VisChem: Building mental models of the molecular world using interactive multimedia

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Understanding chemistry involves being able to link what one sees substances doing in the laboratory, to what one imagines is happening within these substances at the invisible molecular level. Only then can these ideas be communicated using abstract symbolism (e.g. chemical formulas), terminology and mathematics. The *VisChem* multimedia resources (*QuickTime* animations and video) explicitly link these three levels – the molecular, laboratory and symbolic.

Research in chemical education over the last 20 years has revealed that many students have unacceptable, incomplete or non-existent mental models of chemical substances and processes at the molecular level. This problem is considered a major cause of misconceptions in chemistry, and is one reason why many students do not engage with the subject.

In this poster session we will demonstrate some of the *VisChem* molecular-level animations (see http://vischem.cadre.com.au/). However, multimedia resources that promote meaningful learning should require 'cognitive struggle', facilitated through engagement, rather than by passive reception. We will describe how the animations are presented in live teaching contexts, and incorporated into interactive multimedia resources, to build mental models of the molecular world through meaningful 'cognitive struggle'.

Animal use in teaching: Implementation of alternatives

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The use of animals as teaching tools has come under increasing scrutiny. Expanding technology has greatly increased the range of teaching tools available and these are being used to replace animals and increase the breadth of teaching/learning methods. The paper considers the implementation of a computer simulation to replace an animal-based practical in an undergraduate unit on animal behaviour. Staff and students involved in the animal behaviour unit were interviewed with the goal of qualitatively evaluating the unit with reference to the changes to the educational outcomes, including animal welfare issues and student motivation. The introduction of computer simulations, to replace animals, requires a clear understanding of the educational outcomes desired and a high level of planning, designed to motivate the students.

Teaching and learning data analysis in a complex environment

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Two problems face courses in science that deal with data and the creation of information: first there is the complexity of the issues to be addressed; second there is the limited applicability of statistical approaches. Where the methodology is 'data making', classically through experimentation, the problem is not serious for the approach of statistics is very valuable. Where the methodology is 'data taking' the issues are different. Databases are large and rarely samples. Instead they are from the population: remote sensing, climate records, the population census are just a few. In this field the techniques of exploratory analysis and data mining are more appropriate. The problem for education is how to train students to deal with these environments.

The presentation discusses a course which explores these issues. It is supported by a poster. A new approach to data analysis and interpretation is necessary. It relates to the processes by which we comprehend our environment and develops analytical methods that are relatively assumption free. It relies heavily on computer aided learning modules and a range of case studies to develop experience. It sets, as a project, the problem of exploring variation in the climate in the longer term. Programs were prepared for the analytical steps and made direct and easy to use so that attention could focus on the tasks of application to the problem, knowledge of the analytical method and interpretation to create and communicate information.

IT skills of university students in 2001

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General background

This paper is the second in a series of investigations on the computer skills of undergraduate students at the start of university.[1] The use of computers is becoming more widespread in education and in the wider Australian community.[2-4] Increasingly, universities are depending more on information technology (IT) in their mainstream activities. Some examples of IT usage in Australian university teaching and learning include:

- dissemination of materials through the Web, email, bulletin boards, etc.;
- on-line assessment;
- electronic submission of assignments;
- typed (word processed) reports; and
- collaborative and cooperative learning through discussion groups and computer-mediated communication.

General university policy[4] and the use of information technology (IT) in university teaching and learning are implicitly based on **the assumption that university students are becoming more computer literate**.

