Keller's Personalized System of Instruction: Was it a Fleeting Fancy or is there a Revival on the Horizon?

Heidi L. Eyre

Keller's Personalized System of Instruction dominated the literature in the teaching of psychology and behavior analysis in the 1970s and 1980s. After this brief flourish of interest, PSI research trickled off to a nearly imperceptible stream in the 1990s. However, with the increasing availability and ease of use of computers and the internet, along with demand created by an ever-growing need for distance education, PSI is beginning to curry favor among a new generation of faculty members. The question of whether this resurgence of interest will be permanent revival or fleeting fancy will depend on how researchers deal with the PSI paradoxes that stymied the researchers of the 1970s and 1980s. This article will review the current state of PSI research including the riddles left to be untangled, illustrate how computers have affected the PSI movement, and discuss the role PSI might play in distance education.
Keywords: Personalized System of Instruction, PSI, Mastery-Based Learning, Distance Education, Fred Keller, Keller Method, Keller Plan, Mastery.

Keller's Personalized System of Instruction

Keller created the Personalized System of Instruction (PSI) in the late 1960s in order to help students in Brazil be able to learn course material without an instructor standing by their side. Soon after, he brought his PSI program back to the United States. Due to its heavy reliance on behavioral principles, it was quickly adopted by many psychology professors and by individuals outside of psychology. Keller (1968) outlined five basic components that he deemed to be essential for a PSI class: (1) mastery of course material, (2) the use of proctors, (3) self-pacing, (4) stress upon the written word, and (5) use of lectures and demonstrations primarily for motivational purposes.

In a standard PSI course, the course material is broken down into small units of study (e.g., one textbook chapter). The unit mastery component requires that students learn this small quantity of information and pass a test over this information by reaching some mastery criterion (e.g., 80%, 85%, 90%, or 95% correct). If students do not reach the mastery criterion then they restudy the information and retake the unit test as many times as it takes for them to demonstrate mastery of the material. Course credit is awarded when the unit has been mastered and there is no penalty imposed for not passing a unit test on a given attempt. The intent behind this is to reinforce test-taking attempts and mastering those tests while not punishing incorrect responses or failed attempts at mastery.

Another element in PSI is the use of proctors. Proctors, alternatively called mentors, peer-reviewers, or tutors, are students who have previously mastered the material. Students can either be ones who have previously taken the course and are hired or given course credit for serving as proctors (called external proctors by Sherman, 1992), or they can be students enrolled in the course who have previously mastered a given unit of study (called internal proctors; Sherman, 1977). The proctors provide individualized feedback to PSI students about their unit test performance and often provide individualized tutoring in areas where the student is weak.

The self-pacing feature of PSI courses allows students to move through the course material at their own pace. Thus, they can spend less time on material they understand and more time on areas they find difficult. In the initial PSI courses developed by Keller, students were not constrained by the traditional semester barriers. Rather, they could continue to work on a given course until they passed all of the unit tests.

Finally, within Keller's system the instructor is seen as the facilitator of learning rather than the person who imparts knowledge. For PSI students classroom meetings are typically used to help clarify material and motivate students to be engaged learners. The detailed learning of the material takes place outside of classroom meetings through students' active reading of the textbook and supplemental materials. Many PSI classes that use a short-answer format rely on students' answering of guided study questions from the readings.

Current State of PSI

The PSI movement once consisted of hundreds of teachers and researchers generating multitudes of publications. They had a dedicated journal (*Journal of Personalized Instruction*) and even a Center for Personalized Instruction that served as a clearinghouse for PSI information (Sherman, 1992). Literature reviews and meta-analyses indicated that PSI was a more effective teaching method than traditional lecture methods (Kulik, Kulik, & Bangert-Drowns, 1990; Kulik, Kulik, & Cohen, 1979) and even the most ardent critic acknowledge the superiority of the PSI method (Taveggia, 1976). Many studies were conducted to determine the most efficient ways to train proctors, to reduce student procrastination, and to determine which elements of PSI were essential for the system to function effectively. However, a quick examination of PsycInfo will show that the number of PSI studies from 1990 to 2006 numbered fewer than 50.

