Teaching strategies that support student development of conceptual understanding of chemical equilibrium using visualization software

K. W.P. Anula Weerawardhana

University of Wollongong

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Teaching Strategies that Support Student Development of Conceptual Understanding of Chemical Equilibrium Using Visualization Software

A thesis submitted in fulfilment of the requirements for the award of the degree

Doctor of Philosophy

From

University of Wollongong

By

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B Sc, PG Dip Ed, M Ed (IT in Ed & Training), M Phil

Faculty of Education

2006
Declaration

I declare that this thesis submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Education, University of Wollongong, represents my original work unless it has been otherwise referenced or acknowledged, and the document has not been previously submitted for qualifications at any other university or academic institution.

K.W. P. Anula Weerawardhana
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Abstract

Many researchers and examiners report that senior high school students often have an inadequate understanding of fundamental chemical concepts. Chemical equilibrium is an example of one of these concepts and researchers suggest that the abstract and dynamic nature of chemical equilibrium is one reason why learning/teaching difficulties occur.

For the purpose of this study, conceptual understanding of chemistry is defined as a blend of conceptual knowledge, the ability to translate among different representations, and the application of this knowledge to new situations.

The study focused on the contribution of multiple representations to learning and teaching strategies that assist senior high school students and teachers to develop conceptual understanding of chemical equilibrium. This purpose was achieved progressively through answering four research questions.

1. What difficulties do students face when developing conceptual understanding of abstract chemistry concepts, particularly chemical equilibrium?

2. What difficulties do teachers face when developing students' understanding of abstract chemistry concepts, particularly chemical equilibrium?

3. What features of computer-based visualization software support the development of conceptual understanding of chemical equilibrium?

4. What strategies do teachers employ when they use these features of computer-based visualisation software in classroom teaching?

An investigation of students' performance in the HSC Chemistry examination found lower performance in two areas: use of language; and factual, conceptual and procedural knowledge. Three possibilities for students' lower performance were explored here through the literature review. In addition, two major areas of teachers' difficulties in facilitating students' conceptual understanding of chemical equilibrium were identified from the literature review.

Two instructional software programs, SMV: CHEM - Synchronized Multiple Visualisations of Chemistry and VisChem - Visualising the Molecular World, that focus on teaching chemistry with macroscopic, sub-microscopic and symbolic
representations, were reviewed. The review identified specific computer-based visual techniques and appropriate software elements that could be used to address some of the learning/teaching difficulties previously identified. Two studies were then designed to develop and implement teaching strategies that integrated software elements and other resources to address targeted areas of teaching/learning difficulties.

The results from these studies revealed that teacher demonstration of software could contribute to the development of students’ representational competence, however the integration of multiple representations into other learning/teaching strategies were more likely to effectively develop conceptual understanding. The study found that effective teaching strategies were often blends of teachers’ sound knowledge of: subject matter with thorough conceptual understanding; computer-based technologies; and learners’ needs.

The study has implications for science/chemistry teachers, pre-service science teachers, senior high school science students, software designers/resource producers, and Chemistry curriculum evaluation and assessment.
Publications

The following publications emerged from the study as a part of the thesis.


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