Survey details

- University of Western Australia first year medical students
- Deakin University first year chemistry students (Geelong campus)
- Compulsory, first week of 2001 academic year
- Questions based on 2000 survey[1]

General IT skills

- Knowledge of Web, email, and word processing usage has increased
- Knowledge of spreadsheets is significantly lower than for other general skills
- Over 90% of students are multi-skilled
- All students (with one exception) know at least one of Web or word processing
- Student computer training can be designed to build on Web or word processing
- Generally, males have a greater extent of computer skills

Students (%) with general IT skills

	2000	2001		
	U Syd	Deakin U		UWA
	Ref [5]	Ref [1]	This work	This work
Web	} 82	87	94	93
Email		85	92	93
Word processor	89	99	98	97
Spreadsheet	50[(a)]	88[(b)]	77[(b)]	62[(b)]

(a) General spreadsheet use
(b) Spreadsheet use to analyse and plot numerical data

Students (%) with multiple skills[(a)]

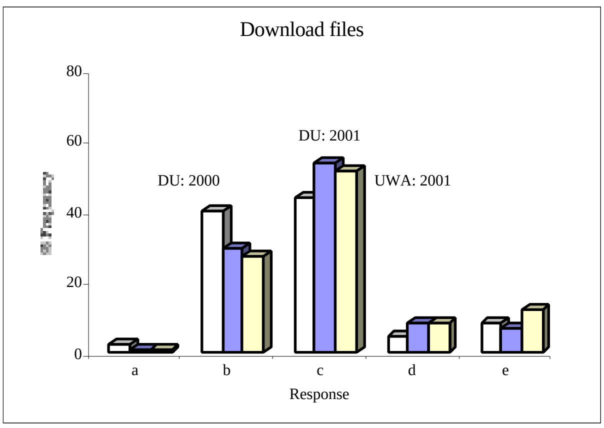
	2000	2001			
		Deakin U		UWA	
	Ref [1]	This work			
	All	Fem.	Male	Fem.	Male
4 skills	75	62	79	55	66
3 skills	15	34	12	32	30
2 skills	5	4	3	6	3
1 skill	4		6	6	2
none	1			1	

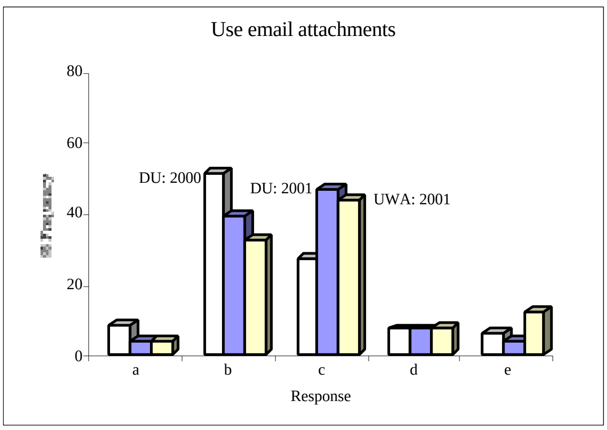
(a) Web; email; word processor; spreadsheet

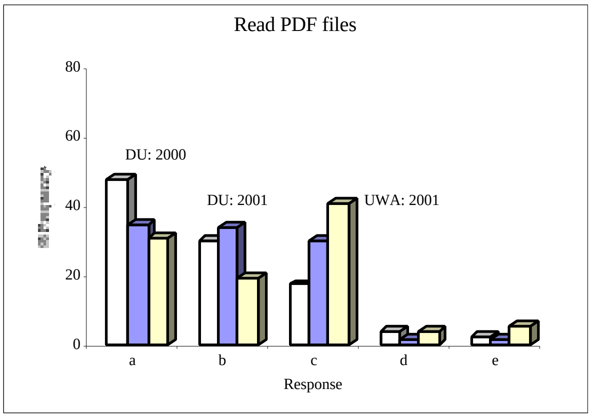
Specific IT skills

- Significant numbers do not know how to download files, use attachments or read PDF files.
- IT training is required for:
  - electronic delivery of teaching materials;
  - electronic assignment submission;
  - submission of (word processed) scientific reports.

