

The Personalized System of Instruction:  
A Flexible and Effective Approach to Mastery Learning

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## The Personalized System of Instruction: A Flexible and Effective Approach to Mastery Learning

Most educators devote a considerable amount of time and effort to deciding exactly what it is they would like their students to learn. The scope and sequence of the curriculum is carefully determined, specific learning objectives are constructed for each unit or lesson, instructional activities are designed to support the objectives, and assessments are created to measure whether or not students have gained the desired skills and knowledge. Unfortunately, in most educational settings this thoughtful attention to the purpose and nature of our instruction is often accompanied by the dangerous underlying assumption that relatively few students will (or can) actually meet the course objectives. We accept that final scores will be more or less normally distributed in the shape of the familiar bell curve, and “the instructor expects a third of his [or her] pupils to learn well what is taught, a third to learn less well, and a third to fail or just ‘get by’” (Bloom, 1971, p. 47). Such a set of expectations certainly doesn’t seem to promote educational excellence or a positive learning experience for many students, yet it has become practically a defining characteristic of American education.

Some instructional methods, however, are based on a rather different set of assumptions about learning. These methods, often organized under the rubric of “mastery learning,” recognize the importance of building basic component skills and competencies to mastery before teaching more complex or composite material, and assume that most students *can* master a particular topic if given enough time, attention, and instruction to do so (Ormrod, 2000). The challenge, of course, is that in most classrooms it can be very difficult to provide each student with enough time, attention, and instruction to ensure mastery. Since at least the 1920s, a variety of mastery learning strategies have been developed to address such challenges (Block, 1971). From Washburne’s Winnetka Plan (1922) to Morrison’s approach at the University of Chicago’s

laboratory school (1926) to Carroll's model of school learning (1963) to Bloom's Learning for Mastery (1968) to many of the systems described in this volume, each is designed to maximize the proportion of students who attain our educational goals and to make certain that no student is "left behind." One of the most prominent examples of mastery-based teaching is the Personalized System of Instruction (PSI; Keller, 1968).

Developed and introduced in the 1960s as an alternative to the dominant lecture-based method of college teaching, PSI shares several features in common with other approaches to mastery learning. Yet PSI is distinguished by the considerable flexibility with which the details of the system can be implemented and, more importantly, by the remarkable amount of research demonstrating its effectiveness in a variety of settings. Few educational innovations have been subjected to the empirical scrutiny PSI has, and fewer still have emerged so unscathed. Although interest in PSI peaked in the 1970s and has decreased sharply in the decades since (Buskist, Cush, & DeGrandpre, 1991), it remains an attractive model for educators concerned with improving the quality of their instruction. Further, advances in information technology and telecommunications have the potential to greatly improve certain aspects of PSI courses and alleviate some of the factors that have contributed to its decline.

### History and Overview

Fred Keller, Gil Sherman, Rodolpho Azzi, and Carolina Martuscelli Bori initially developed PSI in 1963 while founding the department of psychology at the new University of Brasilia (Keller, 1968, 1982a). Keller became the most ardent advocate of PSI, and the system is sometimes called "the Keller Plan" or "the Keller Method" in his honor. Dissatisfied with conventional teaching methods and well-trained in learning theory, the designers sought to create a system that rewarded students more than it penalized them, promoted mastery of the content,

and increased the amount of interpersonal communication within the classroom. The result was a general course model first piloted by Keller in a small, short-term laboratory course at Columbia University in 1963, and later implemented on a larger scale by Azzi and Bori at the University of Brasilia in 1964 and by Keller and Sherman at Arizona State University in 1965 (Keller, 1968).

### *Key Features of PSI*

The distinguishing features of PSI have been described as self-pacing, unit mastery (requiring the demonstration of mastery of each unit before proceeding to the next), the use of lectures and demonstrations for motivational purposes (rather than delivery of course content), an emphasis on the written word and textual materials (for delivery of course content), and the use of proctors for individual tutoring and assessment (Keller, 1968; see Table 1). Courses based on PSI are also characterized by their use of specified instructional objectives, small-step sequenced materials, repeated testing, immediate feedback, and credit for success rather than penalty for errors (Sherman, 1992). Note that virtually all of these features, in some combination or another, can be found in the other empirically supported teaching methods appearing in this volume and in other mastery learning programs. Indeed, as Keller once commented, “there is probably no single aspect of our system that is really new” (1982a, p. 10). What *was* new about PSI was the way it explicitly linked each of these components to learning and reinforcement theory, emphasized the use of student proctors to personalize instruction, and combined the features into a general model for teaching that quickly gained widespread appeal (Keller & Sherman, 1982a).

