

Contingencies of Reinforcement to Maintain Student Progress Throughout a Web-Based PSI Course

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Abstract

A web-based, freshman level course in computer programming has been offered for three semesters at The University of Texas at Austin using a strict implementation of a pedagogical strategy called a Personalized System of Instruction (PSI). Eighty percent of the freshmen students completed the course at a 100% mastery level of prior educational objectives over the Internet. This article describes the contingencies of reinforcement used to achieve this high completion rate.

1. Introduction

A web-based, freshman level course in computer programming has been offered for three semesters at The University of Texas at Austin. This course is based on the asynchronous pedagogical strategy called a Personalized System of Instruction (PSI), sometimes referred to as The Keller Plan. This paper defines the PSI method, discusses the specific parameters of the course, outlines the unique reinforcement strategies to maintain student progress.

2. Target population and course content

The primary target student population is college freshmen students in Mechanical Engineering at The University of Texas at Austin. Typically 50-60% of this population leaves the college of engineering during their first two years of study. The overall educational objective of this course is to teach a beginning level knowledge of the computer languages C and Matlab as well as to introduce the use of the Internet for email communication, ftp transfers, etc. By blurring the boundary between entering freshmen and advanced high school students, this course should be appropriate for college bound high school students. It should also be beneficial to students on co-operative work study that takes them away from the campus.

The Personalized System of Instruction (PSI) is an ideal delivery method over the Internet because the material is concrete; the incoming freshmen have a wide

variety of beginning knowledge; and computer programming is obviously a mastery-oriented subject.

3. PSI

To implement the PSI method [1,2], course material is divided into units, each containing a reading assignment, study questions, co-lateral references, study problems, and any necessary introductory or explanatory material. The student studies the units sequentially at the rate, time, and place he or she prefers. When he feels that he has completely mastered the material, a proctor gives him or her a "readiness test" to see if he may proceed to the next unit. This proctor is a student who has been carefully chosen for his mastery of the course material. On the "readiness test" the student must make a grade of 100, but if the student misses only a few questions, the proctor can probe to see if the questions are ambiguous and can reword the questions if necessary. If the student does not successfully complete the test, she is told to restudy the unit more thoroughly. She receives a different test form each time she comes to be tested. No matter how many times a student is required to retake a unit, his grade is not affected; the only interest is that he ultimately demonstrate his proficiency. All students who complete the course receive a grade of A.

The basic features of the PSI method are:

7. The go-at-your-own-pace feature, which permits a student to move through the course at a speed commensurate with his ability and other demands upon his time.
8. The unit-perfection requirement for advance, which lets the student go ahead to new material only after demonstrating mastery of that which preceded.
9. The related stress upon the written word in teacher-student communication; and, finally:
10. The use of proctors, which permits repeated testing, immediate scoring, almost unavoidable tutoring, and a marked enhancement of the personal-social aspect of the educational process.

In the original statement of PSI Dr. Keller included a provision for using lectures only for motivation. From

this overall description, it is obvious that PSI is an appealing educational strategy for use over the web. It is asynchronous, emphasizes interpersonal interaction (often missing in web based courses), and it is firmly grounded in educational psychology.

4. Theoretical background

To understand the Personalized System of Instruction and the insistence that the present implementation is a strict interpretation of the method, some background in the underlying theoretical background is essential. PSI is based on B. F. Skinner's theory of behavior called *Behaviorism*[3]. Behaviorism or reinforcement theory basically asserts that behavior is modified by its consequences. To modify an individual's behavior, a teacher should reinforce (reward) good behavior and ignore bad behavior. In this way, the probability that the organism will exhibit the desired behavior in the future is increased. It is not, however, usually desirable for technical reasons to reward desirable behavior each time it is observed. The schedule of reinforcement and the contingencies (or conditions) of reinforcement determine the strength of the behavior.

PSI is designed so that every individual in the system—the student, the proctor, and the professor—is reinforced for behavior that leads to student learning.

5. Technical problem statement

Figure 1 shows the typical behavior of any individual completing a specific task.