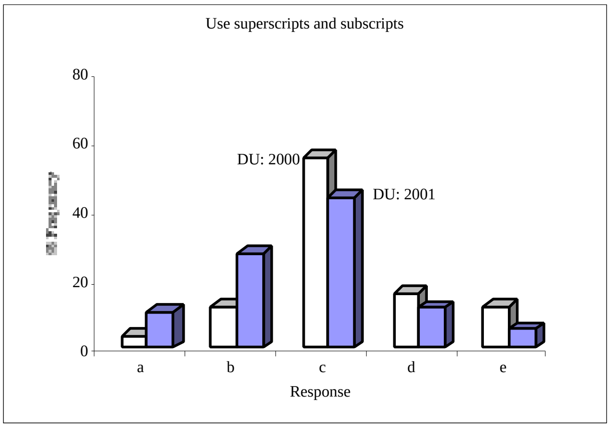
Web/Internet IT skills

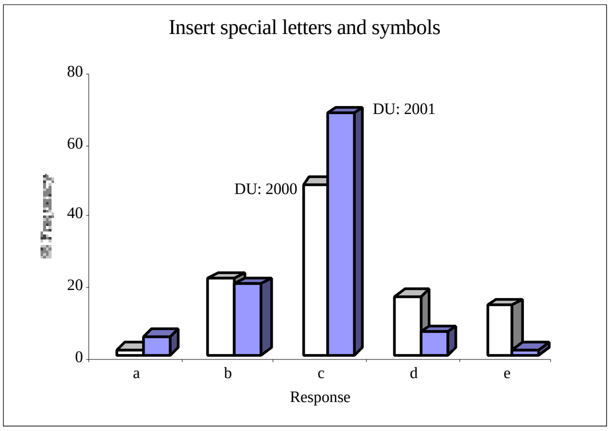


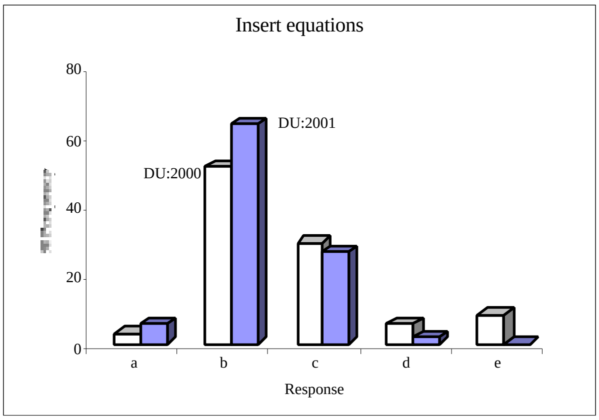




Word processing IT skills







Key to plots. (a) No awareness or knowledge; (b) Awareness but no knowledge of usage; (c) Knowledge to use the technology; (d,e) Expert knowledge to use the technology

Summary

- Students' IT skills are generally high and increasing.
- Students are weak in the use of spreadsheets.
- Students are not fully prepared for the use of electronic teaching media.
- Only the major conclusions have been presented here.

Contact Dr Kieran Lim for more details.

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References

[1]Lim, K. F. and Lee, J. (2000) IT skills of university undergraduate students enrolled in a first year unit. *Australian Journal of Educational Technology*, **16**, 215-238.

[2]Australian Bureau of Statistics (1997) *Business Use of Information Technology*, Canberra: Australian Government Publishing Service.

[3]Australian Bureau of Statistics (2001) Use of the Internet by households, Australia. Australian Bureau of Statistics, Report 8147.0.

[4]Education Network Australia (2000) The Way Forward: Higher Education Action Plan for the Information Economy, Education Network Australia (EdNA).

[5]UniServe Science (2000) Survey of computing experience and skill development needs of incoming first year students at The University of Sydney in 2000, The University of Sydney.

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.

References

Website: http://www.une.edu.au/agronomy/ozsoils.html

Biggs, J. B. (1991) Good learning: what is it? How can it be fostered? In J. B. Biggs (ed.), *Teaching for learning*. Australian Council for Educational Research, Hawthorne.

Daniel, H. and Lockwood, P. V. (1998) A case study of interactive multimedia in tertiary science teaching. In F. Poyas (ed), *Online Development: issues for authors and students*. Proceedings OLA Virtual Conference '98. Open Learning Australia. http://www.ola.edu.au/virtcon/daniel/poster.htm

Laurillard, D. (1993) *Rethinking university teaching: a framework for the effective use of educational technology.* London: Routledge.

