system. They tell the learners what they should be able to do at the end of the unit (Keller & Sherman, 1974, chap.4). Although Sherman (Keller & Sherman, 1974, chap.4) advocates extremely specific objectives, Caldwell (1985) states that it is extremely difficult to generate many thought provoking quiz questions with extremely specific objectives. A balance was achieved between objectives that easily allow multiple questions and objectives specific enough to let the learners know what they should be able to do at the end.

Study questions were comprehensive over all unit objectives, but did not duplicate quiz questions as recommended by Sherman (Keller & Sherman, 1974, chap.4). The procedure section describes to the learners what activities to complete in order to cover all the unit objectives. The procedure section recommends what sections of the chapter to read and the study questions to answer (Keller & Sherman, 1974, chap.4).

The first two PSI units were developed to be slightly easier than the following units as Sherman (Keller & Sherman, 1974, chap.4) recommends. It was difficult to determine unit size as PSI units should be testable within 15-20 minutes, yet also maintain a one unit/week pace (Sherman & Ruskin, 1978). Sherman (Keller & Sherman, 1974, chap.4) also recommended that for a fifteen-week semester, there should be between 15-20 units. However, PSI courses generally only cover 4/5 of the material that regular courses cover (Keller & Sherman, 1974, chap.4). Units were determined according to logical breaks in content to provide discrete, yet stand-alone study guides. Study guides were developed in Dreamweaver™ 4.0 and distributed online. (For an example study guide, see Appendix B).

In addition to the study guide, a separate webpage for each unit was developed to

fulfill Keller's recommendation of a "study hall" proctor (Appendix B). According to Keller (1974), the study hall proctor stands between the learner and the materials in order to clarify and explain the materials. The study hall proctor does not give the answer away, but expands on the material and guides learners. Normally in ITMA, learners communicate with an ITMA grader for feedback and clarification. However, in order to leverage current technology within the online environment, computer-generated feedback and guidance for the study questions was provided in the form of interactive pop-up boxes, which explained answers and gave examples to the study questions. If a student needed some assistance with the study questions, s/he could go to the "Guidance and Clarification" page and click on the hyperlink to view the feedback. The feedback was designed to fulfill the role of the study hall proctor to clarify the material. However, if learners still needed guidance, they were encouraged to email the ITMA grader. There was always an email link for learners to email an ITMA grader within the "Guidance and Clarification" pages.

Development of the Quizzes

Two issues were addressed when developing the quizzes. The first issue was content and format. The second issue was the logistics of taking the quiz. The final issue was the feedback provided to the learners on the quiz. These issues are discussed in further detail.

Content and Format

PSI quiz questions were developed directly from the unit objectives, and every unit objective was tested in every quiz (Keller & Sherman, 1974, chap.4). (See Appendix A under Materials and Implementation for specific recommendations made by Sherman) However, Sherman (Keller & Sherman, 1974, chap.4) also recommends that the quiz only take about 15-20 minutes and can be corrected in five minutes. It is important to remember that each quiz must have alternate forms for learners who failed to master the material initially. Since learners are allowed three attempts to master the material, three different versions of the quiz were developed using a mixed test format of multiple choice, true/false, matching, fill in the blank, and short answer (Keller & Sherman, 1974, chap.4). Sherman's (Keller & Sherman, 1974) comment, "Many instructors writing test material find they have "run dry" after writing two test forms. A week later a third form

seems to flow more easily" (p. 32) was followed in order to create the quiz versions. The number of unit objectives determined how many questions were on each version of the unit quiz. Quiz questions, answers, and feedback were developed in Excel and exported to different Access tables.

The Logistics of the Quiz

In this online version of PSI, the computer is responsible for the administrative duties of a "proctor". These duties include: keeping track of student progress, restricting progress of students who fail to demonstrate mastery, permitting students who demonstrate mastery to continue to the next quiz, recording the scores, and making sure that learners do not receive the same version of a quiz twice. The computer also performs some of the grading duties. Grading duties of the testing proctor include scoring the exam, providing immediate feedback on missed questions with recommendations on what material to study, permitting learners to explain answers, and changing answers if mastery is shown (Keller, 1974; Sherman, 1974). In this system, the computer performs the first four functions. The functionality of the system was programmed using Cold Fusion™, Access, and Javascript by the ITMA programmer so that the system would be familiar to learners and integrate seamlessly into existing ITMA databases.

Quiz Outcomes

There are three quiz outcomes in the Keller system – failure to master the material (<80%), mastery of the material (90% or greater), or an outcome between those two (80-89%). The computer system was programmed to control learner progress for each of these three outcomes. According to Keller (1968), once a learner masters the material, s/he should be permitted to proceed to the next unit. Sherman (Keller & Sherman, 1974, chap.4) recommends that mastery be set at 90%. If a learner misses too many questions, the "grading operation stops right there and [he] is advised to study further." (Keller & Sherman, 1974, p.18) Keller does not define how many questions are too many, but says if a learner misses two or three questions, s/he has the opportunity to explain the answers to a proctor. Neither Sherman nor Keller have made any strict recommendations on when the learner can explain answers vs. when the learner is told to re-take the exam. Therefore, if mastery is set at 90%, missing 2-3 questions would probably fall in the 80% range, depending on the number of questions on the quiz.

If a learner failed a quiz, s/he was told to come back after a period of time and try again. Keller (1974) recommended 30 minutes, but Sherman (Keller & Sherman, 1974, chap.4) recommended one unit/day. Therefore, the system was programmed such that learners who failed a quiz would have to wait two hours before attempting to pass again. Sherman (Keller & Sherman, 1974, chap.4) also stated that if a learner failed the quiz three times, s/he must contact the instructor to discuss the study question and arrange alternative assessment. The computer system was programmed to allow learners to input the URL for their study questions when they failed a unit quiz the second and third times.

Evaluation of Materials and System

Three levels of evaluation occurred. The first evaluation was a "proof of concept" evaluation, where this PSI system was examined for its faithfulness to the Keller ideas. The second evaluation was a formative evaluation by an ITMA course designer/grader. The third evaluation was a small group comprised of five ITMA learners.

Proof of Concept Evaluation

Two PSI experts, Mike Metzler, Ph.D, from Georgia State University, and Tom Head, Ph.D., from Virginia Tech, performed the "proof of concept" evaluation. This evaluation took place in two phases. In phase one, they reviewed the materials (course overview, study guides, guidance and clarification pages, and quizzes) in print form. Printed copies of the webpages were sent to Dr. Metzler in an email as attachments (per his request), as well as a hardcopy delivered via FedEx. Also included was an evaluation checklist (Appendix C). Copies of all quiz questions were included in a Word document. Dr. Head received the same materials in hard copy delivered to his Virginia Tech office.

In phase two, they evaluated the online Keller experience. They were given access to the Course Overview page at http://filebox.vt.edu/users/hopeless/psi_instructionalmedia/assignments.htm. From here, they could access the webpages in the online environment. Each evaluator was given a login name and password to enter the online quizzing system. They were also given an evaluation checklist (Appendix C).

In both evaluations, they were asked to evaluate the faithfulness of the decisions made, the design, and the materials used in this version of Keller to the original Keller courses. All evaluation checklist criteria were based on Keller's (1968) description of a PSI course, Keller's (Keller & Sherman, 1974, chap. 3) description of the basic system,

and Sherman's (Keller & Sherman, 1974, chap. 4) recommendations for logistical decisions. Evaluators were invited to provide additional comments if they thought some criteria were lacking or missing.

Formative Evaluation

An ITMA course designer was asked to formatively evaluate this online Keller system. She was asked to determine if the overall format and approach would be suitable for ITMA, to look for inconsistencies and errors in the materials and processes, and to make suggestions for improvements. She was provided with the course overview page, the study guides and "Guidance and Clarification" pages, and the quizzes in printed format. She was also given access to the instructional materials online and the online quizzing system. An evaluation checklist was created for all of the materials (Appendix D). She was not asked to comment on this course as a PSI course, or to comment on the material. She was invited to make any other recommendations or suggestions that were not covered by the checklist.

Small group Evaluation

Five ITMA learners, currently enrolled in the program and within 6 credit hours of graduating, agreed to provide summative feedback. They were asked to go through the course materials and report their opinions on the course format in terms of its learning benefits and if this course format would be enjoyable to them as distance learners. They were provided with access to all online materials and the online quizzing system. They were asked to go through the course, starting with the course overview, and then complete the online survey (Appendix E). They were not asked to try and learn the material, since the focus of this survey was not to focus on learning outcomes, but, rather, their opinions (as distance learners) on the course features. The survey questions were based on prior surveys used in PSI courses to gather information on student perceptions of PSI (for example, Hess, 1971; Nelson & Scott, 1974).

CHAPTER THREE

Overview of Results

This chapter describes the final online version of PSI that was developed, as well as explanations (based on the literature) for the design decisions that were made. The results of the "proof of concept", formative, and summative evaluations are summarized also.

The Final Product

The final product is a web-based course that uses Dreamweaver™ and Cold Fusion™ to create a PSI experience for the learner and the grader. The product will be described below first as if a learners was taking the course and then as if a grader is grading the course.

Overview of the Learner Experience Using this Modified Online PSI Course

The learner experience is shown in Figure 2. This section describes the general PSI processes a learner experiences. These processes will be elaborated on in later sections. Learners review the study guides and chapter material in the text at their own pace. All course study guides are available initially, and progress through the course is controlled by quiz performance, as Sherman (Keller & Sherman, 1974, chap.4) recommends.

When they feel ready to take the quiz, they login into the online quiz system and take the quiz. The next step depends on how well they perform on the quiz. If they achieve 90% or better, they are allowed to access the next unit's study guide and continue to complete new coursework (Keller, 1974). If they score less than 80%, they receive feedback that suggests the material they need to review, and they can take a different version of the quiz at a later date (Keller & Sherman, 1974, chap.4).

If they achieve 80-89%, they can enter an explanation for the incorrect answers and send them in for grader review. The grader then decides if the learner has adequately defended the answer. If so, the learner's grade is changed to indicate mastery level, and the learner is allowed access to the next unit of material. If the grader decides that the learner has not demonstrated mastery, then the learner is advised of the materials to re-study and is allowed to re-take a different version of the quiz at a later time.

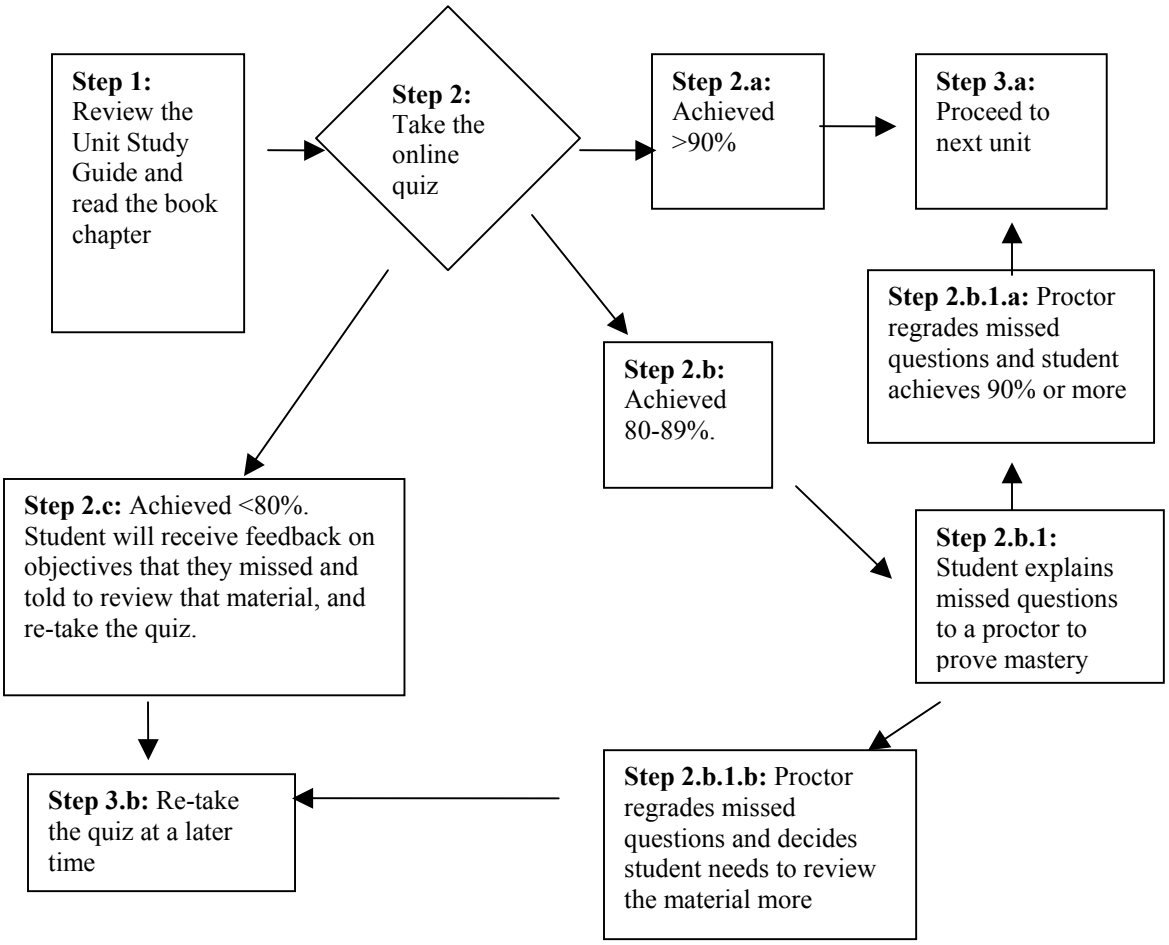


Figure 2. Steps in PSI online – The process the learner will follow to complete a unit.

Only quiz grades at the mastery level are counted in the overall grade. The learner has three attempts to master a unit quiz (Keller & Sherman, 1974). If after three attempts, the learner still does not achieve mastery, the learner will have to contact the instructor and arrange an alternative demonstration of mastery at the instructor's discretion (Keller, 1974).

The Learner Experience: Course Overview, Unit Materials

This section describes the course overview and unit materials created for these units. As a learner, the first step is to review the course overview and study the instructional materials (Step 1 in Figure 2).The course overview, all eight unit study guides, and accompanying guidance pages were made available on the World-Wide-Web (http://filebox.vt.edu/users/hopeless/psi_instructional media/assignments.htm). Learners

could access them freely at any time they wished (Figure 3). Each unit study guide had a

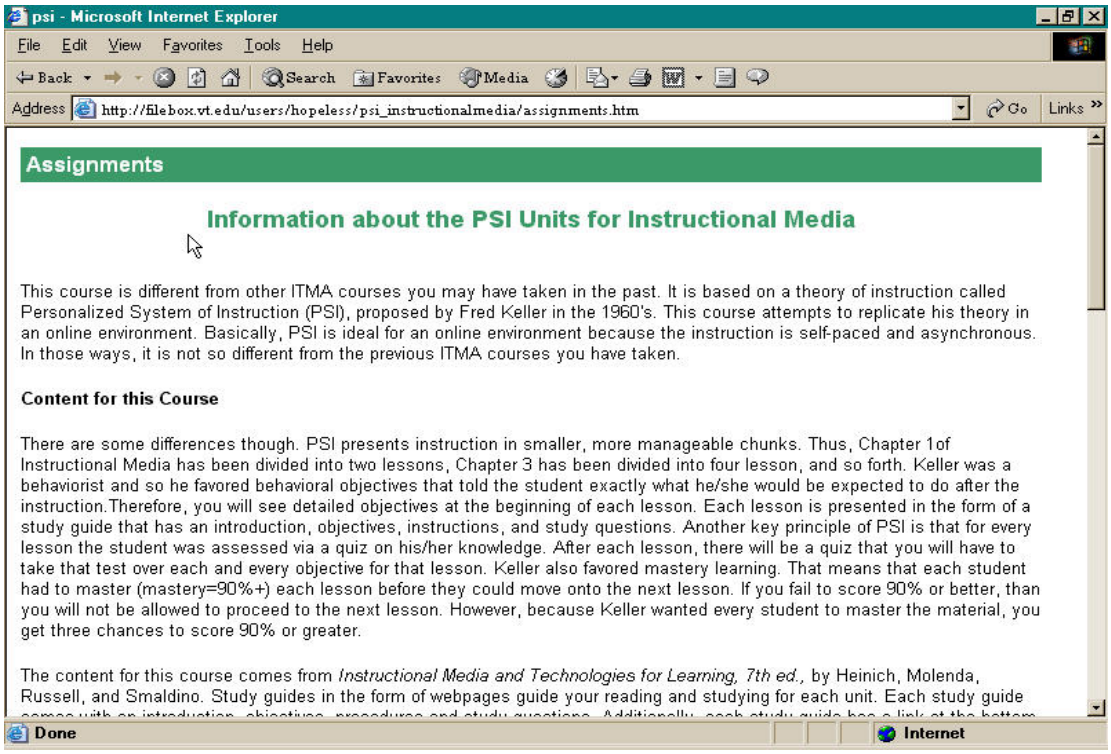


Figure 3. Assignments page available to users on the WWW.

link to the quiz interface. (Figure 4) Also, within each unit, learners were told to upload

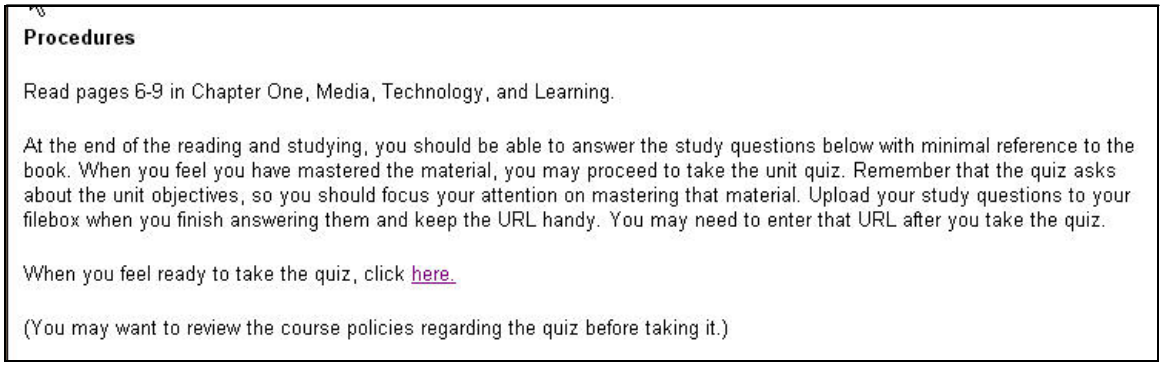


Figure 4. Excerpt from study guide one with quiz link shown.

