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School of Education

**The Design and Development of E-textbooks to Support
Problem-based Learning in Secondary School Science
Classrooms**

Nigel Stewart

**This thesis is presented for the Degree of
Doctor of Philosophy
of
The University of Notre Dame Australia**

April 2018

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other institution.

To the best of my knowledge and belief this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signed: Nigel Stewart

Date: 11/04/2018

ABSTRACT

Problem-based Learning (PBL) is widely used in education and extensive research has been conducted into the use of PBL to improve student learning. E-textbooks are a relatively recent development and represent the next stage of evolution of print media with improvements in the presentation of information. They also offer the possibility of being used as a learning tool rather than just as a store of knowledge. This thesis attempts to develop a set of design principles that allow the development of e-textbooks to promote PBL in secondary school science students.

This research presents the results of a four-year study, between 2013 and 2016 with different classes, that aimed to investigate the development and use of e-textbooks to facilitate PBL in secondary school science classrooms. It involved identification of constraints that limit the implementation of PBL and measurement of their effect on learning through PBL. These included learning, pedagogical and technical constraints. An investigation was conducted into the use of e-textbooks to augment PBL and ameliorate these constraints. Through a process of Design-based Research, a set of principles was established that might promote the successful use of PBL and e-textbooks in secondary science contexts.

A review of the research literature revealed that PBL can have a powerful impact as an educational tool if the learning environment is well managed. However, certain constraints to using PBL, especially in secondary schools, require investigation. E-textbooks may also be able to improve student learning using PBL while ameliorating some of these constraints. The three research questions developed

for this research aimed to identify such constraints and identify factors that could increase the impact of PBL on student learning using e-textbooks.

This study used a qualitative approach to investigate the use of e-textbooks to support PBL in secondary school science classrooms with some quantitative data used to support one aspect of the study (student knowledge). Data collected from a PBL Evaluation Tool before and after each intervention were used to measure student knowledge, planning, monitoring and evaluation and student engagement. In addition, data were collected through focus group interviews and observations of students in class. The four-year time span of the study allowed the collection of a large amount of data that provided opportunities for triangulation.

The three research questions guided the development of a set of design principles that will be useful in the future development of e-textbooks that support PBL. The results of the study were several design principles that could be used by teachers and schools to develop e-textbooks to support a PBL program. These principles are presented using a road map analogy that illustrates the journey undertaken in this research. The design principles involve the pedagogy of the teacher, the design of the e-textbook and the facilitation of the students in the PBL environment.

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GLOSSARY

ACARA

Australian Curriculum and Reporting Authority (ACARA) is a body established by an act of parliament, which is responsible for development of the national curriculum, assessment and reporting within Australia.

Cycle

The completion of two iterations within one year of a Problem-based Learning (PBL) program in a class or classes with different topics.

E-textbook

The result of integrating classical book structure ...with features that can be provided within an electronic environment is referred to as an electronic book (or e-book), which is intended as an interactive document that can be composed and read on a computer. (Landoni, 2003, p. 168)

FGI

Focus group interviews conducted at the researcher's school by the researcher's supervisors using students randomly selected from classes in which the iterations took place. Five to six students participated in each interview.

Gaming

A term used to describe playing digital games on a computer.

ICO

Informal classroom observations made by the researcher during each lesson in each iteration regarding students group work, teacher student interaction and general impressions of the lesson.

ICSEA

Index of Community Socio-Educational Advantage is used specifically to enable fair comparisons of National Assessment Program – Literacy and Numeracy (NAPLAN) test achievement by students in schools across Australia. A value on the index corresponds to the average level of educational advantage of the school’s student population relative to those of other schools (ACARA, 2015b).

ICT

Information and communication technologies have been defined as “a diverse set of technological tools and resources used to communicate and to create, disseminate, store, and manage information” (Blurton, 1999, p. 46). Skryabin, Zhang, Liu, and Zhang (2015, p. 50) noted that “a broad definition of ICT includes computers, the Internet, telephones, personal digital assistants (PDAs) and mobile phones, television, radio and audio-visual equipment.”

Independent school

A school in Australia that derives most of its funding from private sources rather than from the government.

Iteration

A single learning event in which students are presented with a problem and work towards a solution and then complete a pre- and post-iteration evaluation. The iterations were: Newton's Laws (cycles one to three, abbreviated to NL1, NL2 and NL3 respectively), Chemical reactions (cycles one and three, abbreviated to CR1 and CR3) and Compression and Tension (cycle two, abbreviated to CT2). Where student responses from focus group interviews are included from each iteration, they are identified in the following way: (FGI Iteration topic Student number). For example, '(FGI NL1 S1)' means a response from Student 1 in the first iteration of Newton's Laws.

Secondary school

A high school educating students from Year Seven (13 years of age) to Year 12 (18 years of age).

STEM

Science, technology, engineering and mathematics "refers to teaching and learning in the fields of science, technology, engineering, and mathematics; typically including educational activities across all grade levels, from pre-school to post-doctorate, and in both formal and informal classroom settings" (Kennedy & Odell, 2014, pp. 246–247).

VMWare Horizons

A platform that allows a user to emulate a computer operating system and applications on another device without using the hardware of the physical device they are using.