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Report from the Field

An Intelligent Tutoring System for Adult Literacy Learners: Lessons for Practitioners

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Abstract

This article is written by two researchers and a teacher involved with the development and implementation of a web-based intelligent tutoring system for adults reading at elementary levels. A description of the tool is provided, followed by some of the challenges faced in designing, developing, and using the tool in adult literacy classrooms.

Keywords: digital literacy tools, adult basic education, reading comprehension, intelligent tutoring systems

Teaching reading comprehension to adults can be daunting because it is a multi-faceted activity involving many underlying processes, including vocabulary, background knowledge, memory, and reasoning (Greenberg et al., 2017). Many instructors do not have in-depth knowledge of key comprehension strategies and/or do not have the training on how to effectively teach these strategies (National Reading Council, 2012). Compounding these issues is that while learners may score similarly on the Tests of Adult Basic Education (TABE; 2019), their underlying knowledge and application of comprehension strategies to complicated text may vary from one learner to another. Finally, many learners have trouble attending class on a consistent basis (Greenberg et al., 2013) which makes it difficult to deliver the continuous instruction necessary for developing reading comprehension skills. Within this context, AutoTutor was designed as a supplemental reading comprehension instructional digital tool for adults. Specifically, it was created by researchers as part of an intervention study (Grant R305C120001) that included group face-to-face reading instruction interweaved with independent AutoTutor lessons. Our sample included adults identified as reading between the third and eighth grade levels by their

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adult education programs in the metro-Atlanta and metro-Toronto areas.

There is precedence for using instructional apps for teaching reading comprehension strategies with various populations such as children and nonnative English speakers (e.g., Klimova & Zamborova, 2020; McCarthy et al., 2020). In the past two decades, there has been an increase of digital tools used with adult literacy learners (Dixon, 2020). However, compared to other populations, there is a paucity of digital tools specifically designed for adult learners (Graesser et al., 2019). In addition, the poor infrastructure of many adult basic education programs makes incorporating technology a challenge (Rosen & Vanek, 2017). This article, written by two researchers and a teacher, describes the development and implementation of a digital tool that takes into consideration the needs of adult learners and the infrastructure of adult basic education programs. We hope that the descriptions of our experiences will conjure issues for practitioners to consider when making decisions about classroom digital tool use.

Description of AutoTutor

AutoTutor is a web-based tool with 30 lessons teaching five categories of reading comprehension strategies known to be problematic for individuals who struggle with reading: predicting purpose, acquiring vocabulary, clarifying sources of confusion, evaluating and elaborating, and summarizing (Lovett et al., 2012). Each lesson takes between 20 to 55 minutes. Most lessons are preceded by an optional 2-minute video which overviews key concepts that the lesson will cover. AutoTutor was designed to work on a desktop computer, laptop computer, Chromebook, and tablet. Headphones are needed if the learner is in a classroom or other public setting (more information on AutoTutor can be found in Graesser et al., 2019).

Adult Learners and Their Instructors

Good literacy instruction needs to be engaging and follow core principles of effective instruction, such as the use of authentic materials, esteem boosters, and sensitivity to the skills of each individual learner (National Reading Council, 2012). AutoTutor was designed to meet these criteria. As shown by the example in Figure 1, lesson topics include authentic materials such as help wanted ads, job applications and rental agreements. It includes two animated conversational instructional agents (Cristina, the computer agent instructor and Jordan, a computer agent student) who engage with the learner in a conversational *trialogue*. Learners are logged in using their name so that, throughout the lesson, both Cristina and Jordan refer to the learner by his/her name (a feature which our learners loved). After the 2-minute video, lessons often begin with Jordan (the computer agent student) providing a real-life problem upon which Cristina (the computer agent instructor) bases the lesson and associated activities. Many learners have difficulty with spelling and writing (National Reading Council, 2012). Therefore, AutoTutor activities require that learners respond by selecting a correct answer to a question about a text by highlighting, dragging, or clicking answer choices.

AutoTutor is very interactive. As seen in Figure 1, the learner sees two "talking heads" on the top of the screen (Cristina and Jordan). Two agents have some advantages over a single agent interacting with the learner (Graesser et al., 2017). For example, adult learners often have histories of low academic self-esteem (National Reading Council, 2012), so AutoTutor is designed

to minimize the amount of negative feedback learners receive by Cristina who typically directs her negative feedback to Jordan. In AutoTutor, the learner often answers Cristina's questions before Jordan, with algorithms created such that Jordan is incorrect more often than the learner. Our learners occasionally were found yelling at Jordan that he needs to listen to them more often! They seemed to especially enjoy the occasional game competition mode embedded in some of the lessons, with the learner's score always either winning or tying Jordan's score.