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All of the key components of PSI were derived from the overall goal of promoting mastery of the course content (Sherman, 1982a). Mastery of each unit is required because a full understanding of material appearing later in a course is usually dependent upon mastery of the concepts, principles, facts, and/or skills appearing earlier in the course. Some degree of self-pacing is required for any mastery-based teaching method because students learn at different rates, and there will be considerable variability in the amount of time it takes each student to master a unit. Lecturing, as a live performance designed to convey critical content, is impractical in such a course because it prevents the students from progressing through the material at their own pace (or would require that each unit lecture be delivered multiple times). This leads to a reliance on textual materials, which can be accessed at the student's convenience, as the primary vehicle for delivering the course content. Finally, proctoring was deemed necessary for PSI courses in order to administer the many assessments and, more importantly, to provide students with immediate feedback, additional tutoring or instruction, and some degree of social reinforcement for their performance.

In the prototypical PSI course, students use a study guide and text book to individually work through small units of material. When the student is ready, he or she will then complete an assessment, or test, based on the unit. The assessment often takes the form of a brief multiple-choice test, but virtually any format can be—and has been—used, including short-answer items, essay exams, interviews/oral assessments, problem-solving tasks, or a demonstration of skills. Upon completing the assessment, the student immediately meets with a proctor for grading and feedback, discussion, and/or tutoring. If the student meets the mastery criterion for the assessment, he or she is free to continue on to the next unit; if not, then the assessment (or, more frequently, a parallel version thereof) must be taken again later until mastery is achieved.

Students are allowed to retake the test as many times as necessary without penalty until their performance indicates sufficient mastery of the material. This cycle is repeated for each unit of material, with the student progressing through the course at his or her own pace. Lectures, demonstrations, laboratory exercises, and review assignments may also be incorporated throughout the course. The course is completed when the student meets the mastery criteria for all of the units.

Many PSI courses implement one or more of the key components somewhat differently (see Kulik, Jaksa, & Kulik, 1978). Common variations include the use of deadlines to reduce student procrastination and ensure timely completion of the course, the complete elimination of lectures, adjusting the criteria for mastery, modifying the size of the instructional units, using different student populations to serve as proctors, limiting the number of times a test can be retaken, altering the role of the proctor, eliminating proctoring, and using computers to deliver content, administer tests, and/or provide feedback. Determining exactly which features must be implemented—and how—in order for a course to be deemed a “PSI course” can be a troubling issue (Sherman, 1992). Guidance can be found in the empirical literature, however, and this is a topic to which we shall return later.

### *The Rise of PSI*

Shortly after PSI was described in Keller’s seminal 1968 article “Goodbye, Teacher . . .” and at various professional conferences, others began using the system and reporting their experiences. Sherman (1982b) provides an excellent account of the dramatic expansion of PSI research and application, and some of the more revealing details are summarized below. By 1973—only 10 years after a prototype PSI course was first tried at Columbia University and only 5 years after most people had even heard of PSI—over 300 papers, articles, and research reports

on PSI had been published, and by 1979 there were close to 3,000 such publications. Most of the earliest implementations of PSI were for college-level courses in psychology, physics, and engineering, but this quickly changed as a series of PSI workshops and conferences in the early 1970s, along with the remarkable success of PSI reported in the literature, drew the interest of educators from a wide range of disciplines at all levels of education. Before long, PSI was being used to teach many different subjects to many different populations in elementary and secondary schools, community colleges, four-year colleges and universities, hospitals, businesses, prisons, and the military. Even though it has always been used predominantly with college students, PSI was proving to be flexible enough to work in a variety of settings, and in 1979 there were over 5,000 PSI courses known to be in existence.

From 1971 to 1979 the *PSI Newsletter* served as a communication forum for PSI teachers and researchers, and from 1973 to 1979 the Center for Personalized Instruction at Georgetown University “served an information clearing-house function, surveying PSI courses in different disciplines and at all educational levels throughout the country” (Sherman, 1982b, p. 74). The Center also sponsored PSI workshops and conferences, assumed publication of the *PSI Newsletter*, and began publication of an academic journal entitled the *Journal of Personalized Instruction*. Within a short period of time, PSI had emerged as a powerful educational movement that was inspiring countless research studies, garnering extensive support and interest, and encouraging many teachers to rethink the purpose and process of education.

