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Designing simulations to improve learner outcomes in ecological education

Robert M. Corderoy
University of Wollongong

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**DESIGNING SIMULATIONS TO IMPROVE
LEARNER OUTCOMES IN ECOLOGICAL EDUCATION**

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

DOCTOR OF PHILOSOPHY

from

UNIVERSITY OF WOLLONGONG

by

**ROBERT. M. CORDEROY
B.A.(Geol)., M.Ed(IT)., M.A.C.E., JP.**

FACULTY OF EDUCATION

2001

Declaration

I, Robert Malcolm Corderoy, certify that the material within this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Education, University of Wollongong, is wholly my own original work unless otherwise referenced or acknowledged. This thesis has not been submitted for the award of qualifications at any other institution.

Robert. M. Corderoy
30th August, 2001

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Included Software

Exploring the Nardoo

Hybrid PC/Mac version CD-ROM

(Inside back cover)

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Robert. M. Corderoy
30th August, 2001

Abstract

The study of complex ecological processes presents many difficulties for learners including the time frame in which it may take place and the complexity of the relationships involved. The learning outcomes and level of understanding of the underlying relationships for students studying such processes may be effectively supported and improved through the use of carefully designed simulations which provide the learner with the opportunity to explore and test their ideas, knowledge and understanding without risk. The purpose of this study was to design, develop, implement and test the efficacy of a simulation tool designed to simulate algal bloom in a river catchment environment in terms of its potential to produce improved learning outcomes and understanding of relationships for the learners.

There has always been a 'suspicion' amongst some educators, particularly those who have limited computer literacy, that the platforms of the information technology revolution are simply 'new toys' in the hands of resource developers and researchers, and that the outcome is simply an application of such technologies in the misguided belief that such delivery systems for educational experiences provide some sort of advantage over the more traditional methods.

This study is based on two assertions with regard to the educational effectiveness of simulations in educational environments. First, that to be effective simulations need to have been designed in accordance with contemporary theoretical principles in terms of both pedagogical and user interaction issues with regard to modelling the real world effectively so as to provide an authentic environment in which the user may construct knowledge and understanding of complex processes. Second, that students using such simulations will have better learning outcomes and develop a deeper understanding of the relationships between the variables involved than those who are exposed to a more conventional approach in terms the representational media adopted, available resources and teaching methods.

In summary, the study was designed to test the efficacy of the assertion that with careful design, interactive simulations which mimic complex ecological processes can provide the opportunity for improved learning outcomes and the development of a deeper understanding of the underlying relationships.

The experimental materials used in this study comprised the software package *Exploring the Nardoo* and the algal bloom simulation tool embedded within it. The package is an interactive multimedia CD-ROM based learning environment designed with a constructivist approach. It attempts to provide a realistic, risk free information rich learning space in which students may explore, test their understanding of specific issues, and develop solutions to authentic tasks.

The methodological approach adopted for this study was of a classic experimental design (pre/post test) and based in the Scientific Paradigm. Such a pure experimental approach was essential to testing the stated hypotheses, however in order to provide a more complete picture of the nature of user/software interactions, a hybrid quantitative/qualitative approach was used.

The data set on which the analysis of the study was based was collected using researcher designed instruments; a Knowledge Acquisition Schedule (KAS), a Cause and Effect Schedule (CES) and a User Perceived Value Schedule (UPS). Subjective information in the form of field observation records and comments was also collected. Such an approach provided a context in which the research question could be tested and considered while maintaining the necessary research rigour. The operational population, third year pre-service student teachers, was chosen from the target population by the use of the technique of “cluster sampling”.

The data collected from the Knowledge Acquisition Schedule (KAS) indicated that use of the package *Exploring the Nardoo* resulted in significantly improved acquisition of factual knowledge for both the control and experimental groups. This was not unexpected as the overall design of the software was such that all students had access to extensive multi-format information on all aspects of algal blooms and the investigation was designed so as to be ‘independent’ of the algal bloom simulation tool. The fact that the experimental groups KAS mean scores showed a significantly greater increase than those of the control group would suggest that using the simulation tool also supported factual knowledge acquisition.

Analysis of the Cause and Effect Schedule (CES) data suggests that the simulation tool also facilitated a deeper understanding of the processes and the relationships between causal factors for the students who had access to the simulation tool. Examination of the pre and post CES mean scores data indicated that the students using the simulation tool not only improved their CES mean scores, but improved them by a significantly greater margin than those in the control group. This outcome adds support to the assertion that, when students have the opportunity to test and re-assess their mental models of complex systems, the processes and relationships at work, in meaningful learning environments and supported by appropriate tools, there is the potential for improved learning outcomes and the development of deeper understanding. The data collected from the UPS added support to these findings and issues relating to the design and function of the simulation tool.

In summary, the overall findings suggest that, simulations which are designed in terms of contemporary theoretical principles with regard to functionality and pedagogical strategies, and are embedded within rich, multimedia based learning environments have the potential to provide the user with a greatly enriched experience by facilitating the review of existing learner knowledge and the construction of new learner knowledge.