In addition, each guidance page had an email link to an ITMA grader. (Figure 5). their study question answers to their Virginia Tech filebox before taking the quiz. This way their study question answers would be available online for review. All the learners have to do is provide the URL for their study answers to the grader during the quiz taking process.

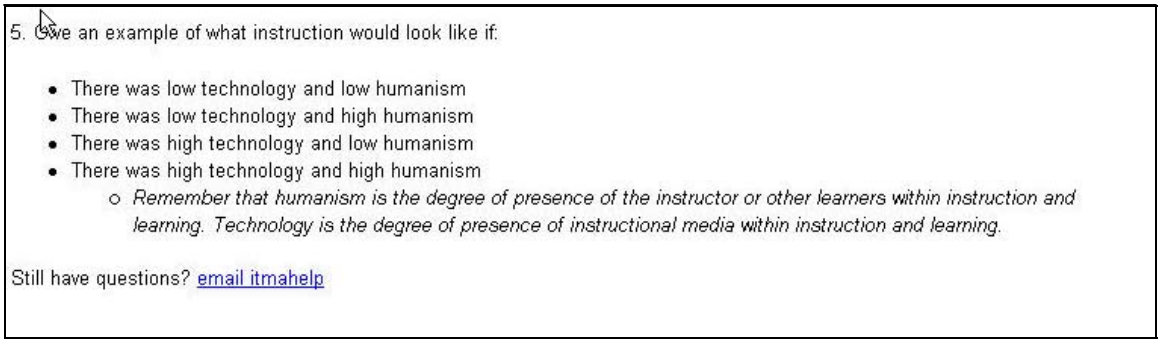


Figure 5. Excerpt from guidance page one with email link shown.

Keller also stressed the importance of the written word in a PSI course (Keller, 1968). All instruction and guidance was written text, with the exception of Unit 8. Unit 8 instructed on visual literacy and visual images were needed. Keller (1974) agreed that visual images could be used when appropriate (Figure 6).

Self-pacing is an important tenet of Keller's PSI. Almost all of the ITMA courses are self-paced, with no required deadlines. If students have not completed a course by the end of the semester, they are automatically assigned an Incomplete with no academic penalty for late work. This aligns with Sherman's (1974) recommendations that, ideally, a learner in a PSI course could take an Incomplete if all units were not mastered, and suffer no academic penalty.

The Learner Experience: Moving through the course

This section describes the processes of moving through this modified PSI. Learner progress is controlled by their level of mastery. One of the goals of PSI is mastery learning (Keller 1974). Once a learner demonstrates mastery, he is allowed to continue through the course. Originally, unit materials were withheld until mastery was determined. However, Sherman (Keller & Sherman, 1974, chap.4) recommends that the learner's progress be determined by their mastery of the quizzes. If the learner mastered the quiz from unit 1, they would be permitted to take the unit 2 quiz (Keller & Sherman, 1974, chap.4). In this version, the learner can view all course materials at any time, but cannot take a quiz without mastering the previous material.

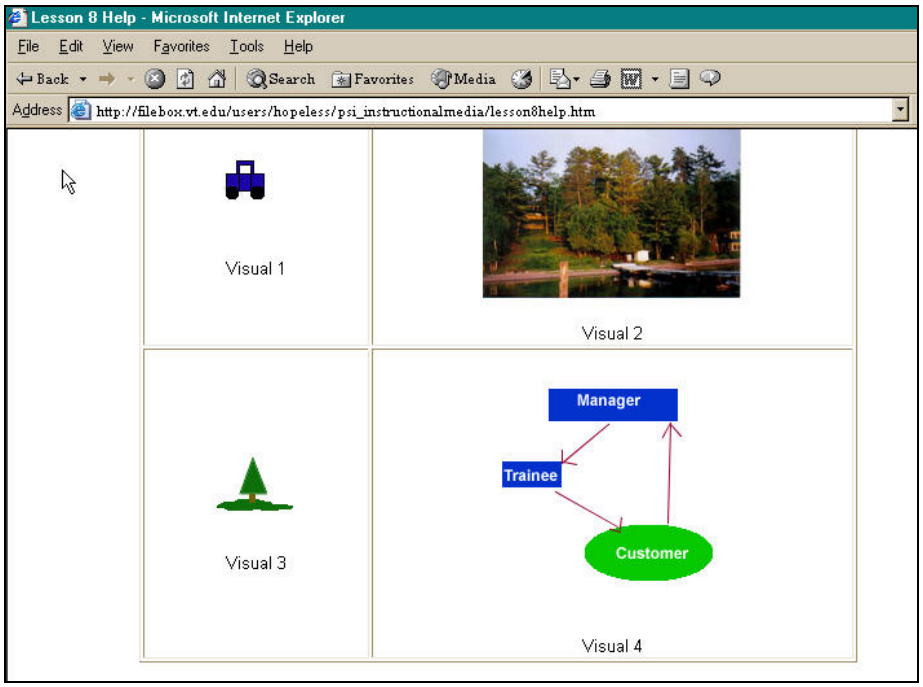


Figure 6. Lesson 8 - visuals were created to support the instructional objectives.

Once the learners feel comfortable with the material and ready to demonstrate mastery, they are ready to login to the quizzing system (http://128.173.109.8/itmagrading/hope_quiz/student_login.cfm) (Step 2 in Figure 2). This link is available in the study guide. The first screen is a login screen (Figure 7).

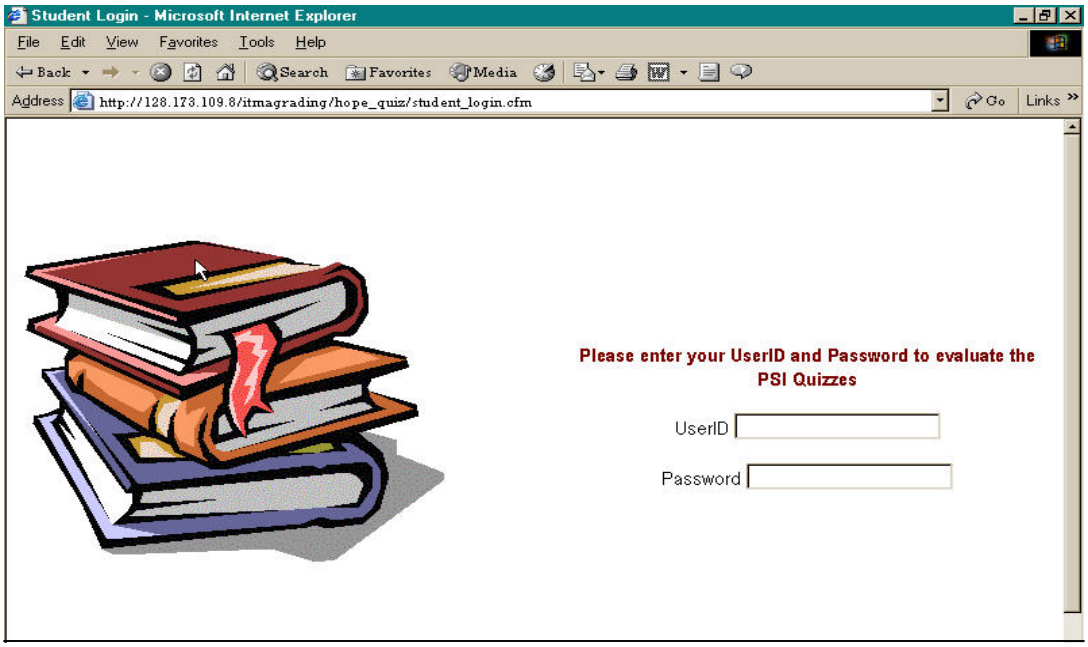


Figure 7. Learner login screen to take quiz.

The system compares their login name and password to the information in the table, and if they match, permits the learner to continue. Once logged in, the learner can either view their progress in the course (view a quiz) or take a quiz (Figure 8). If the learner opts to take a quiz, s/he will select "take a quiz" and click on the submit button. This takes them to an information screen that tells them what quiz they are working on (Figure 9). When they click on "Take Quiz," they are shown the quiz (Figure 10). After submitting the quiz, feedback is provided on missed questions (Figure 11). Depending on the outcome, learners will get different options. There are three possible outcomes: mastery, failure, or scoring between 80-89%. These outcomes are described in further detail as follows.

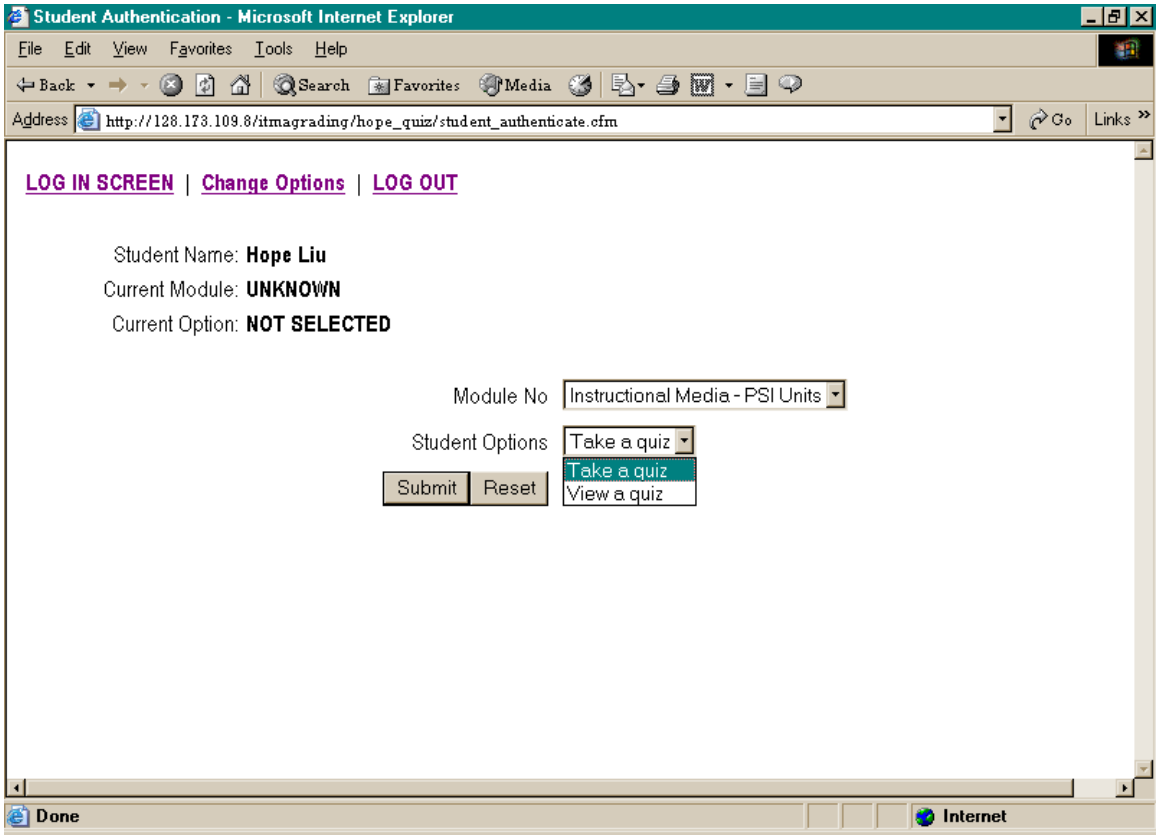


Figure 8. Learner options screen. Learners can either take a quiz or view their quiz results.

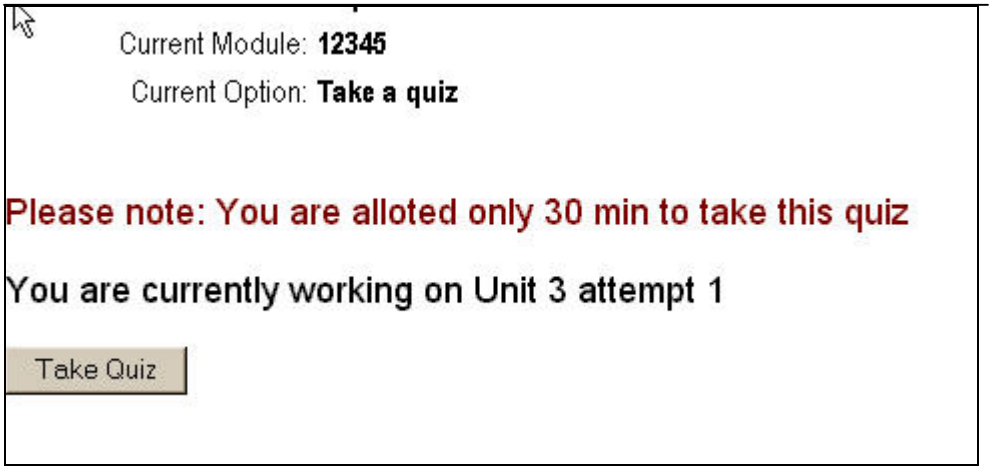


Figure 9. Learners are told what quiz they are working on and the time limit for the quiz.

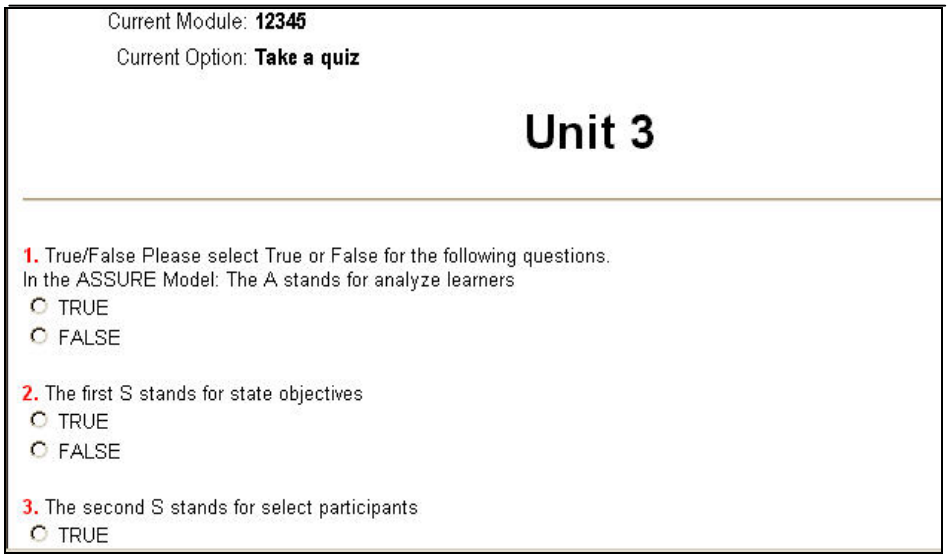
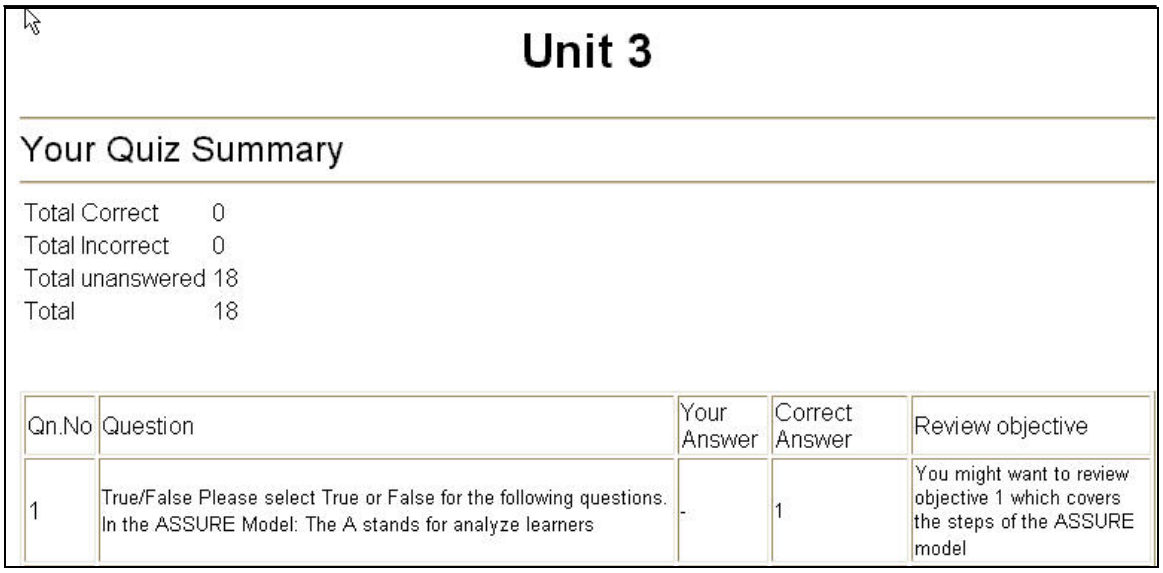


Figure 10. Unit 3 quiz, first attempt.

Outcome 1: Mastery.

One outcome of taking the quiz is mastery (Step 2a in Figure 2). The level of mastery is set at 90% or better per Sherman's (Keller & Sherman, 1974) recommendations. If a learner scores 90% or better, s/he receives the following feedback (Figure 12), and is allowed to take the next unit quiz.