### *The Fall of PSI*

After the Center for Personalized Instruction became defunct in 1979, it became much more difficult to characterize the PSI landscape. It is unclear, for example, whether the number of PSI courses being taught continued to increase, stabilized, or decreased in the years

immediately following the Center's closure. It is clear, however, that there are far fewer PSI courses in existence today than there were in 1979 (Lloyd & Lloyd, 1986) and that the number of research articles pertaining to PSI has decreased dramatically since the 1970s (Buskist et al., 1991; Lamal, 1984). Although PSI continues to be used in a variety of contexts (e.g., Conard, 1997; Hambleton, Foster, & Richardson, 1998; Hansen, Brothen, & Wambach, 2002; Housmanfar et al., 2000; Koen, 2002; Pear & Crone-Todd, 2002; Price, 1999), it was never able to firmly entrench itself in the educational mainstream.

The reasons for PSI's fall from favor are varied, but the most significant likely include the greater amount of initial development time required for PSI courses, the difficulty in adapting a self-paced and mastery-based model to the traditional academic calendar, the hesitation of instructors to transition from a teacher-centered approach to a learner-centered approach, the tendency of educational administrators to value novelty over efficacy (and PSI is no longer novel), and the general inertia of lecture-based teaching (Buskist et al., 1991; Sherman, 1982b, 1992). In many ways, the truly personalized, self-paced, and mastery-based instruction offered by PSI simply does not mesh well with established educational practices. It changes the role of the teacher in important ways (from a "performer" to a "manager" of learning), requires more planning and organization, and demands that academic progress and advancement be governed by student performance rather than a calendar. Further, the widespread use of PSI might have rather striking implications for education: "Imagine what would happen if the entire educational system were PSI-based: huge numbers of peoples, most still in the throes of puberty, might be graduating from college—an unsettling thought for many educators" (Buskist et al., 1991, p. 231). Whatever factors may have contributed to the decrease of interest in PSI, failure to improve student learning and performance was certainly not one of them.

## Effectiveness

Many movements in education are emphatically touted by their advocates, but plagued by a lack of supportive empirical data. Constructivism, for example, has gained many adherents in the field of education recently, but as one commentator notes, “at this point, (constructivist) theory and conjecture far outstrip empirical findings” (Driscoll, 2000, p. 395). This is not the case with PSI. It has been estimated that over 2,000 PSI research studies have been conducted (Sherman, 1992), and the vast majority of these have shown that students in PSI courses learn the course content better, remember it longer, and like the experience more than students in traditional classes.

Given the tremendous amount of PSI research that has been conducted, it may be useful to summarize the findings of several published reviews of this literature. One of the earliest reviews was by Taveggia (1976), in which the results of fourteen studies of courses from introductory psychology, learning, cultural anthropology, chemistry, electrical engineering, mechanical engineering, and nuclear engineering were analyzed. He found that “when evaluated by average student performance on course content examinations, the Personalized System of Instruction has proven superior to the conventional teaching methods with which it has been compared” (p. 1032). One of the progenitors of PSI found Taveggia’s conclusion to be particularly exciting because “it came from a critic of educational research, unassociated with PSI, who was best known for articles demonstrating that nothing one does in the classroom makes any difference (e.g., Dubin & Taveggia, 1968)” (Sherman, 1992, p. 59).

A more extensive review (Kulik, 1976) looked at over 400 PSI articles and found only two that favored traditional course formats over PSI. Moreover, 31 of these studies provided systematic and methodologically sound comparisons of PSI to other methods, and in 25 of these

final exam scores were significantly higher for the PSI students (the remaining six studies found no statistically significant difference between the scores of students in PSI courses and those of students in traditional courses). Support for PSI was found in studies that reported measures other than final exam performance, as well. In these studies, PSI was found to produce superior outcomes in all six studies focusing on retention scores, all four studies focusing on transfer effects, and in six of the seven studies focusing on student attitudes about the course.

Kulik, Kulik, and Cohen (1979) conducted a meta-analysis of 72 studies that compared PSI to conventional instruction for a total of 75 different courses. A meta-analysis is a statistical method for integrating the findings from a large set of individual research studies, and is used to provide a general account of empirical knowledge in a particular domain (Glass, McGaw, & Smith, 1981). The meta-analysis conducted by Kulik et al. used only studies that did not have “crippling” methodological or design flaws, and focused on the five types of outcome measures reported in the studies: final exam scores, final course grades, student satisfaction, course completion/withdrawal rates, and student study time. PSI courses produced outstanding results in each of these areas. Final exam scores of students in PSI courses were found to be, on average, about 8 percentage points higher than those of students in lecture-based classes (indicating an average effect size of .5), and this difference increased to 14 percentage points for retention exams administered several months after the end of a course. Likewise, final course grades in PSI courses averaged nearly a full letter grade higher (.8 using a traditional 4.0 grading scale) than final grades in other courses. Measures of student satisfaction also favored PSI, with PSI receiving higher ratings in most studies for overall quality, learning, overall enjoyment, and work load. The authors relate that “students rate PSI classes as more enjoyable, more demanding, and higher in overall quality and contribution to student learning than conventional classes” (p. 317).

