

# UniServe Science

Bibliography for  
First Year Experience Discussion Forum: Students at Risk  
and  
Improving Learning Outcomes Through Flexible Science  
Teaching  
October 2 – 3, 2003  
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**UniServe Science** has compiled this bibliography from the Web and the following book and journals:

- Research and Supervision in Mathematics and Science Education
- EJSE: Electronic Journal of Science Education
- HERD: Higher Education Research and Development
- Medical Education
- IJET: International Journal of Educational Technology
- Studies in Higher Education
- Learning and Instruction
- AJET: Australian Journal of Educational Technology
- iJMEST: International Journal of Mathematical Education in Science and Technology
- Educational Technology & Society
- Assessment and Evaluation in Higher Education

References are to material published since 1995 that relates to research in university science education.

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Akpan, J. P. (2001) Issues Associated with Inserting Computer Simulations into Biology Instruction: A Review of the Literature. *Electronic Journal of Science Education*, 5(3). [Available at URL: <http://unr.edu/homepage/crowther/ejse/akpan.html>].

This paper reviewed empirical and theoretical issues associated with inserting computer simulations into biological instruction to help students better understand science concepts. Proponents claim advantages for simulations, such as greater experiential learning and higher student motivation. Critics claim simulations subvert scientific understanding because simulated experiences are insufficiently real. One particular focus was the role of simulations as replacements for dissection of animals. This issue is politically controversial because animal rights activists question the morality of dissection, while others argue that science learning is damaged by failure to experience dissection. While suffering numerous methodological defects, the available empirical research on simulations suggests the following: simulated dissection and actual dissections typically lead to equivalent performance on achievement tests, simulations used before actual dissections may enhance dissection performance, and experiential simulations facilitate learning from subsequent didactic instruction. Implications of these conclusions for education practice were discussed.

Alexander, S. (1999) An Evaluation of Innovative Projects Involving Communication and Information Technology in Higher Education. In Bain, J. (Ed.), *Higher Education Research and Development*, 18(2), 173-184.

The article describes the results of a two-year national study to evaluate the contribution of information technology projects to student learning in higher education in Australia. The study reviewed the outcomes of 104 teaching development grants that made significant use of a range of communication and information technologies in projects which had received a total of 4 million dollars in funding. In approximately 90% of cases, the project leaders reported having had the intention of improving student learning outcomes, but only one third were able to report this as the actual outcome. A review of the evaluation methods used by project leaders revealed a strong focus on student reactions to projects, rather than on methods that would have uncovered student learning outcomes.

Antepohl, W. and Herzig, S. (1999) Problem-based learning versus lecture-based learning in a course of basic pharmacology: a controlled, randomized study. *Medical Education*, 33(2), 106-113.

Since its first implementation in a medical programme at McMaster University Canada, problem-based learning (PBL) has become a well-established means of teaching and learning medicine. Extensive research has been conducted and a number of strengths of the method are well supported. Several items, however, remain unclear although there is evidence that no relevant difference exists in factual knowledge among students from PBL and traditional curricula, a controlled, randomized study has not been conducted to address this issue. The Medical Faculty of the University of Cologne is in the process of integrating elements of PBL into its curriculum. In the spring term of 1997, after seven semesters of experience with PBL supplementing the traditional course of basic pharmacology, we did for the first time use PBL instead of the lecture-based course (LBL) and conducted a controlled prospective study to determine the effects of this intervention. One-hundred and twenty-three students were randomly assigned to either PBL (n=63), with tutorial groups of up to nine students, or to the traditional, lecture-based course (n=60). Analysis of the results of both groups in the examination of basic pharmacology, consisting of multiple-choice and short-essay questions, revealed similar scores with a tendency favouring PBL students in the category of short-essay questions. Hence, it seems clear that PBL does not imply a disadvantage in terms of factual knowledge. Students considered PBL to be an effective learning method and favoured it over the lecture format. Furthermore, students reported positive effects of PBL in terms of use of additional learning resources, interdisciplinary, team work and learning fun.