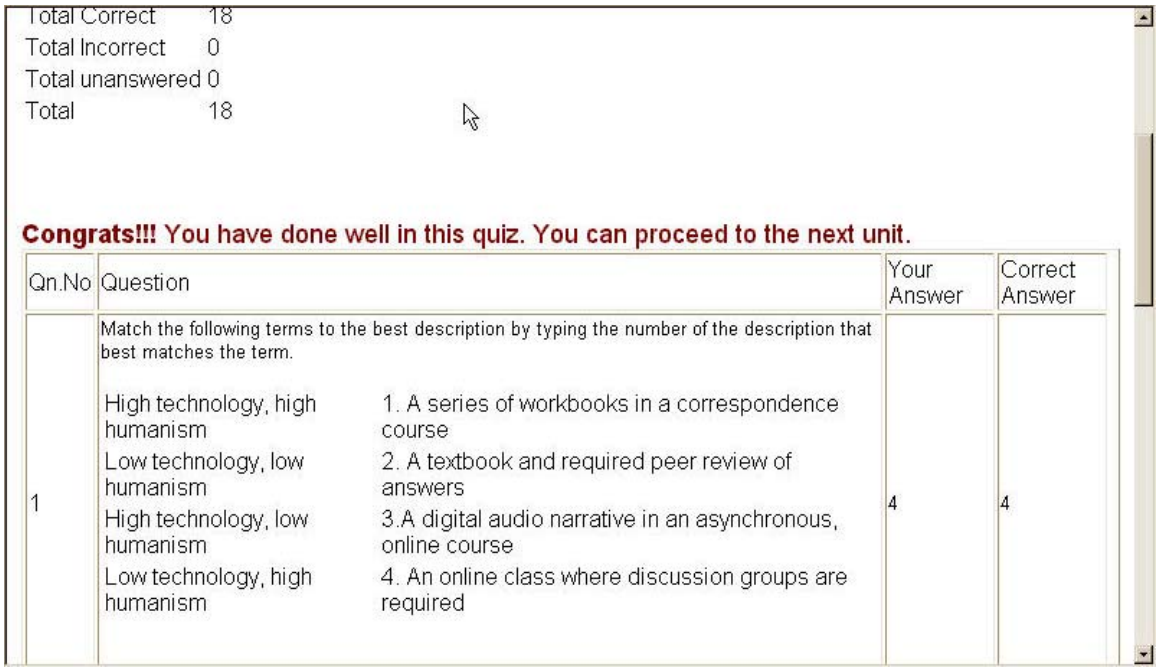
Unit 3

Your Quiz Summary

Total Correct 0
Total Incorrect 0
Total unanswered 18
Total 18

Qn.No	Question	Your Answer	Correct Answer	Review objective
1	True/False Please select True or False for the following questions. In the ASSURE Model: The A stands for analyze learners	-	1	You might want to review objective 1 which covers the steps of the ASSURE model

Figure 11. Feedback on the quiz. Note the overall score, the quiz question, the learner answer, the correct answer, and the "review objective" feedback.



Total Correct 18
Total Incorrect 0
Total unanswered 0
Total 18

Congrats!!! You have done well in this quiz. You can proceed to the next unit.

Qn.No	Question	Your Answer	Correct Answer
1	Match the following terms to the best description by typing the number of the description that best matches the term. High technology, high humanism — 1. A series of workbooks in a correspondence course Low technology, low humanism — 2. A textbook and required peer review of answers High technology, low humanism — 3.A digital audio narrative in an asynchronous, online course Low technology, high humanism — 4. An online class where discussion groups are required	4	4

Figure 12. Feedback screen when learners demonstrate mastery.

Outcome 2: Failing the quiz.

There is considerable debate on what constitutes failure of a PSI quiz. For the purposes of this project, failure was set at anything less than 80% as explained in the

previous chapter. If a learner fails the quiz, they are told to retake the quiz (Figure 13). (Step 2.c. in Figure 2).

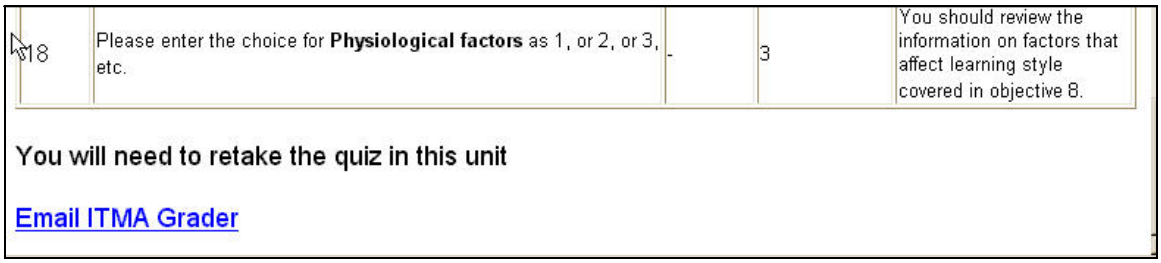


Figure 13. Learner is told to retake the quiz.

In PSI, the learner is allowed three attempts to pass a unit quiz (Keller, 1974; Sherman, 1974). Sherman (Keller & Sherman, 1974, chap.4) recommended that the student be allowed "two attempts at remediation" (p. 32). Because the proctor in this system is a blend of computer and human, there is an opportunity for learners who fail the quiz on the second and third attempts to enter the URL for their study question answers (Figure 14).The URL will display the study question answers to the grader (see the section below on the proctor functions). This way the ITMA grader can provide further clarification to the learner and, hopefully, prevent future failure. If a learner fails the quiz three times, s/he must contact the grader (using the email link) to arrange for alternate assessment as Keller & Sherman (1974) recommended.

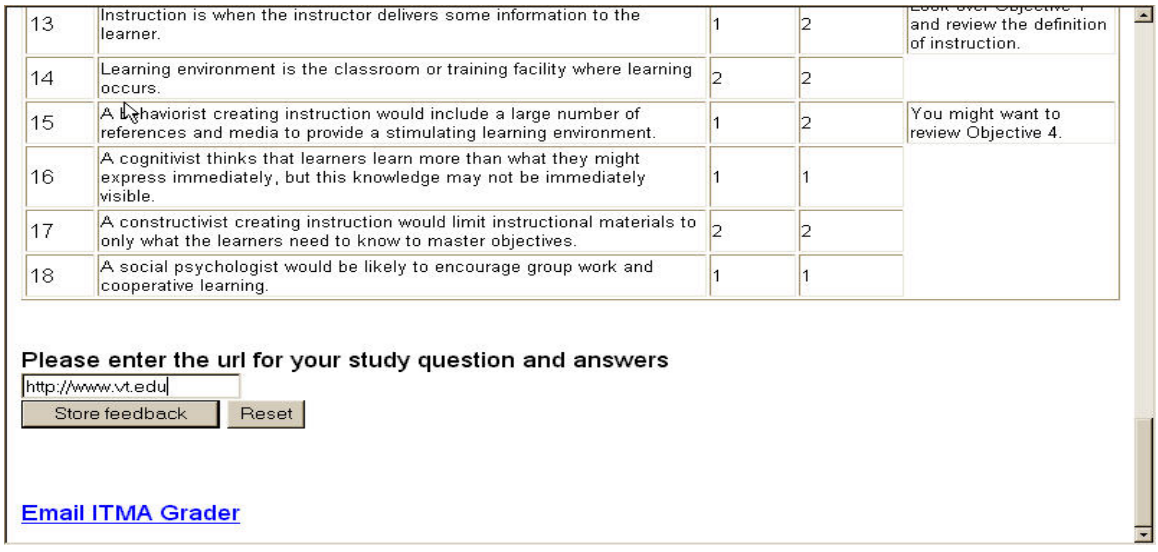


Figure 14. The learner has failed the same unit quiz 2 or 3 times. Here they can upload the URL for their study question answers, then email the ITMA grader to alert.

Outcome 3: Scoring 80-89%

The third outcome is neither mastery nor failure, but scoring 80-89% (Step 2.b. in Figure 2). According to Keller (1974), the learner now gets a chance to defend the incorrect answers to the proctor. In this online system, the learner earning between 80-89% does have an opportunity to present an explanation of the incorrect answers. In this situation, the learner is provided a text box beside the incorrect answer and can provide an explanation (Figure 15) (Step 2.b.1. in Figure 2). This explanation is then available to the ITMA grader who assesses the explanation. If the explanation is satisfactory

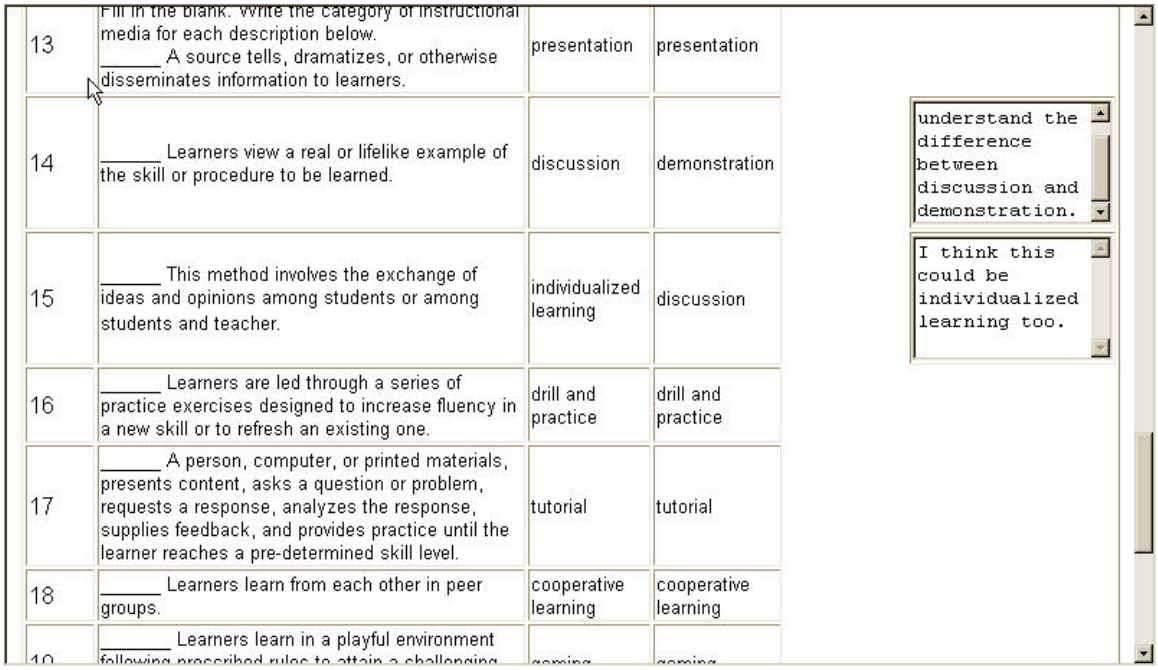


Figure 15. The learner scores between 80-89% and textboxes are presented for the learner to input an explanation.

(Step 2.b.1.a), the learner is allowed access to the next unit quiz. If the explanation does not demonstrate mastery (Step 2.b.1.b), the learner is not allowed to move on and s/he must retake that quiz.

Proctor functions: Study hall and grading proctors

There is another component in this PSI online system – the proctor. In this system, the proctor's functions are represented by a blend of computer-generated feedback and an ITMA grader. Keller (1974) advocated the use of two proctors – the study hall proctor and the grading proctor. In this system, both proctors exist. For Keller,

the study hall proctor stood between the textbook and the materials, and the learner. That is, the study hall proctor clarified information prior to the quizzes. In this online Keller version, the study hall proctor is a combination of computer-generated feedback and an ITMA grader (Table 3).

Table 3.

Comparison of the study hall proctor in a traditional PSI system and modifications

Traditional Keller System Study Hall Proctor	**Modifications**
Human proctor	Combined computer-generated feedback and ITMA grader
Clarified instruction prior to quiz; stood between learner and instructional materials	Computer-generated feedback is built into the "Guidance and Clarification" pages for each study guide by using JavaScript Learners are given the contact information for the ITMA grader for Instructional Media. The ITMA grader can answer any questions or provide further clarification prior to the quiz.

On the "Guidance and Clarification" pages for each study guide, there is computer-generated feedback (Figure 16). Depending on the type of questions, the feedback varies. The goal of the feedback is not to state the answer, but to help the learner understand the material better. Sometimes the learner is told to refer to certain pages within the text. Other times, the learner is given specific feedback for a question.

The other element to the "study hall proctor" is the ITMA grader. Within the ITMA program, each course gets a human grader that usually grades the learner work and provides guidance. In this version of PSI, that ITMA grader will function as the other part of the study hall proctor. Our learners are used to emailing "itmahelp" for guidance in their assignments. At the bottom of each "Guidance and Clarification on Study Guide Questions", there is an opportunity for learners to email itmahelp. When the learners

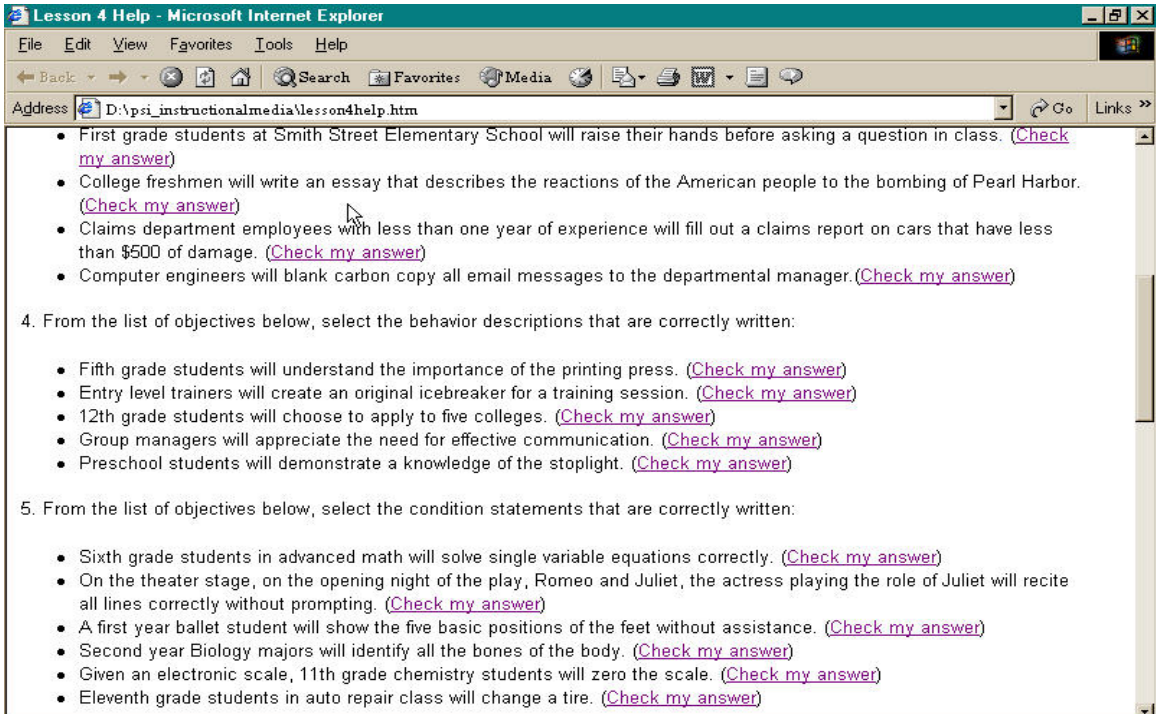


Figure 16. Examples of feedback available in the "Guidance and Clarification" page.

email itmahelp, they get a response from the grader for that course. The learners avail themselves of this opportunity readily and they are used to doing this. This feature is retained within this online Keller system and fulfills the function of the "study hall proctor".

The other type of proctor within PSI is the "grading proctor". In this online system, most of the functions of the "grading proctor" are performed by the computer. The other functions are performed by the ITMA grader. The computer performs the administrative functions of a "grading a proctor", grades the quizzes, and provides most of the feedback on the quizzes. However, when a learner scores between 80-89% on an exam, the ITMA grader must judge the level of mastery shown by the learner. Table 4 shows the adaptation of Keller's description of testing proctors to the online environment. Basically, the idea is to leverage some of the technologies available now to mimic some (not all) of the functions of a human proctor. Keller said, "The use of …a computer is possible under PSI. It may even be desirable at times. But such devices are not to be equated with the system itself." (Keller, 1974, p.19). Therefore, this system uses the computer as the first line of feedback with ITMA graders as the second line of feedback.

Table 4.

Functions of testing proctor and modifications

Traditional Keller System Testing Proctor	**Modifications**	**Who will perform the function in my system**
Description of testing proctor: learner in class, learner who completed the course previously, graduate learner or advanced learner	Computer system: Cold Fusion™ using Access databases, JavaScript ITMA grader: graduate learner in Instructional Technology working for the ITMA program	Computer system and ITMA grader
Administrative Function performed by the testing proctor: records the learner name, assigns the quiz, score for each quiz, restricts access to quizzes depending on score, permits access to new quizzes depending on score	None	Computer system
Grading Function performed by testing proctor: grades quizzes, provides feedback, assigns score, determines learner progress based upon score	None	Computer system
Grading Function performed by testing proctor: determines if mastery learning has occurred, reviews learner's study answers if failure occurs, presents alternative options to assess mastery learning if 3 failures occur	None	ITMA Grader

Because the ITMA grader will need to view learner quiz grades, explanations, and intervene on behalf of the learners, another interface was designed for the ITMA grader. The grader logs in (Figure 17) and is shown different options (Figure 18).

