Chapter 20
Open Content Authoring Tools

Leena Razzaq¹ and Neil T. Heffernan²

¹ Center for Knowledge Communication, 140 Governor's Drive,
University of Massachusetts Amherst, MA 01003-4610
leena@cs.umass.edu
² Worcester Polytechnic Institute, Computer Science Department,
Massachusetts, 01609-2280, USA
nth@wpi.edu

Abstract. Education researchers often disagree about the best ways to improve student achievement. The difficulty of designing, conducting, and analyzing experiments means that there is often a dearth of empirical data to support or refute ideas. To design and conduct a simple randomized controlled experiment to compare two different ways of teaching requires a great deal of effort by a teacher or a researcher. The difficulty of conducting such experiments, and then later analyzing the results, may be why so few randomized controlled experiments are conducted in education. One of the goals of the ASSISTment System is to reduce some of those difficulties. We have built web-based tools that allow researchers to easily design, build and then compare different ways to teach children. These tools can administer randomized controlled experiments to large numbers of students. This paper describes these tools and describes a randomized controlled study that was conducted using them.

20.1 Introduction

Similar to many education researchers, mathematics education researchers tend to have heated arguments about what are the best ways to raise student achievement levels. Unfortunately, there is often a dearth of empirical data to support either side. This lack of empirical data is, at least partly, caused by the difficulty of designing, conducting, and analyzing experiments. While not all questions are best settled with randomized controlled experiments, some are. However, to design and conduct a simple randomized controlled experiment to try to compare two different ways of teaching requires a great deal of effort by a teacher or a researcher. Researchers not only must design and author the content for pretests, post-tests and each experimental condition, but they must also randomly assign students to conditions and collect and analyze large amounts of data.

The difficulty of conducting such experiments, and then later analyzing the results, are probably some of the reasons that so few randomized experiment are conducted in education. Intelligent tutoring systems can alleviate some of these
difficulties such as randomly assigning students, delivering content and collecting data. However, most tutoring systems require computer programming skills to accomplish these tasks and do not make it easy for researchers without programming skills to create new experiments.

One of the goals of the ASSISTment System is to reduce some of those difficulties. The ASSISTment System is a web-based tutoring system that includes web-based authoring tools that allow researchers to easily design, build and then compare different ways to teach mathematics. No computer programming skills are needed. These tools can administer randomized controlled experiments to large numbers of students.

This paper describes the ASSISTment System’s tools for education research. We also describe how we designed and conducted a randomized controlled experiment to compare two ways of tutoring eighth grade math.

20.2 The ASSISTment System

The ASSISTment System is joint research conducted at Worcester Polytechnic Institute and Carnegie Mellon University and is funded by grants from the U.S. Department of Education, the National Science Foundation, and the Office of Naval Research. The ASSISTment System’s goal is to provide cognitive-based assessment of students while providing tutoring content to students.

The ASSISTment System aims to assist students in learning the different skills needed for the Massachusetts Comprehensive Assessment System (MCAS) test or (other state tests) while at the same time assessing student knowledge to provide teachers with fine-grained assessment of their students; it assists while it assesses. The system assists students in learning different skills through the use of scaffolding questions, hints, and messages for incorrect answers (also known as buggy messages) (Razzaq et al. 2007). Assessment of student performance is provided to teachers through real-time reports based on statistical analysis. Using the web-based ASSISTment System is free and only requires registration on our website; no software need be installed. Our system is primarily used by middle- and high-school teachers throughout Massachusetts who are preparing students for the MCAS tests. Currently, we have over 3000 students and 50 teachers using our system as part of their regular math classes. We have had over 30 teachers use the system to create content.

We are attempting to support the full life cycle of content authoring with the tools available in the ASSISTment System. Teachers can create problems with tutoring, map each question to the skills required to solve them, bundle problems together in sequences that students work on, view reports on students’ work and use tools to maintain and refine their content over time.

20.2.1 Structure of an ASSISTment

Koedinger et al. (Koedinger et al. 2004) introduced example-tracing tutors, which mimic cognitive tutors (Anderson et al. 1995) but are limited to the scope of a