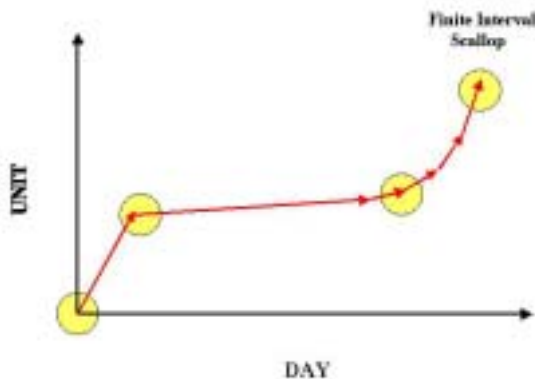


Figure 1. Learning Curve

On occasion it has been called a "learning curve" although Dr. Skinner would firmly deny that it was in any way innate, but simply represents the past schedules of reinforcement of the individual.

In this figure we have plotted the units completed in, say, a web-based course versus the class day, but it could

equally show the performance of a professor preparing a grant or a farmer planting a field, etc. Initially, there is a rapid rate of progress followed by a slower rate, and ending with a scallop near the end. This general curve is recognized in most classes by the astute professor. Several technical definitions are in order. The behavior of a student in the plateau portion is technically known as *abulia* and the scallop near the end is known as a "finite interval scallop." Informally, in English the professor recognizes the student as "cramming" during this last period. Two problems exist with this behavior: first, the student is not allocating his effort reasonably throughout the course often learning superficially near the end to finish, and more importantly, he runs the risk of not completing the course as time runs out. These problems are often associated with web-based courses.

Most professors would prefer student behavior similar to figure 2.

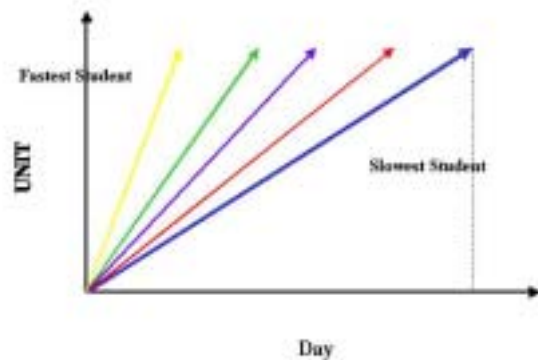


Figure 2. Desired Behavior

In this figure the student who is making faster progress (for whatever reason: better preparation, more intelligence, more time to study) is to the left and the slower student is to the right. Of course, it would be satisfactory for the faster student to delay until later in the course to begin if his workload demanded it.

Basically our problem is to achieve the desired behavior with all groups of students.

6. Undesirable solutions

Several flawed strategies have been used to manipulate the student's behavior in a PSI course. They deviate significantly from the theoretical foundation of the method by imposing external constraints on the student instead of simply reinforcing desirable behavior intermittently. The most notorious strategy to get students started is to impose a "doom's day criteria." It goes something like this: you must finish three units by the end of the first week or you will be dropped from the course." Countless observations of students show that

they will indeed work for that deadline, but then their behavior becomes extremely flat as shown in figure 3. In fact this is an extreme case of abulia. Imposing a second deadline after the first, will create additional behavior, but once again, after the deadline passes, the study behavior goes to zero. Ironically, this is precisely the study behavior we see in a standard lecture course with a series of examinations. The students cram for one exam after the other with minimum behavior in between.



Figure 3. Doom's Day Criteria

A second often-seen attempt to regulate student behavior is seen in the next figure.

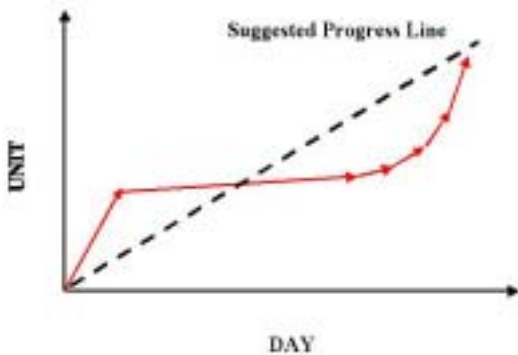


Figure 4. Suggested Progress Line

In this case, the professor has given the class a suggested progress line for completion of the course. In fact, the problem with this strategy is that it works. The average student will indeed fall on this line. The problem is that the "average student" does not exist. According to a behaviorist view of learning, we must look at the behavior of the individual student. What we find is shown in figure 5. In this figure we see the individual behavior of only two of the students in the class. It is

evident that the slower progress of the slower student is increased, but at what cost? The faster student is slowed down to likewise fit her behavior to the expectations of the professor. In other words, both students are under the control of the external goad instead of their own study behavior. This effect has been observed in a very large number of students over 32 years.