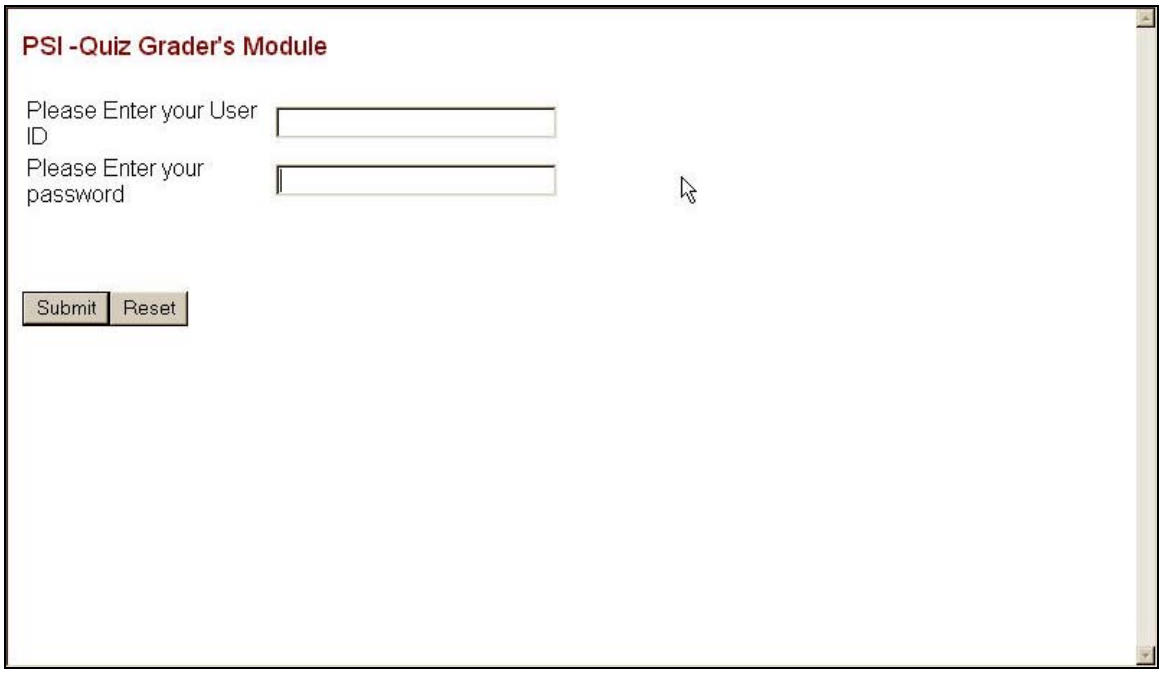


Figure 17. The grader login screen.

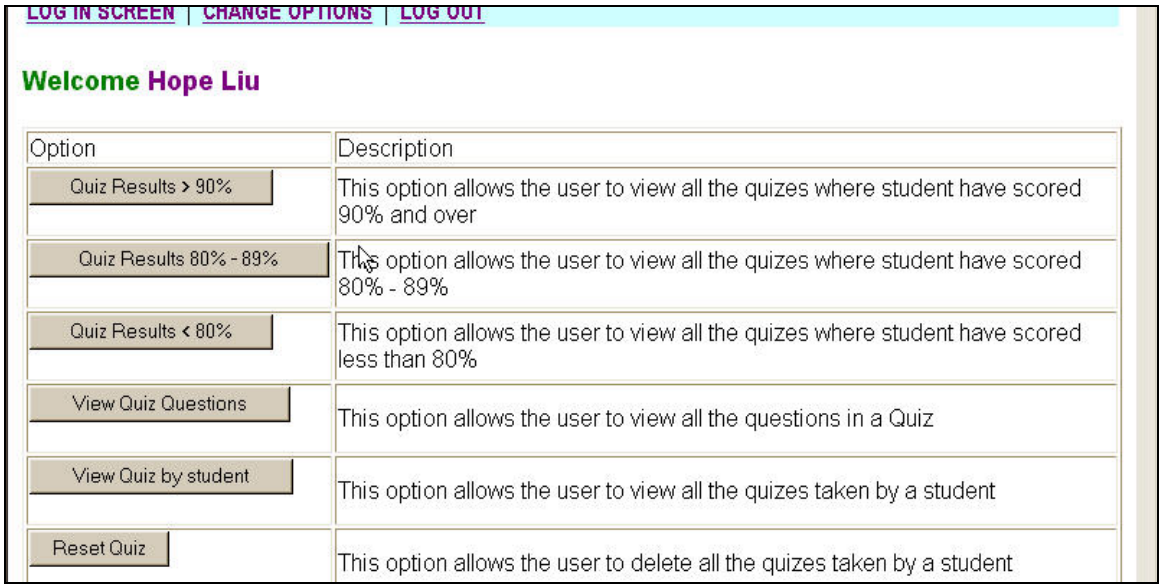


Figure 18. The different grader options screen.

The grader can view quiz results for each possible outcome – mastery, failure, or scores where their expertise is needed (80-89%). Figure 19 shows a typical screen where a grader can view quiz results. When a grader needs to view learner explanations, s/he can

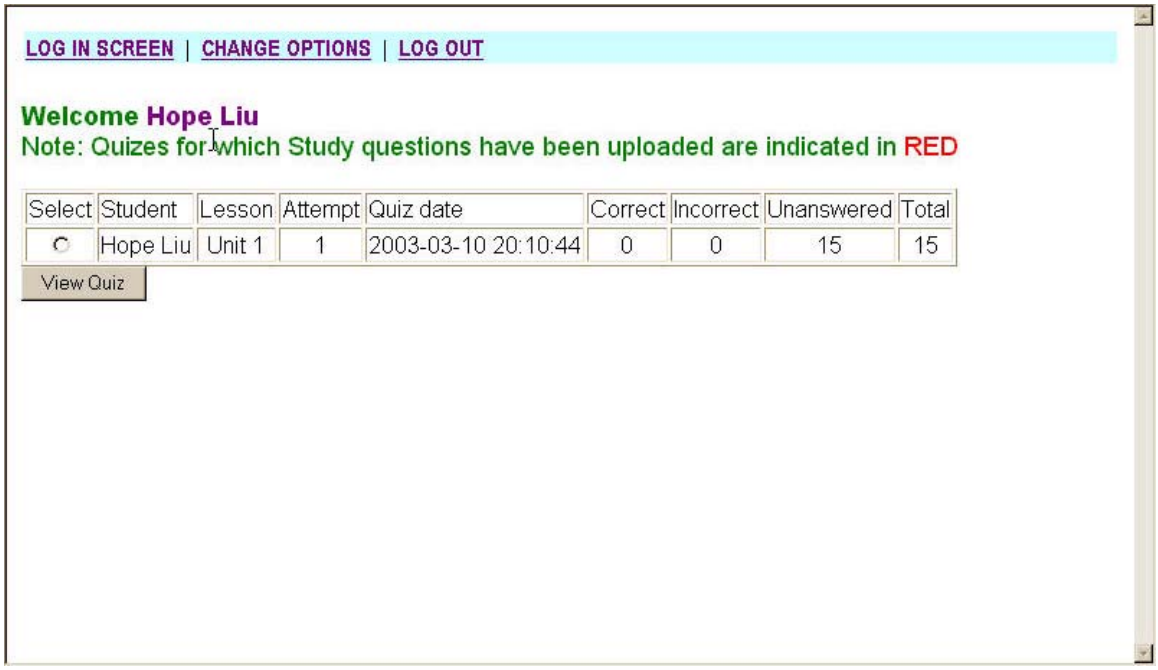


Figure 19. Quiz results for grader.

view these explanations by clicking on the Quiz Results 80-89% button (Figure 20). If the grader thinks that the explanation demonstrates mastery, s/he will accept the explanations by checking the checkboxes. Then, the grader assigns the next unit quiz to the learner (Figure 21). The learner has demonstrated mastery and can continue to the next quiz.

There is another situation where ITMA graders would like to view learner work and that is when the grader wishes to see the learner's answers to the study questions. In this case, (Figure 22), quiz results which had study questions uploaded will be shown in red. This alerts the grader and when they click on that quiz, the URL of the study questions will automatically load. Thus the ITMA grader can perform the grading functions of the Keller grading proctor, but not be burdened with the administrative responsibilities.

Overall Summary of the Product

The online end product adheres to all of the PSI tenets (except the use of the lecture, which Keller (Keller & Sherman, 1974, chap. 3) said "is vastly overrated." (p.20). Self-pacing is incorporated in the units through ITMA's policies. The system will

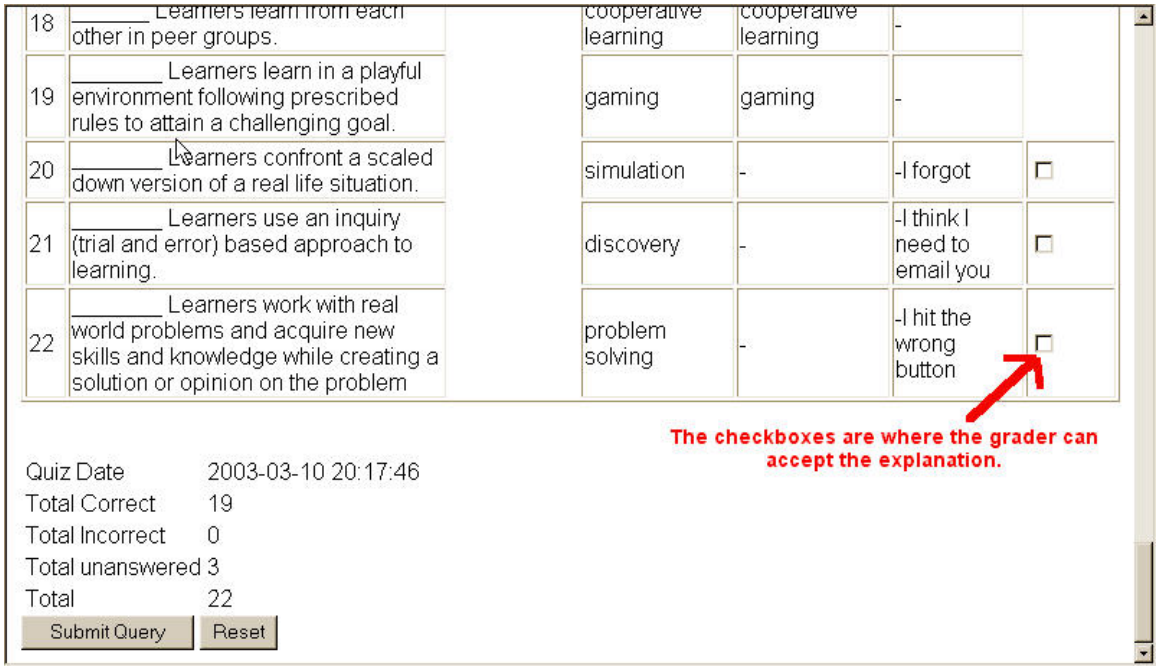


Figure 20. The grader can choose to accept a learner's explanation of an answer

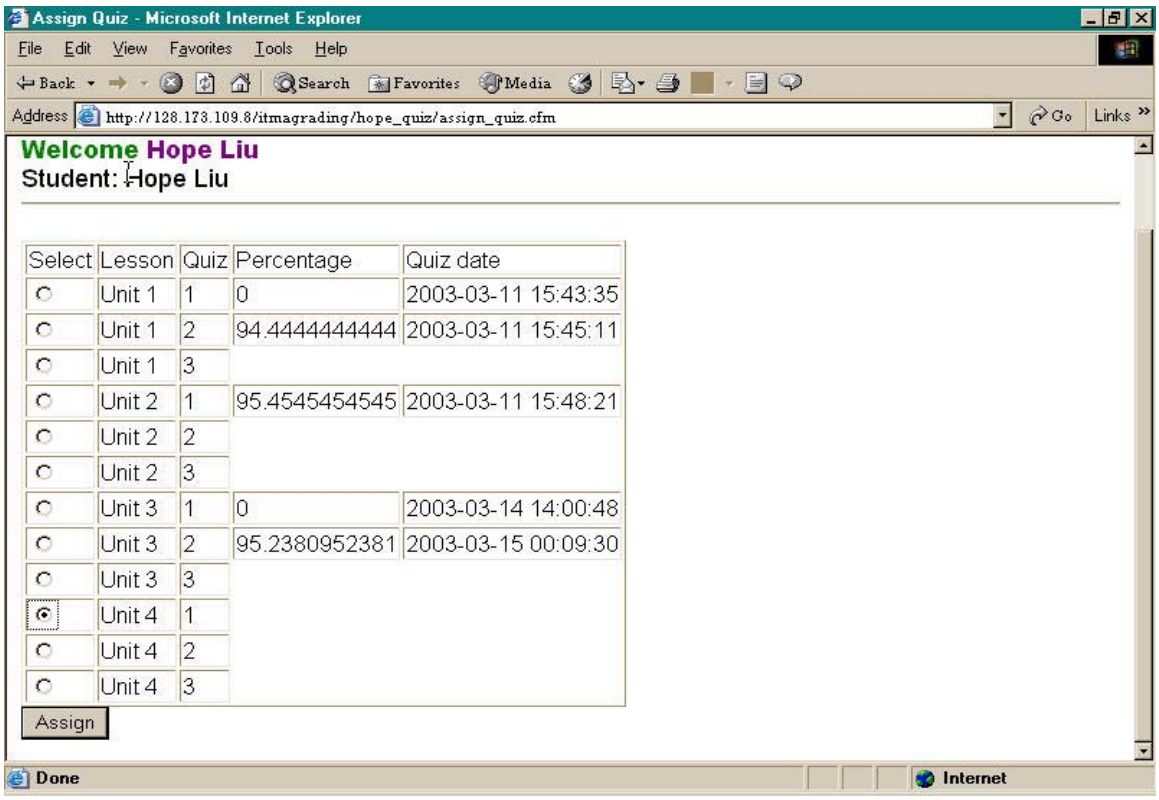


Figure 21. The options for a grader to assign a new quiz to the learner.

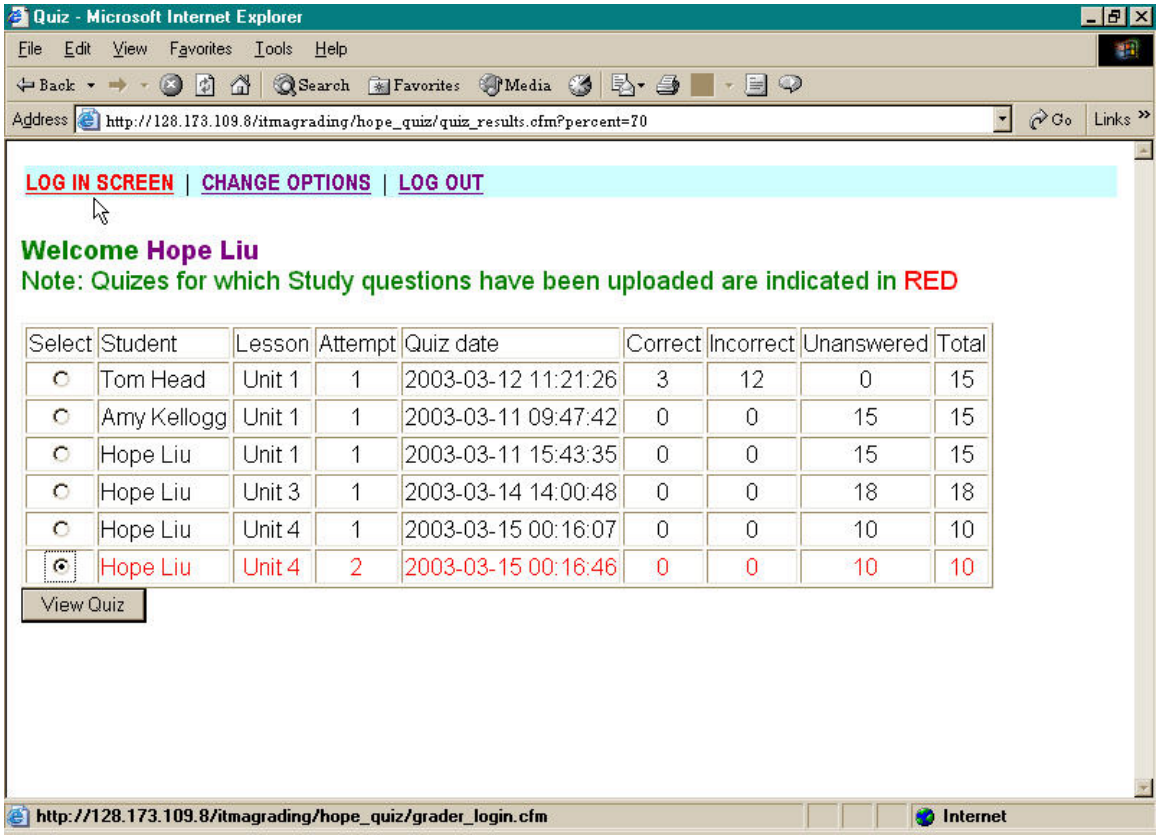


Figure 22. The grader can view learner study questions by clicking on the quiz results in red. This opens the URL the student entered for their study questions.

not allow a learner to take a quiz until s/he has mastered the previous unit. Therefore, the "unit-perfection" (Keller, 1968) (mastery) requirement for advancement is fulfilled. There is stress upon the written word in this online environment as Keller (1968) recommends. Also, the proctor functionality is retained, through a blend of the computer system and the ITMA grader.

Results of the Evaluation Process

Evaluation 1: Proof of Concept

The proof of concept evaluation focused on the fidelity of this online version of PSI to the original paper-based PSI as outlined and described by Keller. Dr. Michael Metzler, (Georgia State University) and Dr. Tom Head (Virginia Tech) are experts in PSI. They agreed to evaluate my product for its adherence to Keller's tenets. This evaluation, conducted in two phases, asked, "Do the materials and processes of this course match the theoretical aspects that Keller envisioned?"

Phase 1. Evaluation of materials.