While learners responded very positively to hearing their names used by Cristina and Jordan and the fact that the agents sounded clear, crisp, and usually natural sounding, we struggled with the notion that both learners and teachers stated that they wanted Cristina and Jordan to face each other when talking. We tried to alter the programming scripts to give Cristina and Jordan more natural movement towards each other and the learner. Unfortunately, due to time and money, this could not be attained. We also grappled with the quantity and quality of Cristina's feedback after correct and incorrect responses were provided by the learner and/or Jordan. This was resolved after many team discussions for each specific lesson.

AutoTutor was designed to be adaptive to individual learner performance. In many lessons, all learners start at the same activity difficulty level and are then tracked onto a more or less challenging activity based on their performance. A progress bar is shown so learners can see how far along they are in the lesson. In addition, next to each lesson learners can see a recycle symbol indicating that they may want to repeat a lesson because they did not complete it or did not pass (defined as 67% or higher). A function is included that allows learners to listen to the text being read aloud as well as a button to repeat questions. If a lesson is interrupted by a technology malfunction/freeze or a learner break, the learner can resume the lesson and "recover" his/her position within 4 hours. For an illustration of our learner experience, please watch this YouTube: https://www.youtube.com/watch?v=lZ6iEsq6VFQ&t=6s.

Many adult learners have limited digital literacy skills (Graesser et al., 2019). We surveyed learners to find out how to create a program that they could use on their own, plus create a digital literacy tutorial program to ensure that they all had the prerequisite digital skills. To aid us in this endeavor, the NorthStar Digital Literacy project of Literacy Minnesota customized a digital literacy assessment for us, and we tested a sample of 105 adults reading at the 3rd-8th grade levels. Based on the results, we decided that students needed to be taught how to scroll up and down, and that for responses we should only require clicking, highlighting, and dragging answers (Graesser et al., 2019).

Learners can see their performance history. When they log into AutoTutor and look at the lesson list, they see a green check mark next to the lessons on which they received a passing score. For lessons where they did not receive a passing score, or which they did not complete, they see a red refresh circle. This is a cue that they may want to retake this lesson. Many of our students repeated lessons at home that they had not passed in class until they were satisfied with their performance.

AutoTutor performance data is also provided for instructors at class, learner, lesson, and item levels. Teachers can drill down into learner data to investigate information such as the time a learner spent on a lesson, the time that they spent reading the materials for a lesson, the path they took on an adaptive lesson (easier vs. harder), and whether they were correct on a specific question.

Percentages of individual learner correct responses on each lesson is printed in red (not passing) or green (passing), so that teachers can get a quick glimpse of how many in a class passed a particular lesson. The data collected by AutoTutor helped our teachers keep track of how their learners were progressing. It also provided information to our researchers, who through their data analysis found that student AutoTutor engagement significantly predicted reading comprehension learning gains (Chen et al., 2021).

Adult Basic Education Program Infrastructure

Implementing technology into adult basic education programs is challenging given the myriad of infrastructure issues facing these programs (Rosen & Vanek, 2017). Below, we describe the challenges we experienced and how we overcame them.

Equipment

Many of our programs did not have enough computers with adequate speed/memory and/or enough mice, headphones, power cords, and extension cords. We therefore supplied our sites with the necessary equipment. Getting the equipment ready for classes presented quite a challenge. After all the equipment was purchased and received, we needed to test all the equipment at each participating program. Next, we needed to test AutoTutor on all computers at the different sites, to make sure that the interaction between AutoTutor and the equipment ran smoothly when all computers were being used simultaneously.

Internet

We needed to make sure that there was adequate bandwidth available to access online programs with a class full of simultaneous users. The number of users can sometimes influence response times from the computer, in our case particularly when sites were conducting TABE (2019) testing. Some sites had firewalls which created obstacles. For example, AutoTutor initially used a YouTube platform, but unfortunately one of our classes was in a location that blocked YouTube. We had to work around this by using a portable Wi-Fi, which we provided, thereby implementing an internal video player. By creating an internal video player in our system and hosting all video content on our own server, we were able to gain greater control over the system and give access to sites where social media content was blocked.

Onsite Technology Specialists

Most of our difficulties involved troubleshooting in terms of connectivity issues. Often programs would make changes to their internet configurations after AutoTutor implementation had started which resulted in new connectivity issues. It helped when there was an onsite technology specialist to provide support before and during implementation. When problems arose, we needed to troubleshoot whether the glitch was due to a problem with AutoTutor or a problem with the internet connectivity of the site.

Implications for Adult Educators

We hope that sharing our experiences helps practitioners as they consider using digital tools with their learners. We invite practitioners to review a guide for digital tool inclusion in Figure 2. Although not every digital tool will necessarily have all the features listed, we hope that this guide will be useful to practitioners who want to select digital tools for their learners.