Baker, W. P. and Lawson, A. E. (2001) Complex instructional analogies and theoretical concept acquisition in college genetics. *Science Education*, 85(6), 665-683.

This study investigated the role of complex instructional analogies on concept acquisition in an introductory college genetics course. The question of whether concept acquisition can be facilitated by use of complex instructional analogies was addressed using an experimental treatment and control group design. The experimental and control group students were administered a pretest of scientific reasoning and genetics knowledge to be used as covariates. The role of complex analogies on student attitude was also evaluated. Experimental treatment included complex instructional analogies. The control group received expository instruction alone. Achievement was assessed by use of eight weekly quizzes. Significant differences in student achievement were found in favor of the experimental group. However, the analogies did not appear to overcome the need for higher-order reasoning skills as the more skilled experimental group students performed



significantly better than their less skilled peers. The attitude survey indicated that the majority of experimental group students believed that analogy-based instruction was beneficial.

Brew, A. (1999) Research and Teaching: changing relationships in a changing context. *Studies in Higher Education*, **24**(3), 291-301.

All research, scholarship, teaching and learning activities taking place in academic contexts are dependent on prevailing discourses regarding the nature of knowledge. These have been turbulent with ideas about knowledge being seriously challenged. This article examines ways in which research and teaching have been changing and shows links with the crisis in ideas about knowledge. It then re-examines debates about the relationship between research and teaching in relation to this context, arguing that in order to understand their relationship it is important to view it in the context of these changes. Implications of the analysis for the relationship between teaching and research in the future are then drawn.

Bullock, C. and Schomberg, S. (2000) Disseminating Learning Technologies Across the Faculty. *International Journal of Educational Technology*, **2**(1). [Available at URL: <http://www.ecel.uwa.edu.au/ijet/v2n1/bullock/>].

The purpose of this article is to share information about an Inter-institutional Faculty Summer Institute on Learning Technologies held at the University of Illinois at Urbana-Champaign (UIUC) for three years running. The authors, the principal evaluator and an Associate Chancellor from the UIUC, present data from a three-year collaboratively based evaluation study conducted for the administration of the Institute. Important findings include the impact the Institute had on attendees' understanding of the role, use, benefits for both students and instructors, and availability of learning technologies in higher education.

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.

This paper reports research into the conceptions of mathematics, orientations to studying it and experiences of learning it of first year university students. A questionnaire based on students' conceptions of mathematics was developed. This and other questionnaires which investigated students' approaches to learning mathematics and their mathematical experiences were issued to students at the beginning of the year and after one semester. The results suggest two qualitatively different experiences of learning mathematics. Differences in students' conceptions of mathematics were shown to be related to their approaches to learning mathematics, their experiences of studying the subject and their performance on assessments.

Crawford, K., Gordon, S., Nicholas, J. and Prosser, M. (1998) University Students' Conception of Mathematics. *Studies in Higher Education*, **23**(1), 87-94.

A Conceptions of Mathematics Questionnaire was developed, designed to provide an indicator of the nature of students' conceptions of the subject matter they were studying. The scales of the questionnaire were based upon a set of conceptions of mathematics identified in an earlier phenomenographic study of students studying mathematics. The scales represented fragmented and cohesive conceptions of mathematics. Evidence was found supporting both the validity and reliability of the scales. A fragmented conception was found to be associated with a surface approach and a cohesive conception was found to be associated with a deep approach to studying mathematics.

Dochy, F., Segers, M. and Sluijsmans, D. (1999) the Use of Self-, Peer and Co-assessment in Higher Education: a review. *Studies in Higher Education*, **24**(3), 331-350.

