Integrating Information Technology and Science Education for the Future: A Theoretical Review on the Educational Use of Interactive Simulations

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Digital aids such as animations and simulations provide opportunities to test predictions that cannot be investigated through practical experiments in the classroom and may enhance students’ understanding and engagement with science.

(ACARA, 2010)
Outline

1. Goals of Science Education
2. Interactive Simulations
3. Why Study Interactive Simulations?
4. Implementations of Interactive Simulations in Science Education
5. Further Research
Goals of Science Education

1. Develop conceptual understanding
2. Foster science process skills
3. Help students understand the nature of science
4. Teach the unique conventions of scientific discourse
5. Maintain motivation for science learning
6. Support self-identification as scientific thinkers

(National Research Council, 2005)
Goals of Science Education

Dimension 1: Sparking motivation to learn science;

Dimension 2: Developing conceptual understanding;

Dimension 3: Promoting science process skills and understanding of the nature of science;

Dimension 4: Developing students’ skills in scientific argumentation and identification.
Interactive Simulations

- Interactive simulations as external visual representations of dynamic systems of scientific phenomena are considered to be ‘exploratory’ applications.

- Students can observe scientific elements, manipulate experimental parameters, test hypotheses, and get feedback in a timely way (Kozma & Russell, 2005; Gilbert & Boulter, 1998; Plass, Homer, & Hayward, 2009).
Theoretical Frameworks for Studying Interactive Simulations

- Constructivism (Geelan, 1997)

- Mental models and model-based learning (GOBERT, 2000, 2005)

- Cognitive load theory (Sweller, van Merrienboer & Paas, 1998)

- Dual coding theory (Paivio, 1986)
Goal 1: Sparking Motivation to Learn Science

Results of national surveys showed that K-12 students enjoy learning science through interactive simulations

(Partnership for reform in science and Mathematics, 2005; Project Tomorrow and PASCO Scientific, 2008)
Implementations of Interactive Simulations in Science Education

Goal 2: Developing Conceptual Understanding

+ de Jong (2009)
+ Quellmalz, Timms, & Schneider (2009)
+ Evans, Yaron & Leinhardt (2008)
+ Yaron & Leinhardt (2008)

- Clark, et al. (2009)
- Xie & Tinker (2006)
Implementations of Interactive Simulations in Science Education

Goal 3: Promoting Science Process Skills and Understanding of the Nature of Science

• Klopfer, Yoon, and Um (2004)
• Buckley, Gobert, and Horwitz (2006)
• Klahr, Triona and Williams (2007)
Goal 4: Realizing Scientific Argumentation and Identification with Science Learning

Students constructed scientific arguments and became more confident in science learning when they used ChemSense representations (Michalchik, 2008)
Future Research

Cooperation between educational researchers, cognitive scientists, technology designers and policymakers is critical to integrate interactive simulations with science education.
Thank you

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