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Using Embedded Agents to Support Learning

Center for Technology Implementation

Overview

Animated agents and tutors can help provide students with disabilities with targeted, just-in-time supports for learning.

Agents and tutors are the lifelike characters in multimedia software and online applications that pop up on the screen to explain rules, provide hints, or prompt the user to use the program's features. These characters can be human or nonhuman, animated or static. You may have encountered agents when using Microsoft Office (in the form of the "Microsoft Paperclip") or when shopping online. Some businesses, such as Ikea, have developed agents with a degree of artificial intelligence to help shoppers find the information and answers they are looking for without having to call customer service.

In Your Classroom

As technologies improve, more software programs and websites are using agents to assist users as they navigate the program or website, problem solve, search for resources, or contact support.

Students can make use of these agents in a variety of ways. Multimedia agents have been found to:

- Increase interest and lessen content difficulty
- Serve as an effective mentor or tutor
- Simulate peer tutoring

Multimedia environments with well-designed agents can provide just-in-time prompts that support students as they learn content. Most students enjoy agents and find their advice valuable.

Although not all software tools make use of agents or helpers, many tools are adding this feature. Using multimedia agents can be a great way to provide multiple options for representation, engagement, and action.

Digital agents or tutors can provide students with supplemental instruction and guided practice on any number of academic skills. For example, many reading programs now use agents to help students build skills and fluency, or to prompt students to apply comprehension strategies. Similarly, agents are embedded in simulation software that teaches mathematics and science.

Multimedia environments that use agents can support students' understanding of content area concepts and the relationships between ideas and concepts within a discipline.

Choosing Programs With Animated Agents

When evaluating multimedia programs for your classroom, it is important to determine what type of interaction the agent has with users, as well as the quality of the interaction it solicits from users. Focus on programs with agents that:

- Ask questions that promote higher-order thinking ("why," "what if," and "how" questions).
- Do not limit or define student thinking about a topic. Beware of agents that provide students with shallow definitions of key concepts. Look instead for tools that represent multiple perspectives and encourage deep thinking and reflection.
- Speak in a personalized manner, meaning that they refer to students either by name or as "you." For example: "Now, I'm going to help you get started..."

What the Research Says

A series of side-by-side comparison studies with youth and young adults have shown that student learning and interaction are enhanced when they have the opportunity to work with an embedded agent or tutor that is programmed to demonstrate emotions and to speak in a personalized manner (using "you" and "me/we") instead of a static graphic agent or voice narration only (Maloy, Razzaq, & Edwards, 2014; Moreno, 2005; Roll, Aleven, McLaren, & Koedinger, 2011; Ward, Cole, Bolanos, Buchenroth-Martin, et al., 2013; VanLehn, 2011).

In a recent study by Maloy, Razzaq, and Edwards (2014), fourth-grade students completed mathematics modules with the assistance of an online multimedia tutoring system for mathematical problem solving. Students chose one of four agents to act as a tutor: Estella Explainer, Chef Math Bear, How-to-Hound, or Visual Vicuna. Each agent offered problem-solving strategies from different points of view. Students using the online tutoring system achieved an average gain of 23.5 percent (pretest to posttest) across all modules and showed increased confidence in their ability to do mathematics (Maloy, Razzaq, & Edwards, 2014).

Two related studies investigated the use of The Help Tutor—an intelligent agent designed to provide feedback on student help-seeking efforts and determine the impact of this support on the development of student help-seeking skills (Roll, Aleven, McLaren, & Koedinger 2011). The Help Tutor was effective in improving students' help-seeking skills. Further, these improved help-seeking skills helped students to learn new content one month after the help-seeking support was no longer in place.

Further evidence supports the contention that virtual tutoring provided by agents can be as effective as human tutoring (Ward, Cole, Bolanos, Buchenroth-Martin, et al., 2013; VanLehn, 2011). For example, a study of My Science Tutor—an intelligent tutoring system designed to improve elementary school students' science learning—found that this tool was as effective as a human tutor, and more effective than no tutoring (Ward, et. al., 2013). These results confirmed the work of VanLehn (2011), who compared the effectiveness of human tutoring, computer tutoring, and no tutoring. He found that computer and human tutoring yielded similar results in student outcomes.

Atkinson (2002) evaluated student interactions with Peedy, a parrot with a personality, in a multimedia program designed to assist students with algebraic word problems. Undergraduate students working with Peedy reported less difficulty and had higher posttest scores than students in the control condition, who worked with the same narration but without the Peedy agent. Moreover, students who worked with a talking version of Peedy benefited on posttests

more than students who worked with a version of Peedy that presented written explanations in a thought bubble. Students in a study by Moundridou and Virvou (2002) also reported experiencing less difficulty and greater enjoyment with a multimedia program featuring an agent that helped students solve algebraic equations than they did when using the program without the agent.

In another study, middle school students worked with multiple versions of a multimedia agent called "Herman the Bug" within a multimedia program about botany (Lester, Stone, & Stelling, 1999). Changes in test scores demonstrated that all students learned the material, but students who worked with a speaking Herman reported higher levels of interest and engagement than their counterparts who worked with less interactive versions of Herman.

Researchers at the University of Memphis are designing agents that may increase reading comprehension by prompting students to self-explain their learning—i.e., asking themselves "why," "what if," and "how" questions—and engaging them in an interactive dialogue that reinforces reading strategies. AutoTutor and iSTART are two Web-based prototypes that incorporate such agents. Both have been shown to be effective at increasing comprehension of science content text among youth and young adults (Graesser, McNamara, & Van Lehn, 2005; Graesser et al., 2004). AutoTutor uses a human-like head to provide explanations, while iSTART uses a collection of three-dimensional agents, each performing a different function in the training module. Interactive dialogues are incorporated directly into the program through the agent or developed through peer interaction within student pairs. Peer dialogue around a multimedia learning experience has been shown elsewhere to improve learning for young adults (Craig, Driscoll, & Gholson, 2004).

An animated agent is an integral part of the commercial program Thinking Reader® (Tom Snyder Productions, Scholastic). This program embeds strategy instruction into award-winning novels for intermediate and middle school students and is based on research conducted with struggling adolescent readers (Dalton, Pisha, Eagleton, Coyne, & Deysher, 2001). These books are digitized and embedded with multiple supports, including human voice narration, text-to-speech technology, a multimedia glossary, background knowledge links, strategy instruction, and a work log. Agents prompt the students to "stop and think" (i.e., apply reading strategies) and provide corrective feedback on students' performance. These books have been shown to significantly improve the reading comprehension of struggling readers compared with traditional reciprocal teaching instruction (Dalton et al., 2001).

In another study, researchers developed a multimedia training environment called the Language Wizard/Player that included an agent named Baldi, who served as a speech-language tutor. This agent provided specific feedback on students' vocabulary and speech production. Baldi's skin could be made transparent to show the articulatory movements in the mouth and throat. The results showed that Baldi helped young children with autism to increase their vocabulary and generalize their new words to natural settings (Bosseler & Massaro, 2003).

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