The first phase of evaluation focused on the materials designed for the course, as well as some of the design decisions that were made. Appendices C, D, and E show the evaluation checklists. Sherman's (1974) chapter "Logistics" was used to guide the evaluation criteria. Specifically, each unit was evaluated, concluding with an overall evaluation of the materials. Overall, there was agreement between evaluators that the materials were representative of Keller's original ideas and Sherman's recommendations.

Both evaluators agreed that the study guides were comprehensive and followed Sherman's 1974 (Keller & Sherman, 1974, chap. 4) guidelines; all study guides included an introduction, objectives, study questions, and procedures. According to both evaluators, objectives, study questions, and procedures were clear in all study guides, needing no revisions. The guidance pages also clarified, explained, and helped learners, as Keller (1974) envisioned the role of the study hall proctors. However, both evaluators recommended that the unit study guide introductions should be more interesting in the presentation of the information. Accordingly, the introductions were re-written for all eight units. One evaluator also recommended rewriting the course introduction to include more "nuts and bolts of the PSI course." The course introduction was re-written to include more detail about the processes and procedures in the course.

While both evaluators agreed that each quiz question referenced the appropriate objective, was a mixed format of questions, and had three versions, there were some discrepancies about the length of the units and the length of the quizzes. One evaluator thought that the unit size was testable within 15-20 minutes for all units, while the second evaluator thought that some of the units were too lengthy to be tested within 20 minutes. According to Sherman (Keller & Sherman, 1974, chap.4), "there is no formula" (p. 27) for determining unit size, but that each unit covers a week's worth of material. While Keller (1968, 1974) advocated the use of small units (as many as 30 in a course), the actual determination of the size is left up to the instructor. Sherman (Keller & Sherman, 1974, chap.4) also points out that many small units takes away the self-pacing aspect of the system, putting pressure on learners to meet deadlines in order to complete all units. Additionally, Sherman (Keller & Sherman, 1974, chap.4) recommended that for a fifteen week course, eighteen units are desirable, and that an instructor should only cover 4/5 of the material in a normal course. This one unit/week recommendation was also reiterated

in Sherman and Ruskin (1978).

In this online system, three chapters of the textbook were used and divided into eight units. Normally, in this course, thirteen chapters of the textbook are used. Since a PSI course would cover 4/5 of that material, the Instructional Media course would be 10.4 chapters. If the remaining 7.4 chapters were divided in a similar fashion to create PSI units, the PSI course would have approximately 25 units total. This number exceeds the 18 units recommended by Sherman, and it also violates the "one unit/week" recommendation by Sherman (Keller & Sherman, 1974, chap.4). It appears that the unit size is open to interpretation. While smaller units would be best ideally, too many units could harm the self-pacing aspect of PSI.

Further evidence of the subjective interpretation of unit size comes from Sherman and Ruskin's (1978) Appendix information. There are two examples of exemplary PSI units, according to Sherman. Figure 1 shows a unit guide with two objectives for Physics, and a quiz that has three questions. Figure 2 shows a unit guide for Biology with seven objectives, further broken into a total of 21 objectives. The quiz has 21 questions. Clearly, unit size is difficult to judge. Because unit size and appropriate content is hard to judge, no changes were made to the unit size. It was decided that during the summative evaluation, more information could be gleaned from the learners about how long the units and quizzes should be.

Another point of debate that arose was the exclusion of lectures. One evaluator did not agree that omitting lectures and demonstrations did not compromise Keller's system, whereas the second evaluator agreed that it was an acceptable decision. It was further added that some learners needed some personal attention and that lectures were a way of providing this personal touch. One evaluator noted that "ideally, streaming video lectures could be produced that would provide additional motivation for students." However, Keller (1974) noted,

> Relatively minor roles are given in our plan to the lecture and the demonstration. Their purpose is primarily motivational. They are not central to the educational process and they could be eliminated entirely without serious damage…[the instructor] will soon discover, however, that other features of the course are more

important and that the lecture or the show is vastly overrated. (p.19-20).

The context for delivery should be considered with regard to lectures. ITMA is generally a "low-touch" program with learners moving independently through the courses. Learners rarely have prolonged contact with ITMA staff unless something goes wrong or if they are confused about something. In ITMA, courses are designed for the lowest common bandwidth. Learners with a dial-up modem would have a difficult time with streaming video and probably end up frustrated, and not motivated.

Finally, studies by Born and Herbert (1971), Nelson and Scott (1972), Calhoun (1976), and Brothen and Wambach (1998) all reported that learners did not attend lectures and that learners did not find lectures motivating. Therefore, lectures were not incorporated into this version of PSI.

Both evaluators agreed that the first two units might be slightly easier, as Sherman (Keller & Sherman, 1974, chap.4) recommended. However, one evaluator said that there was no "major difference in the degree of difficulty of the units." The other evaluator suggested that "there needs to be more consideration from the students' side [with] options for lectures, length of units, length of quizzes." However, Keller never discussed having options for learners. In fact, Sherman (Keller & Sherman, 1974, chap.4) recommended that quiz distribution be random, with no options. Overall both evaluators agreed that the materials are PSI materials. Specifically, one evaluator liked the "Guidance and Clarification" pages and the different types of questions in the quizzes. The second evaluator thought that the study guides were very complete with comprehensive study questions. In conclusion, one evaluator said, "I believe the materials are representative of the original Keller plan."

Phase 2. Evaluation of online processes

The next "proof of concept" evaluation was to access the materials online and try them out from the learner and the grader perspective. This evaluation material can be found in Appendix C. Specifically, the evaluators were asked to evaluate the study hall proctor as represented by computer-generated feedback in the "Guidance and Clarification" pages and to evaluate the grading proctor as represented by the combined functioning of the computer system and the ITMA grader. They were also asked to give

their overall impressions of this online version of PSI.

One evaluator stated that the study hall proctor, as represented by the computerized feedback, "serves an important function by clarifying information for the student." He did not find any errors with the administrative functioning of the system – mastery learning was forced by the system and record keeping was accurate. The computer system also performed the grading functions well. He summarized his opinion on this version of the grading proctor as "[providing] a more cost-effective and workable system" than the original Keller system. He also agreed that the combination of the computer system and the ITMA grader yielded a level of functionality similar to the grading proctor of the original system. No design decisions were found to corrupt the original Keller concepts, including the extra feedback on missed objectives and the increased time delay before re-taking a quiz.

The second evaluator provided similarly positive feedback. He also agreed that the feedback provided by "the study hall proctor" was an integral feature to the PSI system since it provided "personal access…on an as-need basis." He also said that the feedback provided on the "Guidance and Clarification" pages help clarified the information "very nicely." He found no errors within the administrative processes or the grading processes of the "grading proctor" as represented in this system. He specifically commended the "review" option as " a really cool feature, b/c many students will "just miss" for many reasons, and this gives them a legitimate second chance to demonstrate mastery without having to re-take the whole quiz."

The only two points of concern were the use of an ITMA grader for this course and the lack of verbal explanation by the learner during the quiz process, as Keller recommended. One evaluator said that the ITMA grader should be a content expert as well as able to navigate the PSI grading system interfaces, so the grader can provide correct feedback. The first concern was the use of ITMA graders for "grading proctors". He was concerned that the ITMA grader be adept at using this grading interface, as well as being content experts. This system was designed for seamless integration into the existing ITMA grading system. Look and feel of the webpages, as well as menu options, are similar to existing interfaces used by graders. With regard to content expertise, ITMA graders (doctoral students in Instructional Technology) are selected for as graders for a

course based on their prior experience with content.

The first evaluator stated that often a learner "can verbalize an answer much better than he/she can write it." Keller (1968) advocated the verbal explanation. However, within the context of ITMA, a distance learning program, verbal one-on-one explanations to an ITMA grader would be extremely difficult, and not a practical use of time. The evaluator did state that the written explanation of a quiz answer to the ITMA grader via email "is a real strength of [this] design and should be kept in." Thus, the written explanation, while not optimal, is an acceptable solution.

Overall comments by both evaluators were extremely positive. The first evaluator stated that, his "overall impression is that this is an excellent example of computer-based PSI, and it represents a very sophisticated combination of PSI design, content, and user support." The second evaluator's overall comments concluded with "an outstanding job on adapting the PSI system to a modern, computer-assisted environment." In summary, no substantive changes were made based on this phase of the evaluation.

Evaluation 2: Formative Evaluation

An ITMA grader, with a strong instructional design background in corporate and university environments, was asked to evaluate the materials and processes for the course (Appendix D). Specifically, she was asked to find ways to improve the overall processes and examine the material for errors. She reviewed the Course Overview page. Minor typographical errors were found in the content. The content was revised to make it more "stand-alone" while also putting this course in the context of ITMA. She found an email link to itmahelp@vt.edu that needed to be activated. A graphic was missing from the Course Overview. More instruction was needed on uploading study guide answers. She suggested that learners be told what to name their study guide answers.

All typographical errors were found. The content was revised, per her suggestions, to make the content of the Course Overview page more stand-alone. This consisted of changing the first sentence under "Content for this Course" from "There are some differences though," to "There are some differences between this course and other ITMA courses." The email link was activated, and the graphic was replaced. The instruction on study guide answers was modified to include the names of the files.

She also reviewed each unit study guide and "Guidance and Clarification" page.

Again, minor typographical errors were found, such as an extra comma or period. A few inconsistencies were found between units, such as “p. 60” vs. “page 60” and the style and indentation of bullets. Some diction changes were suggested. The most serious error was found for Unit 6, question 3 on the “Guidance and Clarification” page. There was no feedback for that question. For Unit 8, she suggested rewriting study questions 7 and 8. She also suggested inserting links to the Course Overview page from the Unit Study Guides. She also suggested adding a “Top” link at the bottom of the study guide, and inserting a “Back to the Study Guide” link on the “Guidance and Clarification” pages for easier navigation.

All typographical errors were fixed. Inconsistencies were resolved between units. Diction was modified according to her recommendations. For example, instead of “Given the movie “A Bug’s Life”, sixth graders will compare and contrast by listing five anatomical characteristics that differed between the animated ants’ anatomy and the actual ants’ anatomy” in Unit 4, she suggested re-writing it to be “Given the movie "A Bug's Life", sixth graders will compare and contrast the animated ants' anatomy and the actual ants' anatomy by listing five anatomical characteristics that differed between the animated ants and actual ants.” All links were created and inserted where she suggested. Feedback was created and inserted for question 3, Unit 6. Study questions 7 and 8 for Unit 8 were re-written per her recommendations.

She also reviewed the quizzes. More instruction was needed on quiz questions that had multiple answers. She suggested providing some instruction within the quiz interface on use of the semi-colon for multiple answers. The following instruction was included on the page after login: “Some questions may ask you to provide multiple answers. You should separate those answers with a semi-colon. For example, if the question was “What are the three ingredients in a peanut-butter and jelly sandwich?”, you would write “peanut-butter; jelly; bread.” Some errors were found in the quizzes and feedback. One of the quiz questions in Unit One that covered objective 2 provided feedback that referred to objective 1. This was corrected. Some spelling errors were found. This included the use of the word “quizes” instead of “quizzes”. This was corrected. Some typographical errors were found within the quizzes – extra punctuation, or missed punctuation. These were fixed. Some inconsistencies of font use were found. In

particular, the font of matching questions did not match the rest of the questions. The matching questions were fixed so that the font matched the other questions' font (Arial, 10 pt).

As a result of this evaluation, minor typographical, spelling and grammar errors were fixed. Also, formatting changes were made to some text. Feedback was created for the study question that had no feedback, as well as some navigational links were placed in all the webpages.

Evaluation 3: Small group Evaluation

All five ITMA learners, familiar with the online context this product was designed for and with experience in instructional design and software evaluation, completed the evaluation (Appendix E). Regarding length, all strongly agreed that the length of the quizzes was reasonable and that they could have completed a unit within a week. This endorsement of the length of the units and quizzes resolves the questions brought up in previous evaluations that the units and quizzes were too lengthy. Learner comments on the length of the units and quizzes included, "…the length of these modules is GREAT!" and "good length for a target audience who is likely to be coming home after work to put in a few hours each night." Learners expressed a little concern that the smaller unit size could "result in excessive length in later ITMA courses that are more difficult to master," and also that "if the chapter was a long chapter and consisted of a number of smaller units then it might take longer to complete the chapter."

Learners favorably reviewed the study guides and "Guidance and Clarification" pages as well. Four of them strongly agreed that the introductory material established the focus of the unit. The fifth evaluator merely agreed. All five evaluators strongly agreed that the objectives were clearly written and four out of five evaluators strongly agreed that the study questions were relevant. The remaining evaluator agreed. All evaluators agreed that the feedback given via pop up screens helped the instruction with three evaluators strongly agreeing and two agreeing. Comments on the study guides and "Guidance and Clarification" pages included "I LOVE THIS! There were many times when I had a problem finding the answer to just one question and the [Guidance and Clarification] section would have helped tremendously." One learner commented that she "particularly liked the feedback that had a personalized character to it. [She] found the

drier feedback less helpful." Another person stated that, "the pop up screens are wonderful. It allows for practice without having to worry if I am going to get it "right" the first time." Finally, an evaluator stated that "The pop up screens provided so much help that as a student enrolled in this course I would find it hard not to grasp the concepts because so much support has been built into this PSI online model." Clearly, the feedback was the most notable and appreciated aspect of the instructional materials.

When asked about the quizzing interface, learners all strongly agreed that the quiz interface was easy to use and that they would use the feedback to review specific missed objectives. All agreed that they would use the option of explaining an answer to a grader if they scored 80-89% (three strongly agreed, two agreed). Four evaluators agreed (three strongly agreed, one agreed) that they would upload their study questions for an ITMA grader to review if they failed the first attempt. One person actually disagreed with this statement. However, she later explained that, "[she] would use the option of explaining [her] incorrect answer to the grader if [she] felt [she] could justify what [she] had answered." She further elaborated to say that if "[she] failed to master the material after a second try, [she] would then ask for help. " Other comments on the quizzing interface included, "I like the opportunity to explain my answers to the grader. Sometimes I might not be on the right track, but I think I am. This is an opportunity for the grader to see where I am coming from and help me get on the right track." Another learner stated that "[she] liked the various options provided for students to "defend" or explain answers…[she] believe[s] that this method of communicating aides in "closing the gap" with Distance Learning because the student would have a direct line of communication with their grader."

Two concerns were expressed that the grader would provide timely feedback. One learner expressed that, "long wait time before receiving feedback, or never receiving feedback on a couple of occasions, was responsible for most of the dissatisfaction within the ITMA2 program." Another learner hoped that "the grader would not be swamped with responses of this nature since the material is so nicely presented throughout each lesson." These concerns are based on prior distance learning experiences, though, and do not directly reflect on PSI.

Table 5 shows a summary of student perceptions of various features of this PSI

course that affect their learning. Everyone agreed that self-pacing was extremely positive in terms of learning outcomes, as well as the automatic feedback on the "Guidance and Clarification" pages. With the exception of emphasis on the written word, they thought that all the other features would assist them in their learning. In fact, most of them found that the emphasis on the written word was the feature that would assist them the least in their learning. Most of them desired different presentation formats, other than text. Only one learner stated that all features were beneficial. Similarly, one learner thought that mastery learning would not be beneficial to her learning. Table 6 shows overall opinions by the five student evaluators on this method of instruction. Most comments were general comments on the PSI format overall. For example, one learner said, "I think this method of instruction is FANTASTIC. It emphasizes student learning and gives immediate feedback and help when needed. I just wish we had this for my ITMA cohort!" Another learner commented that, "these features all target the needs of distance learners most closely related to learning." Of interest is that one learner rated mastery learning as least enjoyable, even while admitting that it was most beneficial to her learning. Also of note is the consistent interest in having different presentation formats, such as video or audio.

Finally, learners were asked if they would enjoy a course that uses PSI. All of them agreed that they would (three strongly agreed, two agreed). They also provided explanations as to why they would enjoy a course using this format. One learner stated that email communication with a grader in a distance environment can be delayed but that the "Guidance and Clarification" pages "give hints on where to find material and also give feedback instantly." She also liked the "quizzing situation because it ensures you will not make a failing grade on a quiz and end up scoring low in the class. FANTASTIC!"

Another learner stated that, "this is individualized learning at its best. If I am having trouble I have direct access to the graders, direction to guide my learning of the material, and opportunity to prove to myself I have mastered the material." Another evaluator was a little more cautious, "I would not want to have this much supplemental material (or be expected to achieve mastery) in every course, but this would be a useful and enjoyable way of completing some courses." "Concise, effective, and efficient," was the overall opinion of another evaluator. Finally, another learner wrote, "I truly feel that

the feedback, the communication, and the help throughout each unit makes this a great

Table 5.

Summary of features of PSI course and learners' perceptions of their learning benefits.

Course Feature	Percent that agreed this feature was most beneficial to learning (N=5)	Percent that agreed this feature was least beneficial to learning (N=5)	Comments
Mastery learning	80%	20%	"Mastering small chunks of material before moving on ensures that the student is getting the material before moving on to new material." "If you haven't mastered the material, the long-term consequences can be devastating." "I have enough innate curiousity and motivation to seek correct answers and learn the material without being 'forced' to review and re-take…In general, however, this is a benefit to instruction."
Automatic feedback on the "Guidance and Clarification" pages	100%	0%	"I also LOVE the clarification page…there have been mant [sic] times that I have needed help with a particular question and it sometimes gets frustrating to wait for an email reply to get help." "The automatic feedback on the guidance and clarification pages would be the most benefit for me."
Automatic feedback on the quizzes when you missed a question	80%	0%	"Automatic feedback is extremely helpful in learning environments and I believe is more beneficial to the learner."
Feedback from an ITMA grader when you provided an explanation to a missed quiz question	80%	0%	No comments regarding this feature.

Table 5(continued)

Summary of features of PSI course and learners' perceptions of their learning benefits.