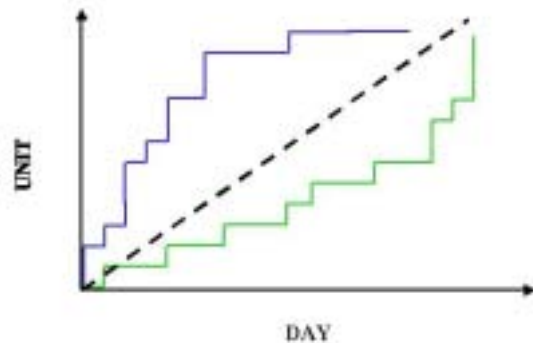


Figure 5. Effect of Suggest Progress Lines

Many other strategies have been used in the past to maintain student progress throughout a course by external control. They all deviate from a *strict* implementation of PSI. The next section discusses the only theoretically acceptable strategy—the one used in the freshman course under discussion

7. Strict implementation of PSI to maintain student progress

Consistent with Behaviorism, the correct approach is to reinforce the behavior you want to occur, confident that it will increase in strength. Several of the many uses of this principle are included here. [4]. The first group concerns the structure of the units themselves, the last few examples are more general in nature.

7.1. Make the first units small and highly reinforcing

Rather than divide the material into logical divisions that follow the chapters in a book, or into units of equal size, try to make them conform to the needs for reward of the student. The first unit should be short, fun, and easy to "hook" the student.

7.2. Initial units

Slowly increase the difficulty of the units approaching your best estimate of the "knee" of the learning curve. This is technically called "stretching the ratio."

7.3. At the "knee" of the curve

Here the units should again be shortened, made more interesting, and slightly different in style. The effort is to re-engage the student.

7.4. Near the end of the course

All students think they can finish more work in the last moment than they can. The trick is to train the students with units of a general complexity during the main portion of the course, and then include easier units at the end. In essence, we make the student's usually unrealistic expectations prove true. They can actually finish the last three units in the last week.

One of the author's colleagues chastised him for the illegal commercial procedure called "bait and switch" in the United States. The guilty merchant advertises one product and then once he gets the customer into the store, switches to a more expensive model. In this case, however, we are on sound theoretical grounds. For those interested, we are manipulating the ratio in a variable ratio schedule to maintain student progress.

The preceding sections 7.1-7.4 emphasized controlling the behavior of students and encouraging them to finish the course by manipulating the reinforcement value of the units. Other strategies are effective as well.

7.5. Approval

One of the strongest known reinforcers in the human community is approval. This is specifically designed into the PSI method. In a regular implementation of PSI, a student making satisfactory progress is encouraged and congratulated by the proctor (a peer) and the professor. This web-based course preserves this important aspect of PSI. Three web cams and a chat window attended by the proctor, the professor, and the student seeking grading of a readiness test afford ample opportunity for selectively using approval as a means of maintaining student progress.

7.6. Presence

A fundamental difference exists in a television program and a play with respect to the relationship with the audience. We should expect a parallel difference between live classroom instruction and most sterile web courses. This course tries to blur the difference between the two in a variety of ways. The professor meets the

course the first day—in person. Very early in the web course, he appears again with additional instructions. When he does so, the style used for the video clip is a professor in the classroom instead of the "talking head" that appears on the nightly news. Throughout the units approximately 15 short clips (some as short as five seconds) offer advice, encouragement, and instructions. The framing of these clips is extremely close and approximates the appearance of the professor when he is live on a web cam. The intent is to blur the distinction between when the professor is live and when he is on video. On course evaluation surveys, it is clear that the students think they know the professor in a personal way.

8. Results

This freshman course has been offered three times. The first time was a beta test with five students. All completed the course. The second time was to 15 students. Ninety-three percent of the students achieved the previously defined course objectives. The last time was with 60 students. Eighty percent of the students completed the course and eighty percent expressed satisfaction with the course structure and wanted to take another course using the same teaching strategy. The course has won a major award for its construction and effectiveness. Based upon this success, it will be required of all 150 freshmen each semester. In the future the intent is to migrate it to high school students, co-op students, and students at a greater distance. As this presentation is being given, the author is teaching this course to his students in the United States from Japan as a continuation of his research in long distance collaboration [5].

9. Conclusions

From the results of this experiment, it is clear that a professor teaching a web-based course using the PSI method can successfully maintain satisfactory progress by managing the contingencies of reinforcement at his disposal without using artificial, aversive control. Although the individual units are password protected for obvious reasons and unavailable to the general public, an overview of the site is open for inspection at:

<http://me205serv.me.utexas.edu>

10. References

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