Finally, course completion rates and estimates of student work load were found to be similar in PSI and conventional classes.

A meta-analysis of mastery learning programs (Kulik, Kulik, & Bangert-Drowns, 1990), including courses based on PSI and Bloom's Learning for Mastery (1968), provides further support for PSI's effectiveness. Of the 108 mastery learning studies included in the analysis, 72 used PSI in college-level courses. Although several different outcome measures were examined, effects specific to the PSI studies were reported only for final exam scores and course completion rate. With regard to exam performance, 62 of 67 PSI studies reported higher final exam scores for PSI students, and 69% of these results were statistically significant. On average, the effect of PSI was to improve exam scores by .48 standard deviations. It is noted that this is a relatively strong effect in educational research, as a review of meta-analyses in education (Kulik & Kulik, 1989) indicates that "few educational treatments of any sort were consistently associated with achievement effects as large as those produced by mastery teaching" (Kulik et al., 1990, p. 292). Unlike their previous meta-analysis of PSI research (Kulik et al., 1979), this review indicated a slightly lower completion rate for PSI classes. However, an analysis of the 29 studies in which data on both course completion and examination performance are reported did not indicate that examination effects were related to course completion. The lower course completion rate found in some PSI courses is probably related to the difficulty some students have completing self-paced courses on time, and various strategies have proven effective at rectifying this problem (see *Implementing PSI in the 21<sup>st</sup> Century* section below).

### Flexibility

It is likely that much of PSI's popularity has been due to the inherent flexibility of the system. From its inception, PSI was designed to provide a general framework for effective

teaching that would allow the instructor the option of using a variety of instructional materials or techniques within individual course lessons. The core unit of instruction in PSI is “more like the conventional home-work assignment or laboratory exercise” and “the use of a programmed text, a teaching machine, or some sort of computer aid within such a (PSI) course is entirely possible and may be quite desirable, but it is not to be equated with the course itself” (Keller, 1968, p. 84). By employing this larger and more general unit of instruction and analysis, PSI grants the instructor considerable flexibility in utilizing other pedagogical tools within the course, and makes the system easier to implement with conventional instructional materials (such as textbooks and study guides). Evidence suggests that instructors can improve the quality of their courses by “simply” adopting the core elements of PSI, while still being able to incorporate whatever types of activities, assignments, assessments, and/or experiences they may value. This makes the model exceptionally accessible to a wide range of instructors, as its implementation requires neither an advanced degree in instructional design nor the use of a prescribed set of instructional materials.

The flexibility of PSI is most apparent in at least two respects. First, PSI has been effectively combined with numerous other instructional technologies. For instance, several of the other methods described in this volume, including the Morningside Model of Generative Instruction (Johnson & Layng, 1994) and the Comprehensive Application of Behavior Analysis to Schooling (CABAS; Greer, 2002), incorporate PSI into their systems. The Computer-Aided Personalized System of Instruction (CAPSI; Kinsner & Pear, 1988; Pear & Kinsner, 1988) outlined in the next chapter combines PSI with computer-based instruction, as have others (e.g., Conard, 1997; Crosbie & Kelly, 1993). Jacksonville State University’s Department of Learning Skills (formerly the Center for Individualized Instruction) combines PSI with both computer-

based instruction and precision teaching (McDade & Goggans, 1993). Of the thousands of PSI courses that have been taught over the past several decades, many other types of teaching materials and methods have undoubtedly been employed in conjunction with PSI.

Second, the model has been used to teach an astonishing array of subjects in a variety of settings. PSI has been used to teach courses in almost all areas of the liberal arts and sciences (Boylan, 1980; Lloyd, 1978), and Sherman (1982c) commented that “while a carefully compiled comprehensive catalogue of disciplines might show some subject matter to be missing, I can not think of any major academic subject that has not been taught using a PSI format” (p. 266). And although much of the research on PSI has been conducted with college students, the system has also been used successfully with elementary and secondary students (Dineen, Clark, & Risley, 1977; Klishis, Hursh, & Klishis, 1980; McLaughlin & Malaby, 1975; Reid, Archer, & Friedman, 1977), behaviorally disordered children (McLaughlin, 1991), adults with mild disabilities (Zencius, Davis, & Cuvo, 1990), low-income neighborhood residents (Fawcett, Mathews, Fletcher, Morrow, & Stokes, 1976), banking professionals (Tosi & Jackson, 1980), U.S. Navy personnel (McMichael, Brock, & DeLong, 1976), and many others. Clearly, PSI is a system that can be adapted to many different instructional needs, learners, settings, and materials.