Many reasons appear to have contributed to PSI's decline from favorability. First, there were disagreements amongst PSI researchers as to what constituted a "true" PSI course. There were courses offered that upheld every tenet of the PSI philosophy and many courses that varied from Keller's prescriptions in a variety of ways. One of the main debates in the literature was at which point the courses diverge from PSI to SLI (something-like-it) to an unrelated course type. That is, some studies claim to be PSI courses but they have omitted the mastery component or the self-pacing component. This makes it difficult to assess PSI's true effectiveness because the failure to find a result may be due to ineffectiveness of the PSI method or improper application of the PSI method. Other issues include having university administrators block PSI courses based on the belief that faculty were not actually teaching if they were not standing in front of the classroom lecturing (Buskist, Cush, & DeGrandpre, 1991; Sherman, 1992). Another common complaint about PSI from the instructor side was the time-intensive nature of administering a PSI course. In the late 1970s, instructors typically developed learning objectives, possibly a study guide to aid student learning of those objectives, created multiple versions of a multiple-choice test, and had proctors mark each of these versions of the test and give students feedback on each test attempt. Training and supervising proctors along with developing the course materials and grading multiple test attempts from each student was an onerous process and many gave this up in favor of more traditional methods (Ainsworth, 1979).

How Computers Have Impacted PSI

Although many debates about PSI still abound, the question of how to efficiently manage all of the tests in a PSI course has effectively been answered. This answer lies with computer and internet technology. Although computer-aided PSI courses have existed since the 1980s (e.g., Crowell, Quintanar, & Grant, 1981; Pear & Kinsner, 1988), the internet has dramatically increased the flexibility of PSI courses. Several researchers have made use of these technologies to create PSI-based programs. For example, the computer-aided personalized system of instruction (CAPSI – http://www.webcapsi.com) is an internet-based program that follows the tenets of PSI (Pear & Crone-Todd, 1999; Pear & Novak, 1996). That is, the instructor sets up units of study covering key course readings with a number of short-answer study questions (e.g., 20) that correspond to each unit. Students enter into the CAPSI system and take unit tests over the readings at their own pace. The computer randomly selects a predetermined number of study questions from the unit for the student to answer. Once answered, the student submits

the unit test that is then marked for mastery by either student peer-reviewers who have already mastered the given unit, a student proctor who has already completed the class, or the instructor.

Although CAPSI only allows instructors to use short-answer questions, many other programs allow for instructors to set up mastery-based multiple-choice tests. Popular course platforms such as WebCT® and Blackboard® have a mastery-based component that the instructor can use to develop a PSI component (e.g., Chase, 2006). That is, instructors can set the percentage that a student must attain on a given test before they are allowed to access the next test. They can also set a maximum number of attempts in order for the student to achieve mastery (e.g., 4 attempts) or dates by which mastery must be achieved. Other programs created by individual instructors allow for integration of multiple-choice questions in unit tests instead of, or in conjunction with, short answer questions (e.g., D. E. Crone-Todd & B. Todd, personal communication, October, 2005).

ALEKS® (http://www.aleks.com) is another computer-based system that is designed to assist students in mastering mathematics and statistics. Although it was not designed as a PSI program, it employs many of the PSI principles such as individualized instruction based on each student's performance, mastery of material, emphasis on the written word, and frequent testing over small units of material. All answers are free response format that are then marked by the computer as correct or incorrect. The computer chooses the problems presented to the student based on a series of algorithms derived from the student's incoming knowledge (based on a pretest) and mastery of previous units to determine what the student is "ready to learn." ALEKS® also periodically reassesses students in order to determine the level of retention over time and to document retention of information (http://www.aleks.com/about_aleks/overview).

Recent PSI Research

Procrastination and Pacing. The issue of student procrastination has plagued PSI courses from the beginning and produces a fundamental paradox that cannot be easily rectified. Because nearly every PSI researcher has noted that procrastination is a major problem in their PSI courses, researchers have spent a great deal of time investigating ways to reduce this problem. For example, instructors have attempted to decrease procrastination through the use of behavioral contracts (Brooke & Ruthven, 1984), bonus points for early completion (Bufford, 1976; Eppler & Ironsmith, 2004; Worland, 1998), allowing students to set the deadlines (Roberts, Fulton, & Semb, 1988; Roberts & Semb, 1989; Roberts & Semb, 1990), consequences for failing to complete units by a target date (Miller, Weaver, & Semb, 1974), and other types of pacing contingencies (Glick & Semb, 1978; Ross & McBean, 1995). However, the paradox is that any sort of additional contingencies that place restrictions on the self-pacing of a course, such as those listed above, violate the course parameters of Keller's method with regard to self-pacing.

Mastery Criteria. Another major paradox in PSI is the mastery criteria. Mastery is the "Essential Essential in PSI" according to the title of Caldwell and colleagues' (1978) article. As mentioned above, in Keller's original courses students were not constrained to a traditional semester system. However, due to institutional regulations and the number of incompletes earned by students in PSI courses, this feature of PSI is infrequently used. Instructors typically try to modify the PSI course so it will fit into the traditional semester by giving students grades based on the number of unit tests passed (e.g., 9 units passed out of 10 would be a "B") or using the PSI component as a part of the total course grade rather than the entire course grade (e.g., Brothen & Wambach, 2001; Eppler & Ironsmith, 2004).