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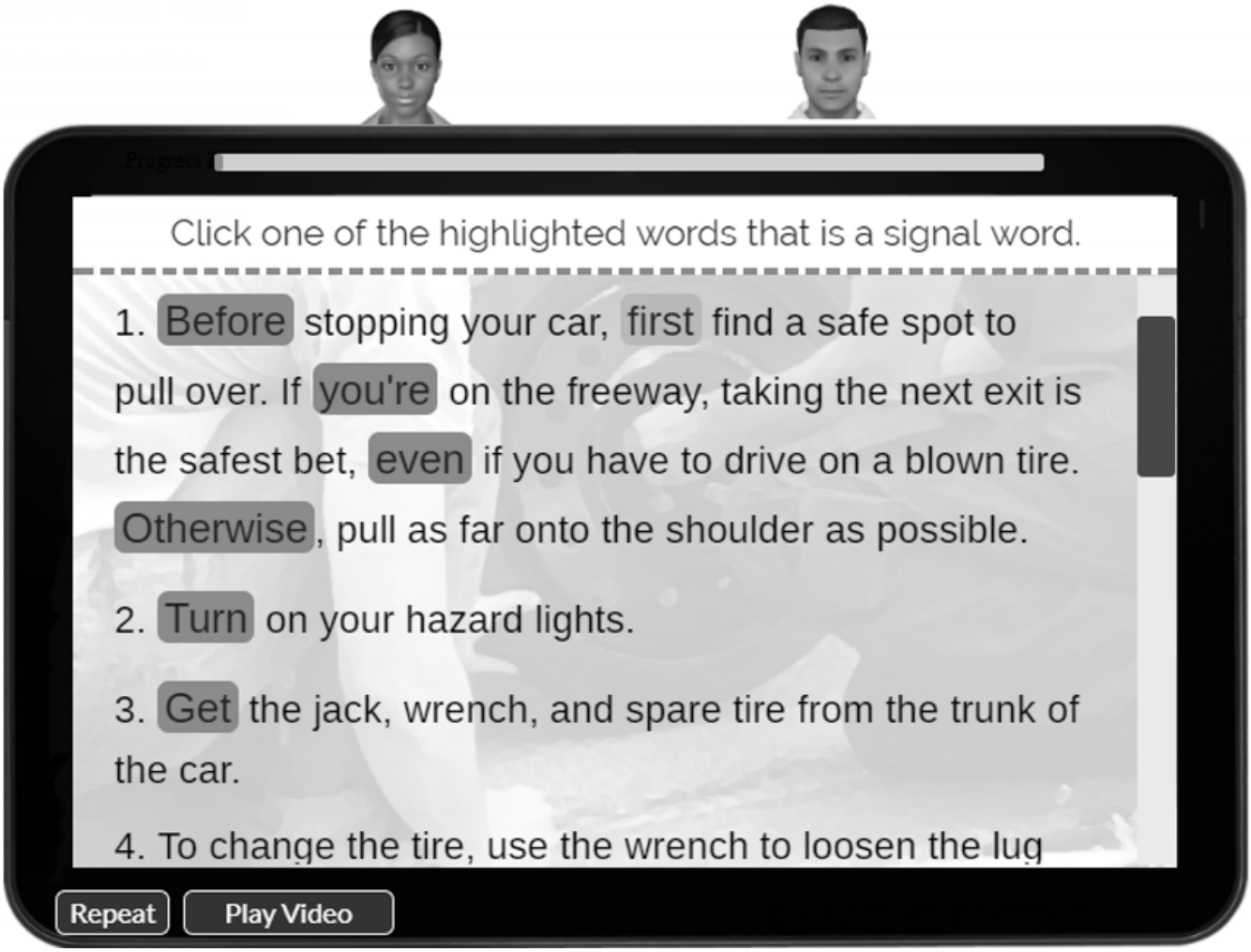
FIGURE 1. Example screenshot and conversation for a lesson on changing a tire.



1. **Cristina** (**teacher agent**)**:** Tiffany, click on the words that signal to us the order in which a procedure is done.
2. **Tiffany** (**adult literacy student**)**:** [selects the word *first* (correct answer)]
3. **Cristina:** Yeah! That is right! *Before* and *first* are signal words. These words signal to us that we must do something prior to doing something else.

FIGURE 2: A guide for practitioners who make decisions about digital tool use in classrooms

- Does each lesson include background knowledge building activities?
- Are authentic adult-oriented topics and examples used in each lesson?
- Does the tool require more than minimal digital literacy skills?
- Is the tool adaptive based on the learner's performance?
- Is corrective feedback presented in a fashion that does not discourage the learner?
- Is there an audio function, so that learners can follow along while the computer reads the text?
- Is there a repeat function, so that learners can have content repeated?
- Is the audio quality of the tool crisp and clear?
- Do learners get real-time performance feedback?
- Does the tool provide the teacher with group and individual performance?
- Does the classroom have the equipment and Wi-fi connectivity necessary for the tool?
- Is the tool a "standalone" tool, or is it one that supplements a specific curriculum?
- Is the tool one that can be easily used on different platforms (e.g., smartphones, laptops, iPads, etc.)?