Course Feature	Percent that agreed this feature was most beneficial to learning	Percent that agreed this feature was least beneficial to learning	Comments
Self-pacing	100%	0%	"Self-pacing for [distance learners] is eliminates a lot of stress." "Self-pacing is essential for professionals and those with families taking these courses."
Smaller units of material	80%	0%	"Cutting the information into smaller units is helpful because it provides a more concise schema into which the material needs to be assimilated." "..allows the learner to focus and analyze one area at a time. This would produce less confusion."
Emphasis on the written word	20%	60%	"I do enjoy having video and audio clips of some things available, but it is not necessary." "I have grown to appreciate the combination of audio with the written word to maximize learning." "A variety of presentation formats would help maintain my attention." "Honestly, none of these options would benefit my learning the least. I chose written word because sometimes it's easy to be misunderstood through written communication.."
None of the above	0%	20%	"I think all of these things will benefit learning greatly."

Table 6.

Summary of features of PSI course and learners' opinions of them.

Course Feature	Percent that liked this feature	Percent that disliked this feature	Comments
Mastery learning	60%	20%	"I rated it as one of the most beneficial, but I know there would be instances where I would become frustrated by just wanting to move on rather than have to master a unit that was giving me trouble."
Automatic feedback on the "Guidance and Clarification" pages	100%	0%	
Automatic feedback on the quizzes when you missed a question	80%	0%	"I like the automatic feedback on the guidance and clarification pages best of all because it allows for stress free practice of the new skill." "I most enjoyed the automatic feedback on the guidance and clarification pages. It was a bit like having an instructor whose only student was me."
Feedback from an ITMA grader when you provided an explanation to a missed quiz question	80%	0%	
Self-pacing	80%	0%	
Smaller units of material	80%	0%	
Emphasis on the written word	20%	40%	"Probably emphasis on the written word is my least favorite feature." "My experience has shown that many if not most learners benefit from visual or audio support."
None of the above	0%	40%	"I feel that all of these features contribute to making this course a great method for Distance Education."

way to learn."

Overall comments from the five student evaluators were quite favorable to this method of instruction. Generally when a doubt was expressed it was based on the distance learning environment, and not the method of instruction. The only recommendation they suggested was to have the information presented in a variety of formats. They most seemed to like the feedback options presented throughout the course. It appears that the Keller system can be successfully replicated in an online environment. One learner summed up her opinion by saying, "it could be useful for individualized distance learning such as the ITMA program." As a result of this small group evaluation, no changes were made to the instructional materials or processes.

CHAPTER FOUR

This final chapter discusses the final PSI product in terms of previous literature and compares this product to previous computerized PSI versions. It also describes some of the practical advantages and disadvantages to designing a course using PSI.

Summary of PSI Adaptation to Online Environment

Overall, there was minimal modification of Keller's PSI tenets to the online environment. Self-pacing was retained according to Keller's definition (Keller, 1968; Keller & Sherman, 1974). Mastery of small units was forced according to Sherman's recommendation that progress be controlled by mastery of unit quizzes (Keller & Sherman, 1974, chap. 4). Current content was divided into smaller, more manageable units. The content came from the textbook for ITMA's Instructional Media course and was developed in Dreamweaver™ primarily as text. The computer system allowed learners to access a unit quiz only if they had mastered the previous unit.

Lectures were omitted as recommended by Keller (Keller & Sherman, 1974, chap. 3). Emphasis was on the written word as Keller (1968) suggested. Finally, the computer system performed the administrative functions of the proctor and the initial grading of the quiz. Interactive pop-up boxes performed the functions of the study hall proctor. Cold Fusion™ and Access were used to create a dynamic database system, which mimicked human grading proctors. ITMA graders were used to discern mastery of a quiz or to provide additional support.

The Final Product in the Context of the Literature

The goal of this project was to develop units of instruction for an online environment using PSI as a model of instruction. Keller's (1968) tenets for PSI are:

1. The go-at-your-own pace feature (self-pacing)
2. The unit-perfection requirement for advancement (mastery)
3. The use of lectures and demonstrations as vehicles of motivation
4. The related stress upon the written word in teacher-student communication
5. The use of proctors for feedback

Sherman (Keller & Sherman, 1974) later operationalized these tenets in his chapter Logistics, so that new practitioners of PSI could create a faithful PSI experience

for their learners. By following Keller's guiding principles and adhering to Sherman's recommendations, a PSI experience was created for an online environment.

Even though modifications were made to leverage technology for the online environment, the overall experience is still faithful to PSI, according to expert evaluators. The following sections will discuss each of the five Keller tenets with respect to this newly created PSI experience and implications for the online context will be discussed when appropriate.

Self-pacing

The online PSI units were created for use in the ITMA program, a distance learning program. Self-pacing in this version of PSI allows learners to access the materials at any time, via Web-delivery, and take assessments at any time as well. Both expert evaluators agreed that the self-pacing employed in ITMA faithfully replicates Keller's first tenet about self-pacing. Learners are allowed to pace themselves in this course without penalty, and can view their progress throughout the course in the quiz interface. If, at the end of the semester, they have not finished the course, they are automatically assigned an incomplete. Keller (Keller & Sherman, 1974, chap. 9) recommended that incompletes be given generously to reduce the aversive consequence of a failing grade. Sherman (Keller & Sherman, 1974, chap.4) also supported a liberal incomplete policy.

Because this PSI experience was created for distance learners, it was important to take into consideration their needs. In this online PSI version, the five student evaluators stated that self-pacing was not only enjoyable, but also mandatory for them as distance learners. One evaluator stated that self-pacing "eliminates a lot of stress," while another stated that self-pacing "was essential for professionals and those with families." Indeed, distance learners have many external demands on their time (Keegan, 1986) and self-pacing allows them flexibility to complete work when time is available. Historically, PSI learners have liked the self-pacing feature (McMichael & Corey, 1969; Born & Herbert, 1971; Hoberock, 1971; Fernald et al., 1974).

Self-pacing needs to be retained to create a PSI experience, as well as to accommodate the needs of learners. There appears to be a good match between PSI's definition of self-pacing and the needs of distance learners for flexible learning.

Mastery Learning of Small Units

In this online PSI product, small units of instruction were created based on logical breaks in the content. Eight smaller units were created from three chapters in the Instructional Media textbook. From the each unit's objectives, three different quizzes were created. Thus, quiz length was determined by the number of objectives in a unit.

There was some debate about the length of the units and the quizzes. One evaluator felt that the length of some of the units and quizzes was possibly too long, and suggested that the student evaluators evaluate the length of the units and unit quizzes. The five student evaluators strongly agreed that the length of the units and quizzes was appropriate and not too long. Four out of five student evaluators liked the smaller units and thought that the smaller size would be beneficial to their learning. These findings agree with Nelson and Scott's (1974) findings that students enjoyed the smaller units, and found them very beneficial to learning.

However, there were some concerns from the student evaluators that breaking the material into smaller units could lead to a longer amount of time spent on the chapter than previously. One evaluator said it could "result in excessive length" in more difficult courses. These comments align with previous student comments in PSI courses that stated there was a large amount of work required in a PSI course (Born & Herbert, 1974, Hoberock et al., 1974).

Mastery learning is forced upon the learners in this online version of PSI since they cannot progress in the course until they score 90% or higher. In this course, learners are allowed three attempts at mastery (Sherman & Keller, 1974, chap. 4). Both expert evaluators agreed that this online PSI system forced mastery. Four of the five student evaluators rated this as beneficial to their learning. One ITMA evaluator felt that this would not benefit her since she was internally motivated. However, mastery learning has been shown to increase performance when compared to non-mastery courses (Goldwater & Acker, 1975; Caldwell et al., 1978; Kulik, Kulik, & Cohen, 1990).

Another ITMA evaluator stated that while mastery learning would benefit her learning, she thought there would be times when she would feel frustrated with it. Previous student evaluations conducted in PSI courses have found similar results.

Students in an introductory psychology course ranked mastery learning as very important to learning, but did not enjoy it (Nelson & Scott, 1974).

The student evaluators stated that the smaller units and the mastery learning would benefit their learning (even if they caused more work or if they did not particularly enjoy these features). Based on these observations, it seems as if Keller's mastery of small units requirement could have learning benefits in a distance environment.

The use of lectures and demonstrations as vehicles of motivation

In this PSI version, lectures were omitted per Keller's (Keller & Sherman, 1974, chap.3) recommendation. Similarly, a number of researchers found that the lectures were not well attended, and did not improve performance (Born & Herbert, 1971; Hoberock, et al., 1974; Calhoun, 1976; Brothen & Wambach, 1998).

Additionally, some design considerations had to be made for the delivery context. One design reason for omitting lectures is that web-delivered ITMA courses are designed for the lowest technological denominator. For example, learners using a dial-up modem might become more frustrated at a low connection speed when trying to watch streaming video. In addition, past experience with the ITMA program shows that learners like to print their assignments out and not be connected to their computer. Streaming video lectures would hinder their flexibility.

However, the first expert evaluator disagreed with the decision to omit lectures, and the second expert evaluator agreed with the design decision to omit lectures, but suggested that ideally lectures could be streamed across the Internet. They both stated that these lectures could provide motivation to learners. Since lectures were omitted, the student evaluators were not asked about them. In the section below, the learners do comment on the variety of media used.

The related stress upon the written word in teacher-student communication

Instructional materials created for this course were text-based Web pages. Specifically, a study guide was created for each unit of instruction. Each study guide has an introduction, objectives, procedures section, and study questions following the recommendations of Kulik, Kulik, and Carmichael (1974) Sherman and Keller (1974, chap. 4), Calhoun (1978), and Spencer and Semb (1978).

Both expert evaluators agreed that all the study guides were created according to these recommendations, and that the objectives were clearly stated and well written. They also agreed that the procedures were clear and that the study questions were thought provoking and clearly stated. Likewise, the student evaluators commented that the introduction focused them on the material, the objectives were clear, and that the study questions were relevant.

As Hoberock et al. (1974) noted, by stressing the written word, the instructor must become clearer and less ambiguous in his/her instruction. They also note that this stress on the written word forces the learners to self-learn and that this self-learning promoted better study skills and exploratory thinking (Hoberock et al., 1974). In a distance environment, where support staff are removed temporally and spatially (Keegan, 1986), self-learning is necessary for success. Certainly an instructional method that helps learners improve their self-learning could assist learners in a distance learning environment. Web-based instruction is more dependent on written materials than in a traditional classroom (Khan, 1997). It appears that Keller's idea of emphasis on the written word is not difficult to adapt in Web-based instruction.

Interestingly, three of five student evaluators stated the emphasis on the written word was one of the least beneficial components to their learning. Two of the five student evaluators stated that it was one of the least enjoyable features of this method of instruction. One ITMA evaluator stated, "a variety of presentation formats would help maintain my attention." Two other student evaluators commented that combining presentation formats would make the course more enjoyable. Although no student evaluations have been found in the literature that ask students about the emphasis on the written word, it appears as though in the distance environment, learners desire information to be presented in a variety of formats, and not just the written word.

Based on these results, it seems as though these student evaluators would appreciate some additional instruction in a different format. Keller (1968) suggested that additional instruction could come in a motivational lecture or demonstration. However, in this version of PSI, the lecture was omitted since Keller (Keller & Sherman, 1974, chap. 4) strongly recommended against including it.

According to Marquardt and Kearsley (1999), multimedia materials increase motivation by capturing more attention and engaging learners more. Furthermore, they contend that, this motivational aspect of multimedia is crucial, especially in a self-study of distance education environment. According to the student evaluators, it appears multimedia elements could enhance this online PSI experience in terms of learner enjoyment and provide some motivation to learners ("maintain my attention"). It also seems that, at least initially, student evaluators would be willing to use these elements to supplement their learning.

Including multimedia elements might increase learner enjoyment of the course, as the student evaluators indicated in their comments, but could also change the PSI system since the emphasis on written word would be altered. Keller (1974) cautions against changing any of the fundamental features since these variations often end "with unhappy outcome." (p. 7).

The use of proctors for feedback

In this PSI experience, the proctoring component was modified. The functions of the study hall proctor were performed by the feedback given via pop-up boxes on the Guidance and Clarification pages. The computer quizzing system and the grader performed the functions of the grading proctor. Both external evaluators agreed that the Guidance and Clarification page fulfilled the functions of the study hall proctor. One evaluator felt that the study hall proctor served "an important function," and the other evaluator commented that it was "an integral feature…[that provided] personal access…on an as-need basis."

The student evaluators also favorable reviewed the Guidance and Clarification pages. Not only did they view the feedback as enjoyable, they also rated it as extremely beneficial to their learning. Comments included, "I love this!' and "I would find it hard to not grasp the concepts of the course because so much support has been built into this PSI online model." Evidently, they thought that the up-front feedback provided by the pop-up boxes would have several benefits: including reduced frustration, practicing a new skill without fear of penalty, and personalization of the course.

Although no research has been conducted on the role of the study hall proctor in a traditional Keller course, there has been some research on the use of computer-based

tutorials that function similarly to the study hall proctor described in this PSI course. Holmberg (1977) found that learners enjoyed the rapid feedback provided by computers and also found it beneficial. Similarly, Rowe and Gregor (1999) used a blend of computer-grading and human graders in their online, web-based instruction. Learners found this system motivating and beneficial to their learning. Although these learners felt that they did not learn more using the computer-based system, they felt their learning was reinforced (Rowe & Gregor, 1999).

The external evaluators thought that the grading proctor was well represented by the blend of computer-generated feedback and the intervention of a grader. Likewise, the student evaluators agreed that they would use the feedback generated by the system to guide their study, as well as the opportunity to have a grader review their study guide answers. Four of them felt that these features in the quizzing interface would benefit their learning and was also enjoyable to them. These results agree with previous results in the literature that learners enjoyed the proctors and found them beneficial, as well as motivating, to their learning (Hoberock et al., 1974; Wittig, 1974).

In terms of web-based course design, it comes as no surprise that the student evaluators thought that the feedback and support were highly enjoyable and beneficial. According to Threlkeld and Brzoska (1994), timely feedback on assignments increases students' enjoyment of the course. In addition, the ability to email a grader at any time during the learning process is another type of interaction that is "regarded as essential by most [distance] learners" (Moore & Kearsley, 1996, p. 129). One ITMA evaluator felt that this system of instruction would decrease "the gap" she felt in distance learning. This opinion is supported by Hackman and Walker's (as cited in Threlkeld and Brzoska, 1994) contention that "distant students viewed favorably instructors who employed strategies for enhancing social presence." (p. 58) These strategies included individual feedback. Another ITMA evaluator commented that she liked the "feedback that had a personalized character. The drier feedback was less helpful." The tone of the feedback evidently mattered to her. Again, this is not surprising in a distance environment, since, according to Misanchuk (1994), the tone of the text, (in a distance learning course) should be "more like speaking than for writing" (p. 127).

Comparisons of this PSI course to other Computerized PSI courses

As stated previously, the idea of adapting PSI to the online environment is not novel. Many other educators have had the same idea. This section compares this version of computerized PSI to other existing computerized PSI versions. Table 7 shows previous versions of computerized PSI compared to this version. Most of the courses seem to be using something like PSI, but not quite. Liberal interpretations of Keller's courses often result in poor performance.

Ainsworth (1979) did not follow a strict interpretation of Keller's tenets and his learners performed extremely poorly. While many features of PSI are good instructional design features (Moore & Kearsley, 1996), selecting some of the features based upon personal preference does not create a PSI experience. The only other version that attempts to fulfill the criteria for a PSI course is CAPSI (Pear & Kinsner, 1988; Pear & Crone-Todd, 1999). The remainder of the discussion will focus on comparing CAPSI with the version of PSI that was developed for this product.

Both CAPSI and this product allow self-pacing. However, in the description of CAPSI, there was no Incomplete option, as Keller (Keller & Sherman, 1974, chap. 3) recommended. Instead, learners were told how many earned points would merit an A, a B, etc. That appears to hinder the idea of learning for mastery, as learners could settle for a lower grade in order to make the end of the semester deadline. In CAPSI, the objectives are written as study questions, and not as objectives (Pear & Kinsner, 1988).

In this product, the proctor is a graduate student with content expertise who is paid to grade student work and provide assistance. CAPSI relied upon internal proctors that is, other learners in the course to grade all assignments. Furthermore, in CAPSI, students controlled the progress of other students (Pear & Kinsner, 1988). Caldwell (1985) asserted that a major problem of using other students within the course to grade quizzes is that they wanted to help out their peers. Laham (1978) also found that when students acted as proctors, the grading was less rigorous than when the student self-graded the quiz. It seems as though there would be a greater chance of learners not fully mastering the material if other learners were grading. However, by using learners to grade the quizzes, they do escape the limitations (such as inflexibility) of computer-graded systems.

This product used a mixed format of questions for the quizzes, per Sherman's

(Keller & Sherman, 1974, chap.4) recommendations. Also, in this current version of computerized PSI, quiz questions are not identical to study guide questions. In CAPSI, the quiz questions consist of three randomly generated study questions that students had

Table 7.

Comparison of existing computerized versions of PSI to this version of PSI.

	Small units/mastery Criterion	Self-pacing	Use of lectures for motivation	Emphasis on verbal/written communication	Use of immediate feedback
PROCTOR (Crowell et al., 1981)	-	+	-	+	+
CAPSI (Pear & Kinsner, 1988, Pear & Crone-Todd, 1999)	+	+	-	+	+
Crosbie/Kelly (1993)	-	+	-	+	+
Brothen & Wambach (1996) Brothen & Bazarre (1998)	-	+	-	+	+
Price (1999)	-	+	-	+	+
Davis et al. (2000)	-	+	-	+	-
Liu (2003)	+	+	-	+	+

+ indicates presence of the feature - indicates absence of the feature

an hour to answer (Pear & Kinsner, 1988). Clearly, this does not follow Sherman's (Keller & Sherman, 1974, chap.4) suggestions that quiz questions should not replicate study guide questions and that quizzes be completed within 15-20 minutes.