Lockwood, P. V. and Daniel, H. (1997) Computer-assisted teaching in soil science. Sciences of Soils [On-line serial], 2. http://www.hintze-online.com/sos/1997/Articles/Art5

McLeod, R. J., Daniel, H. and Lockwood, P. V. (1998) A Study of learning strategies used by students with the Oz Soils interactive multimedia program. In C. McBeath and R. Atkinson (eds), *Planning for Progress, Partnership and Profit*. Proceedings EdTech'98. Perth: Australian Society for Educational Technology. http://cleo.murdoch.edu.au/gen/aset/confs/edtech98/pubs/articles/m/mcleod.html

McLoughlin, C. and Oliver, R. (1998) Scaffolding higher-order thinking in a telelearning environment. In B. Collis and R. Oliver (eds), Proceedings of Ed-Media/Ed-Telecom '98 World Conference on Educational Multimedia and Hypermedia Charlottesville, VA: AACE, 977-983.

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.

Sustaining teaching development through research: The lead up to a National Teaching Development Grant

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Abstract: The modification and rejuvenation of existing curricula and teaching styles to include advances in education research can be a daunting process. The School of Physics at The University of Sydney has successfully launched strategies for student oriented learning in large first year classes. One such strategy, the Workshop Tutorials, has been extremely well received. It is based on cooperative grouping and the extensive education research available on students' conceptual understanding in physics. The origin of these Workshop Tutorials is found in specially designed optional remedial-tutorials for students in a large mainstream first year physics class in 1993. Evaluation and analysis of evaluation has provided a method of incorporating research into what is basically a teaching development initiative. The research has in turn sustained and provided data for ongoing support and growth of the teaching development initiative. The Workshop Tutorials provide a rich context to investigate issues in Physics Education Research, resulting in projects being available to students enrolled in Third Year and Honours Physics units. The Workshop Tutorials form the basis of a successful large National Teaching Development Grant involving several Sydney metropolitan universities.

In this paper we present the key aspects in the initiation and development of the Workshop Tutorials that led to its success. In particular the pivotal role of research in sustaining teaching development will be discussed.

Introduction

Workshop Tutorials are a successful teaching and learning strategy designed to improve student learning. The implementation has been gradual and the learning environment has evolved based on our awareness of educational research data and, in particular, data from researchers in physics education. A conscious effort to maintain a strong research profile within what is basically a teaching development project has led to expansion and growth of the project.

A research basis for the initial stages of the project

The workshops were designed initially as remedial sessions and were based on cooperative learning where students work in teams of four (Heller and Hollabaugh, 1992; Van Heuvelen, 1991). The workshops were evaluated in 1993, introducing an aspect of research. The evaluation elicited qualitative responses and some typical student comments were:

more understanding has made me more confident;
I am now more able to understand how to solve problems more efficiently; and
[tutorials] have increased my interest in physics.

A simple quantitative analysis showed that 87% of the students who attended more than a third of the tutorials improved their marks, the mean average increase being 13%. The evaluation was very basic but the results showed improved student learning outcomes, providing justification for the existence of the workshops.

Research and dissemination

Successful grant applications were written for various university and faculty level Teaching Development Grants. The applications were based on our increased awareness of educational research data and feedback from students and staff. The grants were used to include lecture demonstrations, improve workshop activities, and to expand the workshops into the four mainstream courses. The 1995 student attendance record was carefully maintained and analysed. The evaluations showed that students attending more than half the total number of Workshop Tutorials scored significantly better over the year than those attending less than half. More importantly, in the less tangible affective domain, students' feelings about the learning style used in the Workshop Tutorials had been almost wholly positive. The results supported the claim that students involved in cooperative learning schemes consistently out-perform those in the more traditional teacher-orientated systems (Hake, 1998; Heller et al., 1992; Thornton and Sokoloff, 1998). The workshops were presented at the 1998 Pacific Rim conference (Sharma et al., 1998) and subsequently published in an international refereed journal (Sharma et al., 1999). In addition, research projects within the context of the Workshop Tutorials are available to students in Third Year and Honours and as Vacation Scholarships.

