



CALIFORNIA STATE SCIENCE FAIR 2016 PROJECT SUMMARY

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| Name(s) Anna J. Lou | Project Number 36887 |
| Project Title Closing the Achievement Gap in STEM: Effect of Prior Knowledge on Guidance in Technology-Based Student-Centered Learning | |
| Abstract Objectives/Goals As the United States is falling behind in STEM education and struggling with the achievement gap, there have been many practical obstacles concerning teachers and existing multimedia tools in implementing research-recommended guidance in student-centered learning (SCL) into classrooms. Based on the Cognitive Load Theory and meta-analytic findings, I developed an innovative web-based instructional tool that combined expertise from educational research and best teaching practices to overcome these obstacles and enhance Guided-SCL in chemistry. My objectives were to (a) compare Guided-SCL's short and long term effectiveness with other approaches such as traditional Direct Instruction (DI) and Khan Academy, (b) examine Guided-SCL's short and long term effects on the achievement gap between students with low prior knowledge (LK) and high prior knowledge (HK) and (c) investigate how prior-knowledge level would influence the guidance effects (prior-knowledge activation effect and feedback effect) of Guided-SCL on learning outcomes. Results College students (N = 185) were randomly assigned to Guided-SCL or either of two control groups and were given pre-posttests and one month follow-up tests, resulting in the following key findings: (a) Guided-SCL significantly outperformed traditional direct instruction (d = 1.60, 262% increase) and Khan Academy (d = 1.42, 185% increase) with long-term effects; (b) Guided-SCL fully closed the achievement gap between students with low prior knowledge (LK) and high prior knowledge (HK) for both conceptual and procedural knowledge; (c) Consistent with the Expertise Reversal Effect, prior-knowledge activation significantly benefited LK (d = 0.84) both in the short term and the long term, but harmed HK (d = -0.46); (d) Feedback timing (immediate vs. delayed) made no difference for LK and HK when explanatory feedback was also provided. Conclusions/Discussion This novel work in chemistry classrooms provides the greatly-needed empirical data supporting guidance in SCL and contributes new insight towards more effective and adaptive instructional designs, as well as towards existing research in learning theories. By translating research into practice, this study demonstrates the great potential of using innovative research-based technology to close the achievement gap and improve STEM education in the United States. | |
| Summary Statement My study is the first to systematically implement research-recommended guidance into classrooms and study the influence of prior knowledge on guidance effects, demonstrating the great potential of research-based technology. | |
| Help Received Dr. Susanne Jaeggi (School of Education at UCI) and Dr. James Li provided me with professional feedback and valuable advice. Five chemistry teachers and professors gave input to the design of my instructional tool. Seven additional chemistry professors provided subjects in their classrooms for testing. | |