Both CAPSI and this PSI product focus on the written word. However, CAPSI feedback is not as prompt as this newer product's feedback is. CAPSI feedback comes only from another learner in the course. Feedback could take as long as 24 hours in the

CAPSI course. (Pear & Kinsner, 1988). Finally, CAPSI does not use a mixed format of questions in the quizzes (Pear & Kinsner, 1988), as Sherman (Keller & Sherman, 1974, chap.4) recommends. Finally, CAPSI is a program that must be downloaded, rather than a dynamic system accessible from any public computer with Internet capabilities.

Advantages to Using PSI

Traditional Keller courses have continually produced superior learning and greater learner enjoyment in a variety of subjects (McMichael & Corey, 1969; McMichael & Corey, 1971; Hoberock, Koen, Roth, & Wagner, 1972; Austin & Gilbert, 1974; Kulik, Kulik, & Cohen, 1979). The student evaluators indicated that the features of the PSI course would benefit their learning. In addition, based upon the student evaluators' comments, it appears as though distance learners would very much enjoy this format.

In the particular context of ITMA, the grader of this PSI course would not have to grade learner assignments since, in a PSI course, the grade is determined by the performance on the quizzes alone. The role of the grader for this course would be to provide feedback when the learner asked for it or when the quizzing system asked for review of a learner's quiz question. Hopefully, the amount of time spent grading would be less, allowing the grader to perform other duties.

Another advantage of using PSI is the careful construction of clear objectives, where assessments and activities are directly related to the objectives. Many Universities require accreditation and having clearly defined objectives for each course with clear assessment items for each objective could help the accreditation process (K. Potter, personal communication, Mar. 2003). Because the system records all quizzes, learner progress, feedback, and learner explanations, this data could be analyzed for research purposes.

Disadvantages of using PSI

Although the benefits for the learner are great as noted, there are some disadvantages to using PSI. This study confirms that the main disadvantage is development time. PSI materials take a long time to develop (Sherman, 1972; Greenspoon, 1974). Keller (Keller & Sherman, 1974, chap. 9) states that one practitioner spent 32 hours a week on his PSI course. Although the study guide development is fairly

straightforward, it was the study guide questions, feedback, and quizzes that took up the bulk of the time for this PSI course.

Coming up with three different versions of one question was quite arduous and, at times, boring. According to Sherman (Keller & Sherman, 1974, chap.4), "Devoting a full summer to the preparation of materials for a one semester course is about right." (p. 49). Unfortunately, most developers do not have that luxury. Good instructional design takes a great deal of time. At this point, it is hard to say whether Keller's PSI takes more or less time than other instructional design models.

Caldwell (1985) noted that writing specific objectives limits the quiz questions. This was also the case for this PSI course. Objectives had to be written specifically, yet three versions of the quiz had to be made, with every version different. Eventually, the format of the quiz questions had to be varied because the objectives were so specific. At times different examples were created for quiz questions, but, for the majority of questions, the format was the major difference. While this is not a disadvantage per se, it did make writing quiz questions more mundane. One of the positive things about PSI, however, is that every quiz question is objective-referenced, so the questions are established from the beginning.

Finally, the amount of judgment a computerized grading system possesses is not as discerning as a human grader. The grading of the quiz was not "fuzzy" in that learners must enter the exact answer with no deviations. It was taxing to input different variations on an answer in an attempt to anticipate possible and acceptable differences. As with any computer-graded system (such as Blackboard ™ or a textbook course), the possibilities for errors in grading exist. The advantage of the system created here though is that learners can email a grader immediately if something goes wrong or even explain the answer in the textbox. The limitations of grading are due to the technology and not the fault of the Keller system.

Observations on this Project

Although the student evaluators in this study very favorably reviewed this product, there are a few points that should be expanded. The first is that the student

evaluators did not actually take the units of instruction as if they would for a course. This means that the student evaluators could only conjecture on the learning benefits and enjoyment of the features. Another item is that these student evaluators were involved in the ITMA program, and that the author of this dissertation, is the ITMA student coordinator. There is a possibility that this relationship biased their comments. Finally, although an evaluation checklist was developed to guide their evaluations, it is impossible to know how thorough they were in the evaluation. They might have evaluated all eight units, or only three units. At any rate, although their impressions are favorable and positive, it is important to keep these considerations in mind.

Overall Conclusions on this Online PSI Project

This project's goal was to create a PSI experience in an online environment. This goal was attained. The two expert evaluators concluded that this project faithfully replicated the traditional Keller course in an online environment. Overall comments by them included an "outstanding job on adapting the PSI system to a modern, computer-assisted environment" and "a very sophisticated combination of PSI design, content and user support." When asked if they would enjoy an online course that used PSI, the student evaluators all agreed that they would. They also agreed that the features in PSI would have learning benefits for them. The student evaluators' comments let to two conclusions: this course format is enjoyable and that there are learning benefits to using this format.

Based upon the student evaluators' positive comments about how they would enjoy the PSI format, an entire online three-credit PSI course might increase learner enjoyment of a course in the distance environment. Now that the programming code exists for using PSI, it would be possible to construct future ITMA courses along these principles or to revise existing ITMA courses. While it is an arduous process, revisions could be scaled up over time. For example, a course designer could first write the objectives for an existing course. Next, the study questions and feedback could be created, and then create one quiz, and so forth. Although all student evaluators stated that they would enjoy a three-credit course that uses the PSI format, it is important to note that one ITMA evaluator said she would not want every three-credit course to be in this format. Naturally, it would not be a true PSI course until all Keller's tenets were in place.

The student evaluators did express an interest in having alternate presentation formats. However, simply creating and using multimedia instruction could be detrimental to the purity of this Keller system because it would remove emphasis on the written word. To maintain the fidelity of the PSI system, one way to introduce a different presentation format would be to use streaming video lectures in the way that Keller (1968) originally intended (as rewards for meeting a certain level of mastery). When learners had attained a certain level of mastery, they would be rewarded with a lecture (in the online environment, it could be streaming video).

This project shows that using Keller's PSI as a design model for online learning can be done using a dynamic, database driven system. Expert evaluators found that this computerized PSI replicated the traditional PSI course materials and processes. The five student evaluators liked the course features and felt that they would be beneficial to learning. It seems as though using PSI to design online courses is a viable option, but using PSI also comes with the problems, as well as the advantages, inherent to traditional PSI courses.

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Appendix A: Sherman's (1974) Recommendations for a PSI Course

Major Decision Category	Sub Categories	Sherman's Recommendations	Included in this Modified PSI
Materials	Number of Units	One Unit/Week/Semester	Yes
	Unit Size	Testable in 15-20 minutes	Yes
	Unit Sequence	Determined by course content, but initial units should yield a high success rate	Yes
	Review Units	Should be incorporated throughout units	No, this is not an entire course, and the units are not sequential. Review units would not be logical.
	Amount of Material Covered	4/5 of the normal course content	No, this is not an entire course.
	The Study Guide	Includes introduction, statement of objectives, study questions, procedure	Yes
Course Policy	Test Format	Tests on each and every major unit objective and questions relate to objectives. 15-20 minutes test-taking time. Format of test is determined by content. Three alternate tests. Mixed format of questions.	Yes
	Proctor Materials	Information for the proctor to guide the testing process.	No. The computer grades the quizzes and the ITMA grader is selected for content expertise.

	Grading Policy	Have either grade A or I. Equate a letter grade with the number of completed units. Vary course credit depending on number of completed units.	ITMA policy dictates that students receive an Incomplete until the course is completed. In order to earn an A, all work must be completed.
	Final Exam Policy	Have a final exam worth 25% of the total grade.	Not applicable.
	The Early Final	Make an early final available.	Not applicable.
	Incomplete Policy	Allow incompletes to span interminably.	Yes. This is ITMA policy.
	Unit Test Rules	One unit test per day. Three attempts/unit. Two attempts/day.	Learners are allowed to attempt the quiz two hours after failing the first attempt. There is no limit on the number of unit tests/day.
	Statement on the meaning of "pass"	90% correct	Yes
Implementation	Proctor Assignment	Advanced undergraduates, graduate student, or a fixed group of students	Yes. Graduate students in Instructional Technology.
	Internal Proctors	Students who are ahead of other students in the course	No.
	Class Hours	Slightly more than an average on-campus course	Not applicable.

	Special Announcements	Communication should be facilitated between instructor and students	Not applicable.
	Physical facilities	Large room	Not applicable.
	Study guides and other materials	Not restricted based on number of units passed. Too hard to prevent copying.	Yes.
	The tests	Alternate forms of tests that are presented randomly.	Alternate forms are presented, but not randomized. Randomization was to prevent cheating between on campus students.
	Proctor folders	Proctor materials assembled in folders.	Not applicable
	Course manager	Large courses, one person manages course materials and record keeping.	Yes. Performed by computer.
	Proctor	Tests students' knowledge	Yes, although proctor is a combination of computer and ITMA grader.
	Student	Studies at own pace and takes tests	Yes
	Instructor	Monitor system, arbitrate, develop course, communicate with students	Yes

All content for this table is from Sherman (Keller & Sherman, 1974, chap. 4)

Appendix B: An example of a study materials for Unit 1

Assignments

Course Overview

Study Guide for Unit One - Different Psychological Perspectives on Learning and Instruction

Introduction

When you entered the program, you might have had a specific idea of what learning and instruction were. But, since you've taken Learning Theories for Instructional Design and Instructional Design, you're understanding may have changed. As you go through the program, you should reflect on how your understanding of learning and instruction and how it has changed.

Hopefully, this unit will provide some thought-provoking descriptions of learning and instruction. This unit will introduce you to the definitions of learning and instruction within the field of Instructional Technology as defined by the authors of your textbook. You will also learn about the similarities and differences between four psychological perspectives with regard to learning and instruction. Technology and humanism can exist side by side in the instructional environment. After this unit, you'll have a better understanding of how technology and humanism are represented in the environment. Don't be surprised if some of these definitions are different from what you thought!

Objectives

1. Without the use of course notes or the textbook, learners will define learning as the development of new skills, knowledge or attitudes as an individual interacts with information and the environment.
2. Without the use of course notes or the textbook, learners will define instruction as the arrangement of information and environment to facilitate learning.
3. Without the use of course notes or the textbook, learners will define learning environment as the physical facilities, the psychological atmosphere, instructional methods, media, and technology.
4. Without the use of course notes or the textbook, learners will compare and contrast behaviorism, cognitivism, constructivism, and social psychological perspectives on learning and instruction.
5. Given a scenario where instruction could be improved and without the use of course notes or the textbook, learners will recommend 3 successful learning practices that are supported by all four psychological perspectives.
6. Without the use of course notes or the textbook, learners will interpret the diagram of the technology - humanism interaction by identifying examples of the four instructional conditions.

Procedures

Read pages 6-9 in Chapter One, Media, Technology, and Learning.

At the end of the reading and studying, you should be able to answer the study questions below with minimal reference to the book. When you feel you have mastered the material, you may proceed to take the unit quiz. Remember that the quiz asks about the unit objectives, so you should focus your attention on mastering that material. Upload your study questions to your filebox when you finish answering them and keep the URL handy. You may need to enter that URL after you take the quiz.

When you feel ready to take the quiz, click here.

(You may want to review the course policies regarding the quiz before taking it.)

Study Questions

1. Write out the definitions to learning, instruction, and learning environment. What does the

following sentence fragment describe?
"... the arrangement of information and the psychological atmosphere, instructional methods, media, and technology to facilitate the development of new skills, knowledge or attitudes as an individual interacts with information and the environment."
2. List three characteristics each of the behaviorist, cognitivist, constructivist, and social psychologist perspective on learning. As an educator, do you think that any one perspective is better or worse? Why?
3. Describe the behaviorist, cognitivist, and constructivist approaches to instruction. Write 3-4 sentences about each approach. What would a classroom look like for each of these perspectives? Which perspective does your instructional setting most closely resemble?
4. List the six successful instructional practices that all four psychological perspectives support with a brief description of each. How many of these do you incorporate in your instruction? Can you recall an instance when you revised your instruction to include more of these practices? Why did you do it? Did it work? If you have not revised instruction, can you recall a case where you were the student and you felt like you could have benefited from more of these practices? Why?
5. Give an example of what instruction would look like if:
There was low technology and low humanism
There was low technology and high humanism
There was high technology and low humanism
There was high technology and high humanism
Want some help?

top

Assignments

Course Overview

Guidance and Clarification on Study Answers for Unit One

This page will guide your study for Unit One - Different Psychological Perspectives on Learning and Instruction by providing some helpful direction on study questions.
1. Write out the definitions to learning, instruction, and learning environment. What does the following sentence fragment describe?
"... the arrangement of information and the psychological atmosphere, instructional methods, media, and technology to facilitate the development of new skills, knowledge or attitudes as an individual interacts with information and the environment."

- *You can find the definitions to these terms on page 6 in your textbook. Remember that you will be responsible for committing these definitions to memory on the exam.*
- *For the second question, try substituting in some terms for the definitions.*

2. List three characteristics each of the behaviorist, cognitivist, constructivist, and social psychologist perspective on learning. As an educator, do you favor one perspective over the others? Why?
It might be helpful to think of each style in this way:

- *behaviorism - Learning is largely the result of environmental events. Learners have learned if you can view a difference in behavior (response) after receiving instruction (stimulus).*
- *cognitivism - Learning can occur without a visible change in the learner. Learning is a process of relating new information to previously learned information.*
- *constructivism - Learning is constructed from new information by processing it with previously existing knowledge. Learning will be different for each person and is directly*

uncontrolled by the instruction.

3. Describe, in 3-4 sentences each, of the behaviorist, cognitivist, and constructivist approaches to instruction. What would a classroom look like for each of these perspectives? Which perspective does your instructional setting most closely resemble?

- *It might be helpful to think of each style in this way:*
- *behaviorism - Learning is largely the result of environmental events. Learners have learned if you can view a difference in behavior (response) after receiving instruction (stimulus).*
- *cognitivism - Learning can occur without a visible change in the learner. Learning is a process of relating new information to previously learned information.*
- *constructivism - Learning is constructed from new information by processing it with previously existing knowledge. Learning will be different for each person and is directly uncontrolled by the instruction.*

4. List the six successful instructional practices with a brief description of each. How many of these do you incorporate in your instruction? Can you recall an instance when you revised your instruction to include more of these practices? Why did you do it? Did it work? If you have not revised instruction, can you recall a case where you were the student and you felt like you could have benefited from more of these practices? Why?

- *Keep in mind that these instructional practices are the ones that all three perspectives on instruction can agree on.*

5. Give an example of what instruction would look like if:

- There was low technology and low humanism
- There was low technology and high humanism
- There was high technology and low humanism
- There was high technology and high humanism
- *Remember that humanism is the degree of presence of the instructor or other learners within instruction and learning. Technology is the degree of presence of instructional media within instruction and learning.*

Still have questions? email itmahelp

top
Back to Study Guide

Appendix C: Checklists for theoretical aspects evaluation

Materials Checklist

Criteria	Yes	No	Comments
Unit Size			
Unit could be completed within one week.			
Is the unit size testable within 15-20 minutes?			
Study Guide			
Study guide includes: Introduction, Objectives, Study Questions, and Procedures			
Introduction introduces material and captures the interest of the audience.			
Objectives clearly state what the learner should be able to do (behaviorist) at the end of the instruction.			
Study questions are comprehensive over unit objectives.			
Study questions do not duplicate quiz questions.			
Procedures section clearly tells learners what they must complete in order to cover unit objectives.			
The guidance for study questions clarifies, explains, and helps (Keller 1974).			
Quizzes			
There are three versions of each quiz.			

Each unit objective is tested on each quiz. *			
The quiz could be completed within 15-20 minutes.			
Each quiz has a mixed format of questions (multiple choice, true/false, matching, short answer, etc)			

* You can view the quizzes and the objectives at the end of this unit packet.

Overall Materials Evaluation

Please circle Yes or No for each question, and, if you like, provide some comments that further clarify your position.

1. Do you think that the self-pacing described within the ITMA program replicates Keller's idea of self-pacing?

Yes No

Comments:_____
_____
_____
_____

2. Do you agree that omitting lectures and demonstrations as "rewards" for learning is an acceptable omission that does not compromise Keller's system?

Yes No

Comments:_____
_____
_____
_____

3. In this version of PSI, is the emphasis on the written word?

Yes No

Comments:_____
_____
_____
_____

4. Are the first two units easier than the remaining units?

Yes No

Comments:_____
_____
_____

_____

5. Does the course introduction clearly communicate to the student the intent and processes of Units 1-8? (See attached)

Yes No

Comments:_____
_____
_____
_____

6. Overall, are the materials viewed here representative of Keller's original ideas and Sherman's recommendations?

Yes No

Comments:_____
_____
_____
_____

Online Evaluation Checklists

Evaluation Checklist for Study Hall Proctors

Criteria	Yes	No	Comments
Does the feedback on the "guidance and clarification" pages help clarify the information prior to the quiz?			
Does the access to an ITMA grader for help at any time during the instruction help fulfill the role of the study hall proctor?			
Is the combined functionality of the computer-generated feedback and the ITMA grader represent a study hall proctor?			

1. Most PSI systems do not have a "study hall proctor". However, Keller (1974) recommended one. Do you think it is an integral feature to the PSI system?

Yes No
Comments:_____
_____
_____

Evaluation for "Grading Proctor"

Criteria	Yes	No	Comments
Administrative functions – performed by computer			

Records the student name and scores for quizzes			
Assigns new quizzes based upon previous progress			
Scores each quiz			
Presents three versions of quiz			
Does not allow student to take the same version of the quiz			
Restricts access to future quizzes if student fails quiz			
Permits access to next quiz when a score of 90% or more is achieved			
Grading functions – performed by computer			
Grades quizzes			
Provides feedback on objectives for missed quiz questions			
Provides score for each quiz			
Grading functions – performed by ITMA grader			
When student scores between 80-90%, reviews student explanations to determine if mastery learning has occurred			
When student fails exam two or three times, reviews student study question answers to clarify student understanding			
Can change grades and intervene on behalf of student			

1. Overall, does the combination of computer system and ITMA grader yield a level of functionality similar to the "testing proctor" in the original Keller system?