Basis for a successful grant application

In 1999 we put forward an outline of a proposal for an organizational National Teaching Development Grant. The proposal satisfied the selection criteria which required that there be educational research background, knowledge of relevant happenings at other institutions, potential for growth and transferability, evidence that student learning does improve and that some work had been carried out. The university teaching and learning unit provided assistance in preparing a polished application. The proposal was to design and produce Thematic Physics Workshops based on the Workshop Tutorials. In consultation with colleagues from several Sydney metropolitan universities, we proposed developing and providing a coherent resource package which can be used at different institutions so as to improve student learning in both mainstream and service courses. Physics educators would have the flexibility to extract workshops appropriate to their syllabus and readily insert them into existing courses.

Current status of the project

The grant application was successful and a Project Manger has been employed for two years. The Workshop Tutorials have been run successfully at the Australian Catholic University with students enrolled in environmental science, in the Department of Biomedical Sciences at The University of Sydney with students doing bridging courses, at the University of Western Sydney with several groups of engineering students and at The University of New South Wales with students enrolled in Optometry. Student learning experiences in the tutorials are being continuously evaluated to maintain a quality learning environment. The academic content of the worksheets themselves are being constantly evaluated and improved to produce an end product which is both correct and promotes conceptual understanding through collaborative learning. The methods of evaluation have been expanded to include minute papers and focus groups.

Presentations on various aspects of the project are being made at relevant conferences and meetings. In September and October 2001 the project team will run a series of workshops at various centres in Australia. The aim of the workshops will be to demonstrate the teaching and learning style and make available the teaching material that has been developed. Currently the schedule is to have two workshops in Melbourne on 24 and 25 September, one workshop in Hobart on 26 September, in Brisbane on 2 October, in Adelaide on 9 October and in Perth on 10 October.

Conclusion

We have presented a perspective on the initiation, development and current status of a successful student oriented learning environment – the Workshop Tutorials. We have demonstrated that by using results from on-going systematic evaluations, which in itself is a form of research, it is possible for a teaching development project to thrive. An awareness of educational research, and the inclusion of results from educational research further strengthens the project and improves the quality of dissemination. Successful internal small grants and presentations at conferences and internal meetings provide an environment in which interest is readily maintained. The opportunity then exists for larger scale interactions and collaborations.

The Workshop Tutorials provide a dynamic learning environment in which issues in physics education research can be investigated. Aspects of the workshops are available as research projects for students.

Acknowledgments

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References

Hake, R. R. (1998) Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *Am. J. Phys*., **66**(1), 64-74.

Heller, P. and Hollabaugh, M. (1992) Teaching problem solving through cooperative grouping: Designing problems and structuring groups. *Am. J. Phys.,* **60**(7), 627-636.

Heller, P., Keith, R. and Anderson, S. (1992) Teaching problem solving through cooperative grouping: Group versus individual problem solving. *Am. J. Phys*., **60**(7), 627-636.

Sharma, M. D., Millar, R. and Seth, S. (1999) Workshop Tutorials: Accommodating student centred learning in large first year university physics classes, *Int. J. Sci. Ed*, **21**, 839-853.

Sharma, M. D., Millar, R. and Seth, S. (1998) Bridging the gap: workshop tutorials. Proc. of the Third Pacific Rim Conf. on First Year in Higher Education, Vol. II, pp. 31-1 to 31-9.

Thornton, R. K. and Sokoloff, D. R. (1998) Assessing student learning of Newton's Laws: The force and motion conceptual evaluation and the evaluation of active learning laboratory and lecture curricula. *Am. J. Phys*., **66**(4), 338-352.

Van Heuvelen, A. (1991) Overview, case study physics. *Am. J. Phys*., **59**(10), 898-907.

The HSC syllabus changeover and first year student experiences in physics and biology

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Introduction

Student approaches to learning vary from surface approaches to meaningful, deep learning practices. Differences in approach may be related to students' conceptions of the subject, perceptions of the learning environment, prior experiences studying the subject and performance on assessment. Investigating these issues provides insight into student learning processes, a powerful evaluation and feedback process for improving tertiary science teaching and learning.