The growing demand for lifelong learners and reflective practitioners has stimulated a re-evaluation of the relationship between learning and its assessment, and has influenced to a large extent the development of new assessment forms such as self-, peer, and co-assessment. Three questions are discussed. (1) what are the main findings from research on new assessment forms such as self-, peer and co-assessment; (2) in what way can the results be brought together; and (3) what guidelines for educational practitioners can be derived from this body of knowledge? A review of literature, based on the analysis of 63 studies, suggests that the use of a combination of different new assessment forms encourages students to become more responsible and reflective. The article concludes with some guidelines for practitioners.

Ebenezer, J. V. and Fraser, D. M. (2001) First year chemical engineering students' conceptions of energy in solution processes: Phenomenographic categories for common knowledge construction. *Science Education*, **85**(5), 509-535.

In this article, we examine first-year chemical engineering students' conceptions of the energy changes taking place in dissolution. Students were individually interviewed with three tasks in which three different salts were dissolved in water, and 17 transcripts were analyzed using a phenomenographic methodology. Four descriptive categories of energy in dissolution were discerned: (a) you give energy ( $n = 1$ ); (b) water gives energy ( $n = 17$ ); (c) salt gives off energy ( $n = 13$ ); and (d) reaction gives off energy ( $n = 7$ ). Four students gave the same explanation for all three tasks, but more students used the same explanation for two of the tasks: four for Tasks A and B, four for Tasks B and C, and eight for Tasks A and C. Moreover, salt gives off energy was the most common explanation for Tasks A and B ( $n = 3$ ), reaction gives off energy for Tasks B and C ( $n = 3$ ), and water gives energy for Tasks A and C ( $n = 8$ ). Four of the students showed variations of conception within tasks. Students described the solution process of all three tasks using a range of concepts, including previously learned chemical concepts. Even where students used the same chemical concepts in each of the tasks, they did not always give the same meaning to the concepts they used. The phenomenographic categories explanations given by students were used as a basis for developing an approach to teaching energy in solution processes. It is argued that this approach of using phenomenographic categories described at a collective level as a basis for discourse for constructing common knowledge should be used in teaching. It is proposed that a future study must be conducted to develop new trajectories students take to arrive at common knowledge and to understand how to move learners from their personal conceptions to plausible models in solution chemistry within the classroom learning community. Implications for policy are also discussed.

Fazey, D. M. A. and Fazey, J. A. (2001) The potential for autonomy in learning: perceptions of competence, motivation and locus of control in first-year undergraduate students. *Studies in Higher Education*, **26**(3), 345-361.

Autonomy in learning is considered to be a valuable asset for achievement and an outcome of higher education. This study investigated autonomy-related psychological characteristics of first-year undergraduates at registration providing baseline data indicative of a predisposition for autonomous learning. Students' age and sex-related perceptions of competence, self-esteem, motivation and locus of control all theoretically related to autonomous behaviour, were measured. The results indicated a positive profile for new students, with motivation at the internalised end of the spectrum and a perceived internal locus of control. Students are, however, cautious about or unsure of their abilities to meet the demands of higher education and this needs to be addressed by teaching staff if autonomy in learning is to be demonstrated. Age and sex differences were not as prevalent as had been expected. Students arrive at university with the potential to be autonomous in their learning. It is the responsibility of those who structure the learning environment to nurture undergraduate potential if autonomous behaviour is to be realised as an outcome of higher education.

Ferry, B., Hedberg, J. and Harper, B. (1999) Designing computer-based cognitive tools to assist learners to interpret graphs and tables. *Australian Journal of Educational Technology*, **15**(1), 1-19.

This paper reports on the development and evaluation of cognitive tools used to interpret graphs and tables. The development of these tools was informed by research about how learners interpreted graphs and tables. A prototype of the cognitive tools was trialed with a small sample of preservice teachers. This prototype was then improved and used again with a larger sample. Data from individual audit trails of software use, journal entries and interviews with a small sample of preservice teachers were used to evaluate the cognitive tools. The findings showed that the simple, context-specific cognitive tools developed helped to reduce the cognitive load associated with the interpretation of graphs and tables.

