Beetle-Grow: An Effective Intelligent Tutoring System to Support Conceptual Change

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Abstract
We will demonstrate the Beetle-Grow intelligent tutoring system, which combines active experimentation, self-explanation, and formative feedback using natural language interaction. It runs in a standard web browser and has a fresh, engaging design. The underlying back-end system has previously been shown to be highly effective in teaching basic electricity and electronics concepts.

Beetle-Grow has been designed to capture student interaction and indicators of learning in a form suitable for data mining, and to support future work on building tools for interactive tutoring that improve after experiencing interaction with students, as human tutors do.

We are interested in partnering with teachers and other education researchers to carry out large-scale user trials with Beetle-Grow in the classroom and remotely.

Author Keywords
intelligent tutoring; natural language; interaction data; conceptual learning; physics; electronics

Description of Demonstration
Our demonstration will showcase the Beetle-Grow intelligent tutoring system [3]. Student interaction data (Figure 1) and other indicators of learning are logged in a format suitable for data mining and as training data for

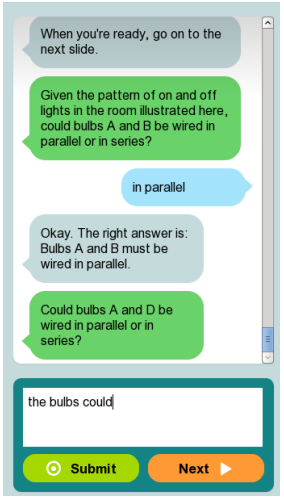

Figure 1: Students use natural language to answer questions in a familiar 'chat'-style interface.

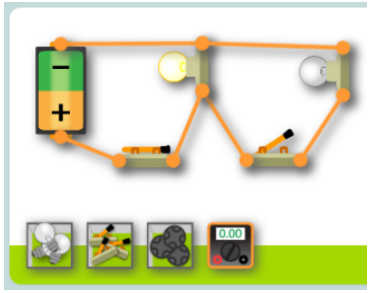

Figure 2: The interactive circuit workbench allows learners to experiment freely.

machine learning. The system can be accessed through a standard web browser and is designed for large-scale data collection, while also delivering a valuable learning experience in its own right.

The curriculum used in BEETLE-GROW implements the conceptual change instructional approach [1] in the context of a simulated circuit workbench (Figure 2). This approach encourages students to think deeply about the phenomena that they observe and to attempt to infer the underlying explanatory principles in the domain. User studies have shown it to be highly effective, producing significant pre- to post-test learning gains [2].

Our demonstration will work through example exercises from the curriculum that illustrate the conceptual change approach. These examples include (a) using voltage to find a fault in a simple series circuit, (b) understanding the behavior of bulbs in a parallel circuit with multiple switches, and (c) a more complex exercise involving deducing possible wiring arrangements from observed behavior in the real world (Figure 3). We will also describe and discuss the student answers and indicators of learning collected in the online learning environment.

We will use a laptop computer for our demonstration and an external screen for display if possible. Attendees will also be encouraged to try out BEETLE-GROW on their own mobile devices. It can be accessed at http://beetle-grow.inf.ed.ac.uk.

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Figure 3: The browser-based user interface uses industry standard technologies: HTML5, CSS3, JavaScript, and the Play Framework, an open source web programming framework.

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