We are in a unique position to investigate the effects of recent changes in the NSW HSC syllabus by examining differences in student learning from 2001 (the final intake taught primarily under the old HSC) to 2002 and beyond, and to study how the transition from HSC to first year university affects student learning.

Changes in the HSC

The Stage 6 (preliminary and HSC courses) syllabus for each of the sciences is part of a learning continuum learning from Kindergarten to Year 12. In Stage 6 students continue to develop skills through a range of experiences focused on planning and conducting investigations, communicating information and understanding, developing scientific thinking and problem solving techniques, and working independently and in groups.

We would expect the first group of students learning under the new science HSC courses, who will be entering universities in 2002, to have a broader view of their chosen science discipline, to have developed an inquiring mind and to be confident and competent in group activities.

Survey instrument

The survey instrument is composed of three questionnaire sections:

- the *Approaches to Learning Questionnaire*, adapted from Biggs' (1987) *Study Process Questionnaire.* It consists of 28 statements about students' approaches to studying physics or biology, sorted into ***Surface*** and ***Deep Approach*** scales;
- the *Conceptions of Physics/Biology Questionnaire*, adapted from Crawford et al. (1998), consisting of 20 statements on the nature of 'doing' physics or biology, sorted into ***Fragmented*** and ***Cohesive Conception*** scales; and
- *Experiences of Studying Physics/Biology Questionnaire* **(**post-test only), adapted from Crawford et al. (1998), which asks students to evaluate their courses based on their perceptions of the teaching style, the workload and assessment, their level of learning independence and whether the course goals were clearly defined.

Analysis and preliminary results

We will employ a raft of statistical tools to examine the responses to our survey. A **Reliability Analysis** will be used to test the correlations between questionnaire items and related items within each scale. A **Correlation Analysis** will provide a basic look at the structure of the student responses. Then we will use a **Factor Analysis** to identify more carefully any links between variables. A **Cluster Analysis** will allow us to identify groups of students who are responding in similar ways throughout the survey.

A random sample of physics and biology students' responses was selected for preliminary analysis. Correlation, Factor and Cluster analyses of the preliminary data set were performed on the Cohesive and Fragmented Conceptions of Physics scales and the Surface and Deep Approaches to Study scales. The results indicated that correlations exist between Surface Approach and Fragmented Conceptions scales, and Deep Approach and Cohesive Conceptions scales.

The Cluster Analysis highlighted two distinct groups of students. One group tended to score highly on the Deep and Cohesive scales, and low on the Surface and Fragmented scales; the other group tends to reverse this pattern. These early results suggest a link between students' approaches to study and their conceptions of the subject being studied. These two groups have qualitatively different experiences of their studies of physics.

Conclusions

A successful new science-education collaboration between eight researchers in four departments and two institutions has been formed to examine similarities and differences between the first year student experience in different disciplines. The preliminary analysis of the survey data is going well, with links already evident between students' approach to learning and their conceptions of the subject.

Similar correlations were previously noted in Crawford et al.'s (1998) study of students' experiences studying mathematics at university. The results of that study suggest we may find more complex structure after the inclusion of post-test data. We expect to uncover relationships between the students' prior and post-perceptions and understandings of the subject, their perceptions of their learning environment and their prior and post-achievements on assessment.

We will compare student responses across disciplines and institutions to look for differences in learning experiences. We also intend to administer the survey again in 2001, 2002 and beyond to look for early changes in student learning experiences resulting from changes to the HSC, to evaluate undergraduate university courses and programs, and potentially to provide valuable feedback to high school educators.

References

Biggs, J. (1979) *Student approaches to learning and studying,* Hawthorn, Victoria: Australian Council for Education Research.

Crawford, K., Gordon, S., Nicholas, J. and Prosser, M. (1998) Qualitatively different experiences of learning mathematics at university. *Learning and Instruction*, **8**(5), 455-468.

Prosser, M. Walker, P. J. and Millar, R. M. (1996) Differences in students perceptions of learning physics. *Physics Education,* **31**, 43-48.

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