CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

S0417

Project Title

An Artificial Intelligence Enhanced Teaching Model that Significantly Improves Effectiveness and Efficiency in Science

Abstract

Objectives/Goals

The United States is ranked 21st in science among the 34 OECD countries on PISA 2012. Researchers state that any reform of science education must take place "in the classroom." My objectives were to (a) develop an innovative artificial intelligence (AI) enhanced teaching model, (b) compare its effectiveness and efficiency with traditional, direct instruction (DI) at both college and high school levels, and (c) optimize the new teaching model by testing whether variables such as sound and grouping matter.

Methods/Materials

My teaching model applied the cognitive load theories and combined expertise in areas of education, AI architecture, and science. I created an AI computer program as a pedagogical agent to implement research in guided student-centered learning that embedded 73 checkpoints for individualized guidance. In Exp. 1 (N=43, college) and Exp. 2 (N=107, high school), subjects were randomly assigned to the AI or DI group and took pretest and posttest before and after the instruction time. In Exp. 3, another 114 students were tested to determine the best AI condition among: (a) sound-individual (one student per computer), (b) sound-paired (2 per computer), (c) no sound-individual, and (d) no sound-paired.

Results

T-tests detected a significant difference in effectivenss (factual, conceptual, and procedural knowledge gains) between AI and DI in both college ($p=0.00$, $d=1.43$) and high school ($p=0.00$, $d=1.53$), as well as in efficiency (high performance with low mental effort). The d values (>0.80) indicated remarkably large effect sizes. AI increased knowledge gains by 122% in college and 78% in HS. One-way ANOVA and Post Hoc found no significant differences among the 4 AI conditions (Exp. 3). A further two-way ANOVA found neither main effect nor interaction effect between sound and grouping, suggesting that my AI-enhanced teaching model can be implemented with much flexibility to achieve similar learning gains.

Conclusions/Discussion

My project is significant because it (1) answered the call of the US Department of Education in translating many research recommendations into practice in science classrooms, (2) developed an AI-enhanced teaching model that significantly improved the effectiveness and efficiency of guided student-centered learning, which can potentially have a global impact on students, and (3) demonstrated the flexible implementation of the teaching model, adapting to individual preferences of teachers and students.

Summary Statement

I developed an AI-enhanced teaching model that significantly increased instructional effectiveness and efficiency in science, replicated results in both college and high school, and demonstrated its flexible implementation.

Help Received

I received advice on research directions, experimental design, and data analysis from professors in education, math, and chemistry. My high school chemistry teacher and four college professors provided subjects for Experiments 1-3.