Another solution to fitting the mastery component into a single semester is to limit the number of unit test attempts. For example, some instructors allow students to retake unit tests three or four times and take the highest grade from these attempts. The advantage of this approach is that it is likely to encourage students to study before each test attempt since they know opportunities will be limited. The drawback is that a student may not actually achieve mastery after completing the four tests. Some

evidence for this comes from recent research by Eyre, Parks, and Crone-Todd (2006) which suggests that students with unlimited unit test attempts in a course using computer-scored multiple-choice unit tests may not go back and review during the wait time between attempts, resulting in very high numbers of attempts in order to achieve mastery (the class of 31 general psychology students had a 17% pass rate as a whole - they mastered 308 of the 1798 unit tests they took). Thus although they were engaging in high rates of behavior, the behavior was not resulting in mastery of course material. So simply having repeated contact with the material is not sufficient for mastery. Perhaps limiting the number of attempts or using a fixed interval schedule with a limited hold for test attempts may increase more appropriate study behaviors. But again, any delimiters set on the number of attempts would violate Keller's course parameters with regard to mastery and it would also affect student self-pacing within the course.

The conditional pass may be another way to increase critical thinking skills and student mastery of course-related material. Crone-Todd and colleagues (2007) found that the mastery criteria in a CAPSI-taught course appeared to be serving as a punisher since students' unit test attempts tended to decrease after receiving a restudy. In order to reduce the aversiveness of the restudy, they instituted a conditional pass when the answer did not quite meet mastery criteria, but was close. The conditional pass served as equivalent to a revise and resubmit option on a paper. Results indicated that students increased unit test attempts after the implementation of the conditional pass option. Other researchers have also implemented something equivalent to a conditional pass. Liu (2003) set three outcomes for a quiz attempt – mastery (over 90%), failure to master (less than 80%), or an outcome between the two (80% to 89%). In this midlevel outcome the student was allowed to defend his or her missed answers to a proctor in order to demonstrate mastery. If the revised answers were insufficient a restudy was granted but successful defense resulted in mastery.

Proctor Feedback. Research continues to be generated on improving proctor feedback in PSI courses. Chase (2006) demonstrated that students receiving elaborate feedback consisting of specific feedback about which multiple-choice option was correct and which were incorrect and general feedback "which includes conceptual information, definitions, and referential page numbers from the text" (p. 16) showed greater learning gains from first to second quiz attempts than students receiving only the specific feedback in a computer-mediated PSI course. Similarly, Worland (1998) investigated how praise, encouragement, and group information affected course performance. His results were mixed, but they did suggest that praise can serve as a positive reinforcer in a computer-mediated PSI course.

Other Areas of Research. Research on the CAPSI program has thus far examined the effectiveness of feedback in CAPSI (Martin, Pear, & Martin, 2002b), proctor marking accuracy (Martin, Pear, & Martin, 2002a), use of rules to increase peer-reviewer accuracy (Wirth, 2004), student response rate and persistence (Crone-Todd, Eyre, Hutchens, Jones, & Pear, 2007; Eyre, Crone-Todd, Peacock, Klein, & Pear, 2006; Springer & Pear, 2007), and degree of higher-order thinking (Crone-Todd & Pear, 2001; Crone-Todd, Pear, & Read, 2000). Ironsmith and Eppler (2007) have also been investigating how the use of PSI increased learning among low-aptitude students in a computer-mediated developmental psychology course.

Although the vast cadre of PSI researchers from the 1970s has shrunk to a small band in the 2000s, it appears that researchers are still actively working in many areas of PSI including tackling the puzzles surrounding self-pacing, mastery learning, and how to effectively provide feedback to students, especially in the computer-mediated environment.

Future of PSI

PSI in Distance Education. One area where PSI is gaining popularity is in distance education. Grant and Spencer (2003) illustrate why PSI is an ideal format for distance education. In most distance

education classes, like PSI, the written word is the primary method of communicating course-related content. Further, many distance education courses use timed tests or mastery-based tests taken over the internet as their primary assessment measure. These courses are already intentionally or unintentionally similar to PSI. Instructors could easily integrate PSI more systematically into these courses by setting the unit tests to cover a small amount of material, be mastery-based, and self-paced (see Liu, 2003 for a comprehensive example). Proctoring could be accomplished in a variety of ways including synchronous or asynchronous chats, discussion board postings, individualized test feedback, or preprogrammed test feedback if live feedback is not feasible or desirable. Lectures for motivational purposes can be given through streaming video, podcasts, discussion board posts, or other methods.