Gill, P. (1999) Aspects of undergraduate engineering students' understanding of mathematics. *International Journal of Mathematical Education in Science and Technology*, **30**(4), 557-563.

During the academic year 1995-1996 a series of Mathematics Support tutorials were held at King's College London for first-year undergraduates in engineering and science. The students were chosen as a result of their performance on a mathematics pre-test held during their first week at university. The test had been designed and used more than a decade ago for use with pre-university students. A comparison between the 1980s and 1990s performance on the test is carried out and reasons for changes suggested. A further comparison is made between the engineering undergraduates' performance on the pre-test and their scores on their later end-of-semester mathematics examination. This reveals a pattern indicating that an all round understanding of graphs on the pre-test predicted success on the later mathematics examination, despite an almost total lack of graph questions on that examination. Reasons for this pattern are suggested and discussed.

Greca, I. M. and Moreira, M. A. (2001) Mental, physical, and mathematical models in the teaching and learning of physics. *Science Education*, **86**(1), 106-121.



In this paper, we initially discuss the relationships among physical, mathematical, and mental models in the process of constructing and understanding physical theories. We adopt the assumption that comprehension in a particular field of physics is attained when it is possible to predict a physical phenomenon from its physical models without having to previously refer to the mathematical formalism. The physical models constitute the semantic structure of a physical theory and determine the way the classes of phenomena linked to them should be perceived. Within this framework, the first step in order to understand a phenomenon or a process in physics is to construct mental models that will allow the individual to understand the statements that compose the semantic structure of the theory, being necessary, at the same time, to modify the way of perceiving the phenomena by constructing mental models that will permit him to evaluate as true or false the descriptions the theory makes of them. When this double process is attained concerning a particular phenomenon, in such a way that the results of the constructed mental models (predictions and explanations) match those scientifically accepted, one can say that the individual has constructed an adequate mental model of the physical model of the theory. Then, in the light of this discussion, we attempt to interpret the research findings we have obtained so far with college students, regarding mental models and physics education under the framework of Johnson-Laird's mental model theory. The difficulties faced by the students to achieve the understanding of physical theories did not seem to be all of the same level: some are linked to the constraints imposed to the construction of mental models by students' previous knowledge and others, linked to the ways individuals perceive the world, seem to be much more problematic. We argue that teaching should focus on them, at least at introductory level, considering the explicit teaching of the modelling process or at least its systematic practice as a tool that might be appropriate to facilitate this process.

Gunn, C. (1999) They Love It, but Do They Learn from It? Evaluating the Educational Impact of Innovations. In Bain, J. (Ed.), *Higher Education Research and Development*, **18**(2), 185-200.

The SECAL, (Situating Evaluation of Computer-Assisted Learning) framework offers a broadly based method for evaluating learning with technology, in its many forms and implementations. Central to the framework are detailed and discipline-specific definitions of learning and corresponding descriptions of innovative environments designed to exploit the potential of technology, to support achievement of high quality learning goals. The objectives are to collect evidence of how these environments may or may not lead to effective learning and to identify what, if anything might be done to improve the prospects. The concept of situation implies the need to evaluate contextual influences as well as how students and lecturers actually use technology. This is achieved through rich description generated from multidimensional, qualitative methods, which are theoretically grounded in interpretive, critical and postmodern paradigms. The ubiquitous student evaluations of teaching systems are over-reliant on subjective data and offer little insight into pedagogical issues. The case-specific SECAL method uses objective and subjective data to assess how technology impacts on learning processes and outcomes. Broader objectives include grounded-theory development and identification of institutional influences on teaching and learning innovations. This type of evaluation is not particularly easy to conduct, but it's a prerequisite to gaining academic credibility, maximizing the benefits of investment and justifying it in terms acceptable to economic-rationalist administrators. A description of the method in this article is followed by a case study illustrating its practical application.