While PSI provides a flexible framework for the development of effective courses, it should be obvious that the more time and effort that is taken to systematically design, evaluate, and revise the individual modules in a PSI course, the more effective they are likely to be. It should also be obvious, however, that the very structure of PSI promotes the use of known principles of effective instruction and encourages a systematic approach to instructional design. The mastery requirement, for example, entails the development of clearly stated instructional objectives and criterion-referenced assessments. Furthermore, using small, carefully-sequenced

units requires a considerable degree of content analysis, while requiring frequent assessments and tutoring or proctoring ensures active student responding and immediate feedback. The frequent testing in a PSI course also greatly facilitates the formative and summative evaluation of the course, allowing revisions to be made according to multiple indicators of student performance.

### Implementing PSI in the 21<sup>st</sup> Century

Today, educators who wish to use PSI have several important advantages over their counterparts from the previous century. Perhaps the most obvious is the potential that modern information technology has for improving certain aspects of PSI courses. Computers and web-based course management systems such as Blackboard and WebCT can easily be used to administer and score examinations and certain practice activities (e.g., Conard, 1997; Crosbie & Kelly, 1993; Houmanfar et al., 2000), as well as reduce other administrative burdens commonly associated with PSI (e.g., Pear & Kinsner, 1988; Pennypacker, 1978). Peer tutoring, proctoring, and other collaborative activities can also be accomplished via a variety of computer-mediated means, such as email and synchronous or asynchronous online conferencing (e.g., Koen, 2002; Pear & Novak, 1996). A reliance on textual materials is no longer needed either, as the multimedia capabilities of integrative technologies such as the world wide web can be utilized to deliver on-demand course content in a variety of formats (e.g., Hambleton, Foster, & Richardson, 1998; Koen, 2002). Most subject areas have a large number of multimedia tutorials or lessons that are included on CD-ROMs with textbooks and study guides, can be plugged into web-based course management systems, or are available for download from both private and commercial web sites. Even the instructor reluctant to give up lecturing can now be

accommodated by PSI, as audio or video recordings of lectures can be made available online via streaming media, providing students access whenever needed.

Another important advantage modern PSI users have is the considerable body of knowledge about PSI that has accumulated over the past several decades. In addition to the outcome research summarized earlier, there are also many studies (often called “component analyses”) that examine which features of PSI are most vital to its success and how they should be implemented (see Kulik et al., 1978; Sherman, Ruskin, & Semb, 1982). A number of veteran PSI developers and instructors have also published useful advice and tips about planning and managing PSI courses (e.g., Green, 1982; Koen, Wissler, Lamb, & Hoberock, 1975; Keller & Sherman, 1982b, Lewis & Wolf, 1973; Lloyd & Lloyd, 1992). In essence, PSI teachers can capitalize on over three decades worth of research on a specific pedagogical system—truly a rare opportunity in education. Table 2 outlines several suggestions adapted from Lewis and Wolf (1973) that should prove useful to any instructor considering PSI. Additional lessons from the literature are used to inform the guidelines and descriptions in the sections that follow.

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### *Deciding to Use PSI*

PSI seems to be a viable model for the development of many different types of courses in many different disciplines, but it is not necessarily the best option for every instructor or every course. In particular, PSI may not be suitable for courses in which mastery of course content is secondary to providing students with unique experiences or interactions (Green, 1982; Keller, 1982c), or those that rely heavily on group interactions or collaborative activities (Price, 1999).

Instructors who insist on providing students with a high degree of control over course content or learning objectives may also find PSI inappropriate (Keller, 1982c). The amount of time and effort it takes to initially organize and teach a PSI course is considerable (Lloyd & Lloyd, 1986), and those who are unable or unwilling to devote sufficient resources are unlikely to be successful (Green, 1982). Keller (1982c) adds that PSI should not be adopted by teachers hoping to alleviate their teaching responsibilities, for “the role of the teacher is not lessened under PSI; it has only been given a different form” (p. 56). Educators who cannot secure the support of their administration for a course that has few lectures and awards many A’s and Incompletes (depending on how one arranges the grading contingencies) may wish to avoid PSI, as well (Green, 1982; Keller, 1982c). Depending on the nature of the instructional materials employed, courses in which the students have poor reading or independent learning skills may also not be good candidates for PSI (Green, 1982; Roberts, Suderman, Suderman, & Semb, 1990).

