Support for Programmed Instruction in an eTextbook

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ABSTRACT

Students often skip through instructional material without paying enough attention to the content, resulting in less understanding. Inspired by the Programmed Instruction technique, we implemented extensions to an eTextbook system to support instructional slideshows with a large number of interspersed questions. that we call a frameset. Students must answer a question correctly to pass to the next slide. This completely changes how students interact with the material.

CCS CONCEPTS

• **Social and professional topics** → *Student assessment*; • **Applied computing** → **Interactive learning environments**; • **Software and its engineering** → *Simulator / interpreter*.

KEYWORDS

OpenDSA, Programmed Instruction, Auto-generated questions, student engagement

ACM Reference Format:

Anonymized Author(s). 2021. Support for Programmed Instruction in an eTextbook. In ,. ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/1122445.1122456

1 BACKGROUND

Many instructors now use eTextbooks in their courses. But, like paper textbooks, students often skip or skim over material without really engaging. OpenDSA [3] provides infrastructure that lets instructors create eTextbooks that focus on visualizations and exercises. The slideshow is a common element in OpenDSA eTextbooks Slideshows allow students to see content broken into small amounts of text, each slide associated with a visual element, and to freely move forward and back between slides. Our previous research shows that students are more likely to engage nearly identical material when presented as a slideshow rather than as prose. But some students still skip over slides without reading, and many do not engage at the necessary level to understand the slide material.

Programmed Instruction (PI) was invented by B. F. Skinner [6] in the 1950s, and PI teaching machines were once an active topic for research and development. Much of this research died out by the early 1970s, but by then there was a developed understanding related to instruction effectiveness, learner pacing, reinforcement strategies, and long-term effects [5]. Modern web-based interactive systems make PI techniques easily implementable.

SIGCSE '21, SIGCSE '21:

ACM ISBN 978-1-4503-XXXX-X/18/06…$15.00
https://doi.org/10.1145/1122445.1122456

In hopes of increasing engagement with instructional material, we have adopted PI methods to enhance slideshow presentations in OpenDSA. A PI-enhanced slideshow (called a frameset) intersperses simple questions with nearly every slide (or frame) in the frameset. Once the question is answered correctly, students can advance to the next frame. This ensures that students read the frame content and answers the question.

2 METHODOLOGY

Our framesets are implemented in JavaScript using the JSAV library [4]. This allows instructors to easily integrate questions with visual content. Frameset question types include T/F, select the correct answers, select all correct answers on the list, fill in the blank, and embedded proficiency exercise (in general, an existing interactive exercise available within OpenDSA).

Each frameset has a JSON file associated with it that contains the specification for all questions for that frameset. A question object consists of several parts: question type, description (this frame's instructional content), question (this frame's question), correct answer, and (depending on the question type) a list of choices. To increase student feedback, instructors can also specify text to be given in the case of the correct answer, and other text to be given in the case of the incorrect answer.

We hypothesize that not all topics are equally valuable for presentation using PI techniques. Topics like data structures and algorithms have proven to be well presented using visualizations and interactive exercises that require students to demonstrate understanding of the algorithm in question by reproducing its behavior [2]. But to understand more mathematical topics requires that students stay engaged and focused on the details of the presentation [1]. Thus, we have implemented a body of materials using PI framesets for teaching a Formal Languages and Automata course, as this is one of the most mathematical topics in Computer Science. We show in detail how the PI framesets are constructed for best effect in this context.

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3 SIGNIFICANCE OF THE TOPIC

Our main goal in this project is to increase students engagement and interaction with the course content. We seek to encourage students to be active during their studying process. Instead of just reading and skipping slides, they will have to answer a question after reading a small amount of prose. Even if students tend to game the system and click on all answers, students will often see a comment about the correctness of their selected answer and why it is correct or not.

We believe this poster will engage the SIGCSE community, as many participants are CS instructors who have had their own experiences with unengaged student behaviour while reading from online books/systems. Presenting details on our implemented tool will give them insights for using the PI technique in their courses.

This poster will demonstrate the system using materials from our Formal Languages course. This poster can be viewed as a companion to our accepted SIGCSE21 paper about presenting the formal languages course with the use of formal language simulators and interactive exercises. The SIGCSE21 regular paper describes the course as it existed in Spring and Summer 2020, before we adopted framesets for presenting key course material. In this poster, we are able to provide both detailed description of how the framesets are developed by instructors, and initial results from our use of framesets during the Fall 2020 semester. None of this material is in the regular paper.

4 POSTER LAYOUT

The poster will contain five main panels.

4.1 Problem Statement

Here we will describe the drawbacks of using slideshows only in eTextbooks. In particular, we explain the pedagogical differences between slideshows and framesets.

4.2 Framesets Examples

Here we will provide examples of different types of framset questions, and how instructors can provide questions to students with meaningful comments for students correct/incorrect answers.

4.3 How to Create Questions

This section will provide steps and examples about how instructors can create questions and provide feedback for them. Providing many questions to students interspersed with content is normally a cumbersome task. We show how this is relatively easy with a dedicated tool. This will hopefully lead to content with more interaction and engagement for students, which in turn will lead to better understanding.

4.4 Results

Here we present results from the statistical analysis for student time spent using frames. This semester we are using an OpenDSA eTextbook for Formal Languages. We have refactored the Formal Languages book as described in our SIGSCE21 paper to present most material in Programmed Instruction form by using the framesets. In this section, we will provide comparison for students grades when using a book that has PI-frameset versus the same course with traditional slideshows.

We will also present information on student satisfaction for the developed PI-framesets by analyzing students surveys about the developed frameset.