The PSI experience could be further enhanced by incorporating programmed instruction into a PSI course. The students could go through the course using a programmed online text where they fill in the word which the computer would recognize as correct or incorrect. They would work their way through a given unit and be given remedial work for any section not mastered. They then could take a unit test over the same material which they would have to master before the next section of the programmed text became available. Another alternative would be to use a standard text, but have a programmed instruction tutorial available. That is, a student would read the standard text and then take a unit test over a given unit. For any items missed on the test, the student would complete a programmed instruction tutorial over these concepts. The programmed instruction tutorial in this case would serve to replace the live proctors.

Many of the computer-programs listed above, along with several not discussed in this paper, would be capable of being used for a distance education PSI course. Most university students already learn to use a course platform such as WebCT® and Blackboard® and may use these platforms for regular on-campus classes, hybrid classes, and totally online classes. It would not take much effort to modify any given instructor's course to be a true PSI course. Other programs such as CAPSI have also been successfully used for distance education classes (Pear & Kinsner, 1988).

Conclusions

Will PSI become popular once again, or are its days of glory long past? The question of whether PSI will rise again to the level of prominence it once had in the education system will likely rest on how the current generation of PSI researchers resolves the questions that stymied the original PSI innovators. There are many paradoxes yet to be solved, especially with the self-pacing and mastery components. Computers appear to have resolved one the major hurdles to effective PSI course management by automatically grading multiple-choice tests and providing feedback, as well as facilitating the grading of short-answer tests. The computer has also helped PSI move into new venues such as the rapidly expanding field of distance education and online courses where the instructor's traditional role of "lecturer" has been changed into one of "mentor" and "learning facilitator," consistent with Keller's vision and with the administration's blessing. Thus, although there are many problems yet to be resolved, it appears that there may just be the demand and market in the new millennium for this type of innovative approach. We will see in another decade or so if this resurgence of interest blossoms into a full-scale revival or was simply a fleeting fancy.

References

Ainsworth, L. L. (1979). Self-paced instruction: An innovation that failed. *Teaching of Psychology, 6(1),* 42-46.

Brooke, R. R., & Ruthven, A. J. (1984). The effects of contingency contracting on student performance in a PSI class. *Teaching of Psychology, 11,* 87-89.

Brothen, T., & Wambach, C. (2001). Effective student use of computerized quizzes. *Teaching of Psychology, 28(4),* 292-294.

Bufford, R. K. (1976). Evaluation of a reinforcement procedure for accelerating work rate in a self-paced course. *Journal of Applied Behavior Analysis, 9(2),* 208.

Buskist, W., Cush, D., DeGrandpre, R. J. (1991). The life and times of PSI. *Journal of Behavioral Education, 1(2),* 215-234.

Caldwell, E. C., Bissonnettee, K., Klishis, M. J., Ripley, M., Farudi, P. P., Hochstetter, G. T., & Radiker, J. E. (1978). Mastery: The essential essential in PSI. *Teaching of Psychology, 5,* 59-65.

Chase, J. A. (2006). *Differential effects of elaborate feedback and basic feedback on student performance in a modified PSI course*. Unpublished Masters Thesis, University of Nevada, Reno.

Crone-Todd, D. E., Eyre, H. L., Hutchens, S. A., Jones, J. R., & Pear, J. J. (2007). The effect of changing grading criteria on student writing. *Behavior Analyst Today, 8(1),* 35-42.

Crone-Todd, D. E., & Pear, J. J. (2001). Application of Bloom's taxonomy to PSI. *Behavior Analyst Today, 2,* 204-210.

Crone-Todd, D. E., Pear, J. J., & Read, C. N. (2000). Operational definitions for higher-order thinking objectives at the post-secondary level. *Academic Exchange Quarterly, 4*, 99-106.

Crowell, C. R., Quintanar, L. R., & Grant, K. L. (1981). PROCTOR: An on-line student evaluation and monitoring system for use with PSI format courses. *Behavior Research Methods & Instrumentation, 13(2)*, 121-127.

Eppler, M. A., & Ironsmith, M. (2004). PSI and distance learning in a developmental psychology course. *Teaching of Psychology, 31(2),* 131-134.

Eyre, H. L., Crone-Todd, D. E., Peacock, H. M., Klein, J. L., & Pear, J. J. (2006, May). *Student response rate and persistence in a CAPSI-taught developmental psychology course*. In D. E. Crone-Todd (Chair) CAPSIzing Higher Education: PSI on the Internet in Canada and the United States. Symposium presented at the annual meeting of the Association for Behavior Analysis, Atlanta, GA.