*Key Features of PSI: Updated & Revised*

As mentioned previously, the many different permutations of PSI can lead to some difficulty in accurately defining and identifying what PSI is. The inherent flexibility of PSI is one of its primary strengths as a general model for course development, but it can also create problems. These difficulties are illustrated in this warning by Sherman (1992): “A rigid definition (of PSI) can freeze the method into a numbing formula and limit the audience... on the other hand, a very broad definition makes PSI so inclusive as to be meaningless” (p. 62). Fortunately, the extensive research on the various components of PSI can be used to develop a list of empirically-derived core features that succinctly outlines the basic parameters of PSI, but also permits flexibility in their implementation when appropriate.

While some might find it objectionable to alter the “classic” listing of PSI components, it seems worthwhile for several reasons. First, the empirical literature clearly reveals that not all of the features originally identified as critical are necessary for the system to work. The use of lectures for “motivational purposes,” for example, does not appear to have any discernible effect on either student achievement or motivation (Calhoun, 1976; Lloyd et al., 1972; Phillips & Semb, 1976; Roberts et al., 1990). It seems counterproductive and needlessly inflexible to continue insisting on the inclusion of components that do not seem to contribute to the improvement of student learning. Also, some of the features (or at least their basic descriptions) could be refined to reflect our current knowledge about the most effective way to execute them. Finally, other characteristics should be modified in light of recent advances in information technology. As noted earlier, for instance, the reliance on textual materials is no longer an absolute necessity given the range of media now readily available for instructional purposes. For these reasons, the features and guidelines described below and summarized in Table 3 are proposed for use in the definition and implementation of PSI.

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*Unit mastery.* The mastery requirement of PSI appears to be one of the most significant factors in determining student achievement (Caldwell et al., 1978; Hursh, 1976; Kulik et al., 1978; Robin, 1976). This finding is corroborated by reviews of the research on mastery learning programs in general (Kulik et al., 1990). Thus, requiring students to master each unit before advancing to the next should remain a key component of PSI. Research suggests that mastery criteria set at a high level (such as requiring 100% accuracy) may improve student learning

(Kulik et al., 1990), but it seems this finding would be relative to the instructional objectives and nature of the assessment used. Recent theoretical and empirical advances related to the notion of mastery, such as work in the area of behavioral fluency (Binder, 1996, 2003; Johnson & Layng, 1992, 1996; Kubina & Morrison, 2000), could also be incorporated into PSI courses. Additional research in this area might be useful for specifying the parameters under which “mastery” could or should be defined, but simply requiring unit mastery—however it is defined—seems to be sufficient for improving student learning. A related point is that the setting of mastery criteria for units requires the specification of instructional objectives, another characteristic of PSI that must endure. Mager (1997) provides excellent guidelines for developing quality instructional objectives.

Several investigators have examined the relative merit of using either small or large units in PSI courses (e.g., Calhoun, 1976; Semb, 1974), and “evidence tends to show that small units and frequent quizzes are more effective in stimulating student achievement than large units and less frequent quizzes” (Kulik et al., 1978, p. 6). Unit size is a relative matter, of course, so additional guidance is useful. A unit usually covers about a week of work, and a course offered during a 15-week semester typically includes about 15 to 20 units (Keller & Sherman, 1982b). Each unit or module of instruction should consist of the presentation of the course material, an assessment, and feedback. Assessments should be consistent with the unit objectives, and as comprehensive of the unit material as possible. To provide for the mastery requirement, parallel versions of the assessment instrument for each unit may need to be developed (although this depends on the nature of the instrument). It is also recommended that some systematic review be incorporated throughout the course, either through review units or review items on unit quizzes

(Keller & Sherman, 1982b). Research suggests that review procedures in PSI courses enhance student learning and retention (Kulik et al., 1978).

*Flexible pacing.* The self-pacing aspect of PSI can prove somewhat troubling and controversial (e.g., Ainsworth, 1979; Born & Moore, 1978). A certain degree of self-pacing is necessary in order to allow students of varying abilities to each achieve mastery of the material, but research on the issue indicates that self-pacing in and of itself does not impact student learning (Kulik et al., 1978). In fact, there is some evidence that mastery programs that limit self-pacing may produce superior achievement (Kulik et al., 1990).

Of course, the primary problem associated with total self-pacing is that of student procrastination. When a student has complete control over when they study and take quizzes for a course, it is not difficult to understand how competing obligations with fixed deadlines can quickly take priority. Procrastinators can create logistical problems for themselves, their instructors, and their institution's administration (Born & Moore, 1978), as well as get so far behind that they "despair of catching up, and drop out, frustrated and demoralized" (Kulik et al., 1978, p. 9). Indeed, the self-paced nature of PSI is likely the primary reason some PSI courses have lower completion rates than conventional courses (Kulik et al., 1990).