Yes No
Comments:_____
_____
_____

2. After a student fails a quiz, they have two hours before they can take it again instead of 30 minutes (as recommended by Keller) to encourage a deeper level of learning. (This function was disabled for the purposes of this review). Do you agree with that decision?

Yes No
Comments:_____
_____
_____

3. ITMA graders are graduate students in the Ph.D. program in Instructional Technology at Virginia Tech. They are paid to grade student work in our Master's of Instructional Technology courses and become familiar with the courses and content. Are they good candidates for a Keller "testing proctor"?

Yes No
Comments:_____
_____
_____

4. Keller (1974) states that if too many wrong answers (failure) are found, “the grading operation stops right there” and the student is “advised to study further before coming to be tested and graded.” In this system, when a student fails, they are given brief feedback on the objectives that they need to study. Do you think this feedback should be eliminated?

Yes No
Comments:_____
_____
_____

5. In the case of a student who scores between 80-90%, they are provided with an opportunity to explain their incorrect answers in writing to an ITMA grader via email. Although one of the Keller tenets is emphasis on the written word, Keller (1974) had this explanation occur verbally. Do you think that having the explanation in writing is acceptable?

Yes No
Comments:_____
_____
_____

6. Please share any additional comments you have:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix D: Formative evaluation checklist

Criterion	Yes	No	Comments
Does the webpage follow ITMA style guidelines?			
Is the text font clear?			
Is the layout functional?			
Are the navigation controls easy to use?			
Are there any inconsistencies on the page, with regard to text font, color, or layout?			
Do the links work?			
Are there spelling errors?			
Are there grammar errors?			
Does this page clearly communicate the processes of this course?			

Formative Evaluation for Unit 1 Study Guide

Criterion	Yes	No	Comments
Study Guide			
The instructional media chapters were divided into smaller units. Do the divisions make sense? That is, are the units coherent and 'stand alone'?			
Does the webpage follow ITMA style guidelines?			
Is the text font clear?			
Is the layout functional?			
Are the navigation controls easy to use?			
Are there any inconsistencies on the page, with regard to text font, color, or layout?			
Do the links work? (quiz, itmahelp email, "Want some help", assignments)			
Are there spelling errors?			
Are there grammar errors?			
Does the content in the study guide coincide with the course objectives?			
Does the introduction introduce the material?			
Do the objectives clearly communicate what the learner should be able to do after the instruction?			

Are there any objectives that could be improved or clarified?			
Do the procedures clearly communicate what the learner needs to do to complete the unit?			
Are the uploading instructions clear?			
Are the processes for taking the quiz clear? (learners know where to click to access quiz?)			
Do the study guide questions reflect the objectives?			
Guidance and Clarification Page			
Is there feedback for every study question?			
Does the feedback provide clarification for the instruction?			
If there are interactive links, do they work?			
Is the interactivity appropriate?			
Are there spelling errors?			
Are there grammar errors?			

Evaluation for Unit 1 Quizzes

Criterion	Yes	No	Comments
Were you able to login to the quiz system?			
Did the system show your name as the learner?			
Are there three quiz versions for each unit?			
Are the instructions for taking the quiz clear?			
Did the computer score your quiz correctly?			
Does the feedback on the missed questions refer to the correct objective?			
When shown the URL textbox, could you enter your URL?			
Did you know what the navigation buttons meant/indicated?			
Were you able to explain an incorrect answer in the textbox if you scored between 80-89%?			
Did you know what you had to do after each quiz? (take another quiz, move to another unit, wait for the grader?)			
Could you view your quiz grades?			
Could you view your quiz			

progress?			
Are the navigation controls consistent?			
Are the navigation controls easy to use/understand? (you know what each control does)			
Did you have any difficulty using the quizzing system?			
Is the quiz format attractive?			
Is there consistency in text font/color on the quiz?			

What improvements would you make to the quiz interface?

Evaluation for Grader Interface

Criterion	Yes	No	Comments
Were you able to login to the grader system?			
Were you able to view learner explanations in the 80-89% score?			
Were you able to accept student explanations in order to change their score?			
When learners had entered a URL, were you able to view it?			
Were you able to assign a new quiz to students if you had changed their grade?			
Could you view learners' quiz grades?			
Could you view learners' quiz progress?			
Are the navigation controls consistent?			
Are the navigation controls easy to use/understand? (you know what each control does)			
Did you have any difficulty using the grading system?			
Is the grading format attractive?			
Is there consistency in text font/color in the grading system?			

What improvements would you make to this grader interface?

Overall Evaluation

Please note any other improvements that can be made to any materials that would make this process easier.

Appendix E: Small group Evaluation

Evaluation questions	**Reference**
Summative Evaluation for the PSI Units Unit Length *The following two questions ask about the overall length of the instructional units.* **1. In terms of time, the length of the quizzes was reasonable for an ITMA student.** ○ Strongly agree ○ Agree ○ Disagree ○ Strongly disagree **2. I could have completed one unit within a week.** ○ Yes ○ No **Please add any additional comments you have on *the length of the individual units* or on *the length overall*.**	Dr. Metzler suggested I ask the students the first two questions.
	Questions 3-6 focus

Study Guides/Clarification Material *The next questions ask about the study guides and the accompanying clarification material.* **3. The introductory material in each of the the Unit Study Guides established the focus of that unit.** ○ Strongly agree ○ Agree ○ Disagree ○ Strongly disagree **4. The objectives in each Unit Study Guide were clearly written.** ○ Strongly agree ○ Agree ○ Disagree ○ Strongly disagree **5. The study questions on the study guide were relevant to me.** ○ Strongly agree ○ Agree ○ Disagree ○ Strongly disagree **6. On the Guidance and Clarification pages, the feedback given via pop up screens helped clarify the instruction.** ○ Strongly agree ○ Agree ○ Disagree ○ Strongly disagree **Please add any additional comments you have on the Study Guides and "Guidance and Clarification" pages of the *individual units* or on the Study Guides and "Guidance and Clarification" pages of the *units overall*.**	on the instructional materials and address Keller and Sherman's recommendations about the study guides. They are also based on Hess (1971)

Questions 7-10 ask about the features of the online quizzing system.

Quizzing Interface

The next set of questions ask about the quizzing processes.

7. The quizzing interface was easy to use.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

8. If I scored between 80-90%, I would use the option of explaining my answer to a grader.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

9. If I missed a question on the quiz, I would use the feedback to review specific objectives I missed.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

10. I would upload my study questions for an ITMA grader to review if I failed the first attempt at a unit quiz.

- Strongly agree
- Agree
- Disagree
- Strongly disagree

Please add any additional comments you have on *individual quizzes*, *the quizzing interface*, or any of the quizzes *overall*.

Questions 11-15 ask about the benefits to the learning and the enjoyment of the course format. These are based on questions asked by Hess (1971) and Nelson and Scott (1974)

Overall Learning

The next two questions ask about learning benefits.

11. Which of the course features would benefit your learning the *most*? Please select *all* that apply.

- Mastery learning - you must score 90% or higher on the previous quiz before taking the next one
- Feedback - Automatic feedback on the guidance and clarification pages
- Feedback - Automatic feedback on the quizzes when you missed a question
- Feedback - Feedback from an ITMA grader when you provided an explanation on the quiz

☐ Self-pacing - Moving through the material at your own pace

☐ Smaller units of material - Textbook chapters were cut to make smaller, more numerous units

☐ Emphasis on the written word - All instruction and feedback is written

☐ None of the features

Why do you think so?

12. Which of the course features would benefit your learning the *least*? Please select *all* that apply.

☐ Mastery learning - you must score 90% or higher on the previous quiz before taking the next one

☐ Feedback - Automatic feedback on the guidance and clarification pages

☐ Feedback - Automatic feedback on the quizzes when you missed a question

☐ Feedback - Feedback from an ITMA grader when you provided an explanation on the quiz

☐ Self-pacing - Moving through the material at your own pace

☐ Smaller units of material - Textbook chapters were cut to make smaller, more numerous units

☐ Emphasis on the written word - All instruction and feedback is written

☐ None of the features **Why do you think so?**	
Please add any additional comments you have on learning benefits.	
Overall Questions *The final set of questions asks you about your overall opinion on this method of instruction.*	

13. Which features of the course did you like? Please select *all* that apply.

☐ Mastery learning - you must score 90% or higher on the previous quiz before taking the next one

☐ Feedback - Automatic feedback on the guidance and clarification pages

☐ Feedback - Automatic feedback on the quizzes when you missed a question

☐ Feedback - Feedback from an ITMA grader when you provided an explanation on the quiz

☐ Self-pacing - Moving through the material at your own pace

☐ Smaller units of material - Textbook chapters were cut to make smaller, more numerous units

☐ Emphasis on the written word - All instruction and feedback is written

☐ None of the features

Which feature did you like the best? Why?

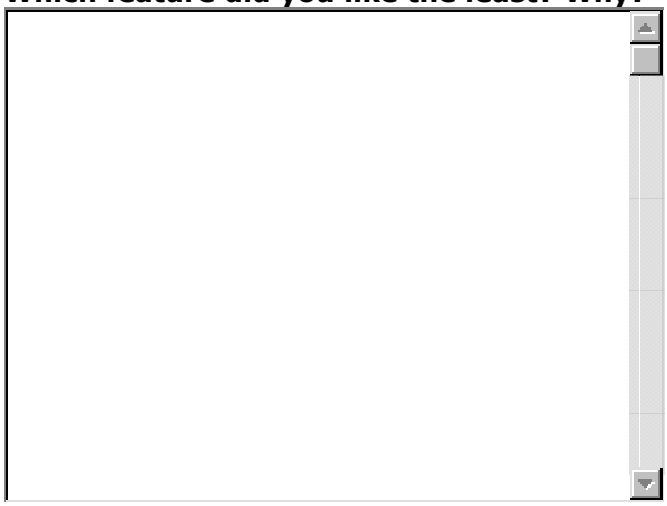
14. Which of the features did you like the least? Please select *all* that apply.

☐ Mastery learning - you must score 90% or higher on the previous quiz before taking the next one

☐ Feedback - Automatic feedback on the guidance and clarification pages

☐ Feedback - Automatic feedback on the quizzes when you missed a question

☐ Feedback - Feedback from an ITMA grader when you provided an explanation on the quiz

☐ Self-pacing - Moving through the material at your own pace ☐ Smaller units of material - Textbook chapters were cut to make smaller, more numerous units ☐ Emphasis on the written word - All instruction and feedback is written ☐ None of the features **Which feature did you like the least? Why?**  **15. Do you think that you would enjoy a course that uses this instructional method?** ○ Strongly agree ○ Agree ○ Disagree ○ Strongly disagree **Why or why not?**	

Please add any additional comments you have on this overall method of instruction.

CURRICULUM VITA

Hope Q. Liu

hopeless@vt.edu

EDUCATION

Ph.D., Curriculum and Instruction, (Instructional Technology Concentration), May 2003.

Virginia Tech, Blacksburg, VA.

- Dissertation: Development of an Online Course Using a Modified Version of Keller's Personalized System of Instruction

M.S., Biology, May 1996. University of Notre Dame, Notre Dame, IN. 3.7 GPA

- Thesis: Vector Status of Aedes triseriatus (Say) in Nicholas County, West Virginia, A Newly Recognized Focus of La Crosse Virus (Bunyaviridae: Bunyavirus)

B.S., Biology, May 1994. Virginia Tech, Blacksburg, VA.

RESEARCH INTERESTS

Instructional Design for Online Learning

Characteristics of Online Learners

TEACHING INTERESTS

Teaching online courses in a 100% online or blended environment.

Specific courses include:

- General Biology
- Instructional Design
- Educational Research
- Distance Learning

RELATED EXPERIENCE

- Research
    - Development of an Online Course Using a Modified Version of Keller's Personalized System of Instruction: This developmental dissertation focused on using Keller's Personalized System of Instruction (PSI) to instruct in an online environment. I created eight instructional units and designed a dynamic database system to manage and grade the learners' work. Experts of PSI, as well as a small group comprised of online learners, evaluated my finished product.
    - Co-investigator on American Sociological Association grant that investigated student perceptions of technology-enhanced instruction. May 2002- 2003. Funded in the amount of $1000.
    - GROVER: As a member of this graduate research organization in virtual environments, I helped investigate the role of context in learning by designing an experiment that tested how well middle school students could learn an algorithm from a computer game compared to a computer experience that was not a game. Presented at AECT 2001 and published in AECT selected papers in 2003.
- Teaching and Related Experience
    - Administrator/Student Coordinator of Virginia Tech's Instructional Technology Master's of the Arts online program (ITMA) (2001-present)
        - Coordinated matriculation and registration procedures, tracked progress, and assisted in the graduation of 200+ distance learners. Managed all

electronic communication with learners and provided learner support for administrative, course-related, and technical problems. Designed, developed, and evaluated Web-based courses developed in Dreamweaver 4.0 and Blackboard 5.0. Recruited new students nationwide and assisted in finding solutions to scalability issues in distance education.

- Intern at American Family Insurance - American Family Insurance Education Division, National Headquarters, Madison, WI (2001)
  - Analyzed corporate culture, technical issues, and instructional issues related to e-learning. Designed, developed, and began implementation of the corporation's e-learning strategy. Wrote and presented accompanying report that analyzed the state of e-learning at American Family and recommendations for future e-learning enterprise. Initiated research on knowledge management report for the Education Division. Assisted in the evaluation of the corporate learning management system. Participated in the Common Look and Feel committee of the Division website. Assisted in the development of Best Practices committee report. Re-wrote all of the Claims Department's instructional objectives.
- Technical Support for Faculty and Staff within College of Human Resources and Education, Virginia Tech (2001)
  - Provided computer technical assistance to College faculty and staff by installing software/hardware and removing viruses.
  - Designed and developed an introductory Excel training manual to College Staff.

- Delivered face-to-face instruction on Excel to College Staff.

- Laboratory Instructor, Department of Biology, Virginia Tech, Blacksburg, VA, January 2000-May 2000, August 1996-May 1997
  - Taught three weekly laboratory sections for general and principles of biology
  - Designed and implemented a novel teaching method for scientific writing that is the basis for future honors' classes
  - Developed extensive class website.
  - Responsibilities included: syllabus design, lecture preparation, grading, and all other aspects of the course
- Laboratory Instructor, Department of Entomology, Virginia Tech, Blacksburg, VA, January 1999-May 1999, January 1998-May 1998
  - Taught two weekly laboratory sections for Medical/Veterinary Entomology
  - Responsibilities included: grading, lab preparation, quiz design, and reorganizing the teaching collection
- Laboratory Instructor, Department of Entomology, Virginia Tech, Blacksburg, VA, August 1997-December 1997
  - Taught one weekly laboratory course for Aquatic Biomonitoring
  - Assisted students in a semester long biomonitoring project that included field specimen collection, experimental design and data analysis
  - Graded student reports and homework

- Laboratory Instructor, Department of Biology, University of Notre Dame, Notre Dame, IN, August 1994-May 1995, August 1995-May 1996
  - Taught three weekly classes of general biology for pre-professional students
  - Responsibilities included: lab lecture preparation, quiz grading, and paper grading

PRESENTATIONS/PUBLICATIONS

Kline, J., Van Gundy, K. and Liu, H. (2003) Student Perceptions of Technology-based Teaching Methods. Paper to be presented at National American Sociological Society meeting. Atlanta, GA.

Liu, H. & Kellogg, A. (2003). Contextualizing the Changing Faces in an Online Master's Program. Paper presented Eastern Educational Research Association, Hilton Head, SC.

Kellogg, A. & Liu, H. (2003). The Effects of Deadlines on Student Pacing in an Online Master's Program. Paper presented at the Eastern Educational Research Association. Hilton Head, SC.

Kellogg, A. & Liu, H. Online Assessment. (2003) Paper presented at Maryland Assessment Group. Ocean City, MD.

Liu, H. (2002). OLIPSI: An Online Integrated Personalized System of Instruction. Paper presented at the Annual Meeting of the Association for Educational Communications and Technology. Dallas, TX.

Ogle, T., Schneider, S., Liu, H., Saenz, B., Macedo, P., & Farrell, I. (2001). Examining the Socio-Cognitive Relationship Between Context and Performance. Paper

presented at the Annual Meeting of the Association for Educational Communications and Technology. Atlanta, GA.

Ogle, T., Schneider, S., Liu, H., Saenz, B., Macedo, P., & Farrell, I. (2001). Examining the Socio-Cognitive Relationship Between Context and Performance. Paper presented at the Annual Meeting of the Association for Educational Communications and Technology. Atlanta, GA. To be published in the 2003 Selected Readings of the AECT.

Nasci, RS, Moore, CG, Biggerstaff, B, Panella, NA, Liu, HQ, Karabotsos, N, Davis, B, Brannon E. La Crosse Encephalitis Virus Habitat Associations in Nicholas County, West Virginia. J Med Entomol 2000;37:559-70.

Ross, Mary H, Liu, Hope Q. Hybridization Studies on Blattella germanica and B. asahinai (Dictyoptera: Blattellidae): chiasma frequency and distribution. Annals of the Entomological Society of America v 88, March 1995. P 215-219.

HONORS/AFFILIATIONS

AECT Member

ASTD Member

EERA Member

MAG Member

American Mosquito Control Association: Honorable Mention in Outstanding Presentation 2000 Student Competition

The 1999 James McD Grayson Scholarship for Outstanding Achievement in Graduate Study Leading to the Ph.D. Degree, Department of Entomology, Virginia Tech

Sigma Xi, The Scientific Research Society, 1999-2000

Gamma Sigma Delta, 1999-2000

Fellowship for Women and Minorities in the College of Agricultural and Life Sciences

1998