Eyre, H. L., Parks, K., & Crone-Todd, D. E. (2006, October). *Student unit test persistence in a mastery-based general psychology course*. Poster presented at the annual meeting of the Southeastern Association for Behavior Analysis, Greenville, SC.

Glick, D. M., & Semb, G. (1978). Effects of pacing contingencies in personalized instruction: A review of the evidence. *Journal of Personalized Instruction, 3(1)*, 36-45.

Grant, L. K., & Spencer, R. E. (2003). The personalized system of instruction: Review and applications to distance education. *International Review of Research in Open and Distance Learning, 4(2),* 1-12.

Ironsmith, M. & Eppler, M. A. (2007). Mastery learning benefits low-aptitude students. *Teaching of Psychology, 34(1),* 28-31.

Keller, F. S. (1968). "Good-bye teacher". *Journal of Applied Behavior Analysis, 1,* 79-89.

Kulik, C. C., Kulik, J. A., & Bangert-Drowns, R. L. (1990). Effectiveness of mastery learning programs: A meta-analysis. *Review of Educational Research, 60,* 265-299.

Kulik, J. A., Kulik, C. C., & Cohen, P. A. (1979). A meta-analysis of outcome studies of Keller's Personalized System of Instruction. *American Psychologist, 34,* 307-318.

Liu, H. Q. (2003). *Development of an online course using a modified version of Keller's personalized system of instruction.* Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg.

Martin, T. L., Pear, J. J., & Martin, G. L. (2002a). Analysis of proctor marking accuracy in a computer-aided personalized system of instruction course. *Journal of Applied Behavior Analysis, 35,* 309-312.

Martin, T. L., Pear, J. J., & Martin, G. L. (2002b). Feedback and its effectiveness in a computer-aided personalized system of instruction course. *Journal of Applied Behavior Analysis, 35,* 427-430.

Miller, L. K., Weaver, F. H., & Semb, G. (1974). A procedure for maintaining student progress in a personalized university course. *Journal of Applied Behavior Analysis, 7(1)*, 87-91.

Pear, J. J. & Crone-Todd, D. E. (1999). Personalized system of instruction in cyberspace. *Journal of Applied Behavior Analysis, 32,* 205-209.

Pear, J. J., & Kinsner, W. (1988). Computer-aided personalized system of instruction: An effective and economical method for short- and long-distance education. *Machine-Mediated Learning, 2,* 213-237.

Pear, J. J., & Novak, M. (1996). Computer-aided personalized system of instruction: A program evaluation. *Teaching of Psychology, 23,* 119-123.

Roberts, M. S., Fulton, M., & Semb, G. (1988). Self-pacing in a personalized psychology course: Letting students set the deadlines. *Teaching of Psychology, 15(2),* 89-92.

Roberts, M. S., & Semb, G. (1989). Student selection of deadline conditions in a personalized psychology course. *Teaching of Psychology, 16(3),* 128-130.

Roberts, M. S., & Semb, G. (1990). Analysis of the number of student-set deadlines in a personalized psychology course. *Teaching of Psychology, 17(3),* 170-173.

Ross, L. L., & McBean, D. (1995). A comparison of pacing contingencies in classes using a personalized system of instruction. *Journal of Applied Behavior Analysis, 28(1),* 87-88.

Sherman, J. G. (1977). Individualizing instruction is not enough. *Educational Technology, 17,* 56-60.

Sherman, J. G. (1992). Reflections on PSI: Good news and bad. *Journal of Applied Behavior Analysis, 25,* 59-64.

Springer, C. R., & Pear, J. J. (2007). *Performance measures in courses using computer-aided personalized system of instruction*. Unpublished manuscript, University of Manitoba, Winnipeg.

Taveggia, T. C. (1976). Personalized instruction: A summary of comparative research, 1967-1974. *American Journal of Physics, 44,* 1028-1033.

Wirth, K. M. (2004). *A study of rules designed to increase peer-review accuracy in a computer aided personalized system of instruction course*. Unpublished masters thesis, University of Manitoba, Winnipeg.

Worland, P. D. (1998). *Proctor feedback in a modified PSI course format: The effects of praise, encouragement, and group information*. Unpublished Doctoral Dissertation, University of Notre Dame.

Author Contact Information:

Heidi L. Eyre, Ph.D.
Department of Psychology
Jacksonville State University
Jacksonville, AL 36265
Phone: (256) 782-5895
Email: heyre@jsu.edu