Several methods for preventing procrastination and promoting timely completion of PSI courses have been offered. Incentive systems which provide students with bonus points or other rewards for meeting various course deadlines can be effective (e.g., Riedel, Harney, LaFief, & Finch, 1976; Semb, Conyers, Spencer, & Sanchez-Sosa, 1975), as can teaching students time-management skills (e.g., Glick & Semb, 1978; Keenan, Bono, & Hursh, 1978). Contingency contracting, in which students who fail to meet instructor-imposed deadlines are required to establish contracts with the instructor for new deadlines, can also improve student progress and

reduce the number of student withdrawals (Lamwers & Jazwinski, 1989). Having students establish self-imposed deadlines can also positively impact student pacing and performance (Lloyd & Zylla, 1981; Roberts, Fulton, & Semb, 1988; Roberts & Semb, 1989). It is recommended that PSI instructors utilize techniques such as these to avoid the negative effects student procrastination may have, and this is why “self-pacing” has been renamed “flexible pacing” here. Courses that are entirely teacher-paced, and do not even allow for advanced students to progress through the course at an accelerated pace, should not be identified as PSI.

*On-demand course content.* Previous listings of the distinguishing properties of PSI included the reduced use of lectures and an emphasis on textual materials (e.g., Keller, 1968). Lectures were discouraged as the primary vehicle for delivering course content because they are ephemeral events that students can not access whenever needed, impose a teacher-determined schedule of learning on all students, and force students to begin attending to new material regardless of whether they had mastered the previous information. Printed material does not have these limitations, and PSI courses thus became heavily reliant on textbooks and study guides.

The true issue, however, is not a matter of the form or medium of the instruction—it is a matter of accessibility. For a self-paced (or flexibly-paced) and individualized mastery program such as PSI, it is imperative that students have access to instruction whenever needed in order to accommodate individual learning rates. At the time that PSI was initially developed, textbooks, study guides, and other printed matter were the most common and cost-effective way to accomplish this. Sherman (1982d) noted that in PSI “written materials (or audiovisual media where available and economically justifiable) must become the major informational source” (p. 23). In the modern “Information Age,” the multimedia instruction to which Sherman referred is both readily available and affordable, and there is no need to restrict PSI to written or textual

materials. Rather than listing “an emphasis on the written word” as a core component of PSI, it seems both more accurate and prudent to simply list “on-demand course content” as a defining feature. The quality of such materials—whether they are in print or electronic format—can vary widely, of course, and their careful selection or production will have a considerable impact on the quality of the course.

*Immediate feedback.* Immediate feedback on academic performance has always been an important characteristic of PSI. Typically, this function has been served by proctors, who would grade student quizzes immediately upon completion and provide written or oral feedback. In fact, the literature suggests that the provision of immediate feedback is the proctor function that has the most significant impact on student learning (Kulik et al., 1978). Because feedback can also be delivered effectively via computerized means (e.g., Crosbie & Kelly, 1993), however, it seems useful to separate this component from other proctor functions. While proctors or other people can certainly still be used to provide feedback, using computers to do so can relieve some of the administrative stress associated with PSI and allow course personnel more time to engage in tutoring and discussion with the students. Of course, some forms of assessment (such as those requiring the written composition of answers) may still require a human to evaluate and provide feedback. No matter what method is used to deliver the feedback, though, immediacy is important: research shows that “delaying feedback in PSI courses interferes with student retention of course material” (Kulik et al., 1978, p. 135).

*Peer tutoring.* As originally conceived, proctors in a PSI course served to administer and score quizzes, provide feedback on student performance, and discuss the material with the student or provide tutoring. Even though some of these functions, such as quiz administration and the provision of feedback, can now be performed by computers, proctors still play an

important in personalizing the student's learning experience. Proctors can be key to improving the individualization of instruction, increasing student motivation, and enhancing "the personal-social aspect of the educational process" (Keller, 1968, p. 83). There is some evidence that interaction with proctors for the purposes of discussion or tutoring may not improve student learning in PSI courses (e.g., Caldwell et al., 1978; Fernald, Chiseri, Lawson, Scroggs, & Riddell, 1975; Hindman, 1974), but there is a larger body of research on tutoring in general that suggests the process can have beneficial effects for both the tutor and the tutee (e.g., Cohen & Kulik, 1981; Cohen, Kulik, & Kulik, 1982; Hedin, 1987). Determining exactly how (or even whether) proctors should be used, trained, and rewarded has been the subject of much research (e.g., Conard & Semb, 1977; Croft, Johnson, Berger, & Zlotlow, 1976; Crosbie & Kelly, 1993; Johnson & Sulzer-Azaroff, 1978; Robin, 1977; Robin & Cook, 1978), but there do not seem to be many clear answers.

