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Note

This paper presents the major preliminary results of 2001 surveys at Deakin University and The University of Western Australia. Contact Dr Kieran Lim (lim@deakin.edu.au) for more details.

Flexibility and efficiency in university soil science education: The *Oz Soils* 3.0 CD-ROM

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Abstract: Based on a 1997 CUTSD grant, we have developed 18 teaching modules for a CD-ROM based interactive multimedia program, called Oz Soils, which is integrated into the teaching curriculum of internal and external undergraduate units at The University of New England to assist students in understanding the fundamental concepts and processes of soil science. Oz Soils incorporates a flexible self-directed learning structure to help achieve this understanding. Other unit resources include a study guide, a practical workbook, and on-line quiz modules conducted through WebCT. Oz Soils makes use of interactive animations, still graphics, and text, and includes interactive self-assessment questions. The program can be readily integrated into a range of study areas which require a basic understanding of soil science including agriculture, forestry, ecosystems management, natural resources, ecology, engineering, mine site rehabilitation, geology, geography and biology. Oz Soils has been extremely well received by students and has been adopted by many Australian university departments which require teaching aspects of soil science. A brief rationale for developing the Oz Soils resource is presented, together with some outcomes of student questionnaires and research on a learning strategies study.

Rationale for developing *Oz Soils*

Soil is one of Australia's most valuable and fragile resources and it is crucial that future resource managers have a thorough understanding of how soils behave and how they interact with other components of ecosystems. Tertiary students have difficulty understanding the core concepts and processes of soil science. By using the *Oz Soils* CD-ROM as part of our teaching, we aim to foster a 'deep learning' approach in students (Biggs, 1991), by which they become more active and motivated in learning, and are encouraged to try to understand the mechanisms and inter-relationships of soil processes, rather than just memorising facts. Students in charge of their learning will be more likely to go on to relate their soils knowledge to the broader environment (e.g. the functioning of agricultural systems). Laurillard (1993) argues that multimedia resources containing self-assessment questions can address most of the requirements for effective learning, and are a substantial improvement over sole reliance on lectures and printed material. The use of animated graphics can encourage a deep

learning approach, as the majority of students (>80%) use their visual memory for learning. Practical classes can be taught more effectively through preparation with multimedia material illustrating either micro-scale processes or familiarising students step by step with complex laboratory procedures. The multimedia program can also be used by students as backup reference material, as additional material for lecture revision, as a means for examination preparation, and for future reference. The interactive material in combination with printed material offers to external students a greatly improved learning environment compared to sole reliance on printed material (Daniel and Lockwood, 1998).

Description of the program

The *Oz Soils* modules are available on a dual-platform CD-ROM for PC and Macintosh computers. *Oz Soils* makes use of still graphics, animations, text, and interactive self-assessment questions. Users can also access at any time an extensive glossary of soil science terms and a list of references for further study. The structure of the program reflects the ecosystem approach taken by the Agronomy and Soil Science group at UNE in teaching soil science, which emphasises interactions between soil and other ecosystem components. This overcomes the traditional limitations of teaching soil science in isolation from related disciplines. The currently developed 18 *Oz Soils* modules are divided into four sections, nutrient cycling, hydrological cycling, soils and the landscape, and soil structure.

Evaluations and outcomes

Students have been using prototype versions of *Oz Soils* (7 developed modules) prior to 1999 and since 1999 have been using Version 3.0 (18 modules) as part of the units Soil Science 211, Soil Science 212 (now combined into Soil Science 220), and Geoplan 211. Evaluations of the program were associated with various stages of the *Oz Soils* development.

An early prototype of *Oz Soils* was evaluated by student questionnaires. Details of this evaluation are reported in Lockwood and Daniel (1997). The results showed that response to the program was very positive, with students who used it as part of an introductory soil science unit reporting it to be easy and enjoyable to use, and believing it to be educationally effective. There was no significant difference in response pattern between female and male students. The minority of students in the sample who identified themselves in the questionnaire as either not enjoying using computers or generally finding them hard to use were generally slightly less positive about *Oz Soils*, but even in these groups a large majority gave favourable responses to the evaluation questions. The result of the evaluation provided encouragement for further development of the program.

A second evaluation (during 1997/1998) was aimed at developing a model of student interaction with *Oz Soils* Version 2.0, to assist in developing an understanding of how this multimedia package does influence student learning. Details of this evaluation are reported in McLeod, Daniel and Lockwood (1998). It was found that many students made good use of higher order learning strategies but failed to use deliberating strategies involving social, professional, or electronic discussions of subject matter. A lack of awareness about the extent of learning opportunities provided via *Oz Soils* was also evident. This suggests that *Oz Soils* is best used as a valuable part of a wider instructional teaching unit rather than as stand alone teaching material. As a result, the integration of *Oz Soils* into the teaching curriculum of introductory soil science units at UNE was enhanced and on-line *WebCT* components (bulletin board discussions, quizzes, etc.) were introduced in 2000.

A third evaluation of *Oz Soils* is currently being conducted as part of a 2000 ASCILITE/CUTSD project. This project involves on-line reflective survey questions, focus group interviews, and questionnaires. The aim is to investigate what cognitive and conceptual scaffolds characterise the *Oz*

Soils resource. The term 'scaffolding' is increasingly used to describe certain kinds of support which learners receive in their interaction with experts, teachers and mentors as they develop new skills, concepts or levels of understanding. The mechanisms for assisting learner cognition from an actual to the potential developmental level of the learner have been extended greatly by technology applications and contemporary research (McLoughlin and Oliver, 1998). Originally, the teacher's role was conceived as providing scaffolded assistance through modelling, contingency management, cognitive structuring and feedback. Through modelling, tasks, skills and concepts can be demonstrated while retaining complexity and authenticity, so that learners can become engaged in the acquisition of new skills. Contingency management is concerned with recognising and rewarding learner actions, while feedback enables students to compare themselves to others. With practice, these mechanisms are internalised and become metacognitive strategies for students to regulate their own learning.

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Flexible learning – helping first year students make the most of an interactive software package

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Physics Concepts and Simulations is a 34 module package for first year science and engineering students which spans introductory physics concepts (Part A) and many standard tertiary level topics in Part B (Mechanics, Waves, Oscillations) and Part C (Electricity, Magnetism, Modern Physics). Its key feature is the level of student interactivity in animated examples, self-review items and virtual experiments using detailed simulations. How it is to be used by students and how it fits with laboratory, lectures, and assessment was a challenge when designing it. When used as an optional resource, most good students used it extensively and found it valuable. The current approach requires all students to do two minor assignments, each on selected aspects of two or three modules, with an emphasis on deeper learning. This has led to a marked improvement in student approaches to learning.