Proctoring is renamed "peer tutoring" here for two reasons. The first is that the term "tutoring" seems to better reflect the most meaningful role of the PSI "proctor," as the term "proctoring" typically suggests merely the supervision and/or administration of exams. When Keller & Sherman (1982a) describe the proctor as "the mediating figure, the bridge that helps to span the student-teacher gap of understanding" (p. 61), they seem to be referring to far more than just the proctor's administrative skills. Further, proctors in PSI courses are usually fellow students who have completed the course already (external proctors) or are currently enrolled in the course (internal proctors), making them true peers. An additional reason for using "peer tutoring" is to more directly connect PSI and its users to the substantial amount of educational research that now exists on tutoring and peer tutoring (e.g., Cohen & Kulik, 1981; Cohen, Kulik, & Kulik, 1982; Hedin, 1987). This literature is certain to hold valuable guidance on how PSI

teachers can best incorporate this important yet complex feature into their own courses (Sherman, 1992, p. 63). Refer to the chapter “Key Instructional Components of Effective Peer Tutoring...” for further information on this topic.

### Conclusion

When PSI was introduced four decades ago, few could have imagined the attention it would receive or the impact it would have. And while the number of PSI courses and research studies have certainly decreased since its heyday in the 1970s, PSI endures. Other instructional innovations and technologies, including those presented in this volume, have surfaced and competed with PSI, but none have fully supplanted it. Perhaps this is because many of these methods complement PSI more than truly compete with it: where PSI is general, they are specific; where PSI focuses on large units of instruction and responding, they focus on smaller ones. This generality and flexibility has served PSI well, as the widespread use of the system and its integration with other instructional strategies over the years serves testament.

At its core, PSI is a general model for course development that is relatively easy to understand and applicable to many settings, learners, and subjects. The basic components of PSI ensure that whoever uses the model will attend to certain key features of quality instruction, such as clear instructional objectives, active and frequent student responding, careful sequencing of materials, and immediate feedback. It is not surprising that these same characteristics can be found in most other empirically supported educational methods. It is also not surprising that this constellation of features resulted in a system that has proven remarkably effective at improving student learning and achievement for so many years, and that continues to serve as an exceptional model for individualizing and strengthening the educational experience.

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Table 1

*Key Features of PSI*

Component	Description
Unit mastery	Students are required to demonstrate mastery of each unit before proceeding to the next
Self-pacing	Students proceed through the course at their own pace
Lectures for motivational purposes	Lectures are used for demonstrations and motivational purposes, rather than for primary delivery of course content
Emphasis on written word	Textual materials are used for primary delivery of course content
Proctoring	Proctors are used to administer and score exams, deliver feedback, and provide tutoring

Table 2

*Tips for Implementing a PSI Course*

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1. Choose quality instructional materials that are appropriate for your students' comprehension level; empirically verified materials are preferable
  2. Make the first units easy (and perhaps smaller) to build confidence; increase difficulty gradually
  3. Avoid including too much material in each unit; the units have to appear manageable to the students
  4. When possible, include review material in assignments, assessments, and other instructional activities
  5. Make assessments as comprehensive and consistent with unit objectives as possible, but also as brief as possible (some students will be taking them multiple times!)
  6. Make use of faster students within the class to tutor slower ones
  7. Encourage frequent feedback from students so that instructional materials and assessments can be revised and made more effective for future students
  8. Provide students with easy access to their course records; using a web-based course management system, such as Blackboard or WebCT, may be a good solution
  9. Choose tutors carefully and reward them appropriately; explore different tutoring options and arrangements until you find one that works for your course
  10. Start small, and be prepared for a large initial expenditure of time developing assignments and assessments; as with any course, future implementations should require less time
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*Note.* Adapted from Lewis and Wolf (1973)

Table 3

*Key Features of PSI: Updated & Revised*

Component	Description
Unit mastery	Students are required to demonstrate mastery of each unit before proceeding to the next
Flexible pacing	Students proceed through the course at their own pace, but strategies to reduce procrastination are recommended
On-demand course content	Primary delivery of course content is via instructional materials that are available to students whenever needed
Immediate feedback	Students receive immediate feedback on educational assessments; can be delivered via humans or computers
Peer tutoring	Peer tutors are available to discuss material and provide tutoring (as well as administer assessments and provide feedback, if necessary)