Hourcade, J. J. and Anderson, H. (1998) Writing for Publication. In Malone, J. A., Atweh, B. and Northfield, J. R. (Eds), *Research and Supervision in Mathematics and Science Education*. Mahwah, New Jersey: Lawrence Erlbaum Associates, 277-298.

After our mathematics or science education research project has been completed, it is natural for us to wish to step back and catch our breath for a moment. However, there is still a critical step remaining in our scholarship. We must decide on a vehicle to share our new knowledge with others. There are many ways to disseminate our research results, including submitting reports and presenting at professional meetings. However, for most of us, the scholarly vehicle of choice remains a professional journal. Submitting research reports to some agency might mean that only one person will see the results of our work. When we present at a professional meeting the results of our research may reach only one or two dozen of one's colleagues. However, even small academic journals have hundreds of readers, with larger journals having worldwide readerships of over 100,000. Thus, by far the most efficient way to present our research work to the world is through publishing papers in journals. Besides access to the wider audience, journals provide a rigorous screening function in furthering the knowledge base in mathematics and science education. Most journals reject many more articles than they accept. What this means is that when an article is accepted for publication by a respected journal, it most likely has been reviewed by a panel of experts and found to make an important contribution to the body of knowledge. To help emerging scholars successfully present their mathematics and science education research in journals, in this chapter we will (a) identify a rationale for scholarly writing, (b) list reasons scholars give for not writing, (c) provide an overview of how scholarly journals function, and (d) suggest practical ways of increasing scholarly productivity.

Housego, S. and Freeman, M. (2000) Case studies: Integrating the use of web based learning systems into student learning. *Australian Journal of Educational Technology*, **16**(3), 258-282.

Competitive pressures on universities to adopt flexible learning are intense. Many academics and managers are responding by incorporating web based learning (WBL) tools into the teaching environment. WBL tools have proliferated in recent years, and some can be used to manage entire courses. The simplicity of WBL systems, like WebCT, TopClass and Blackboard, makes their use in teaching an option for many academics, even those operating without institutional support or encouragement. Academics are seeking meaningful uses of these WBL systems for teaching and learning. The objective of this paper is to describe some meaningful uses with five fictional case studies based on our experiences in innovation and academic development. Our motivation is that academics and academic managers will identify one or more opportunities from the case studies to apply in their own context. Others including Hara and Kling (1999) have identified the need for this research. The case studies show ways in which teaching, learning and administration can be supported, adapted and extended with web based learning systems. Well understood teaching strategies can be improved with simple and easily implemented uses of WBL systems that can benefit on and off campus students. If underpinned by student centred teaching practices, these tools can make significant contributions to the effectiveness of teaching without also imposing an unsustainable demand for resources.

Joyes, G. (2000) An evaluation model for supporting higher education lecturers in the integration of new learning technologies. *Educational Technology & Society*, **3**(4). [Available at URL: [http://ifets.massey.ac.nz/periodical/vol\\_4\\_2000/joyes.html](http://ifets.massey.ac.nz/periodical/vol_4_2000/joyes.html)].

This paper provides a description and some reflections on the ongoing development and use of an evaluation model. This model was designed to support the integration of new learning technologies into courses in higher education. The work was part of the Higher Education Funding Council for England (HEFCE) funded Teaching and Learning Technology Programme (TLTP). The context and the rationale for the development of the evaluation model is described with reference to a case study of the evaluation of the use of new learning technologies in the civil and structural engineering department in one UK university. Evidence of the success of the approach to evaluation is presented and the learning media grid that arose from the evaluation is discussed. A description of the future use of this tool within a participatory approach to developing learning and teaching materials that seeks to embed new learning technologies is presented.

Kaartinen, S. and Kumpulainen, K. (2002) Collaborative inquiry and the construction of explanations in the learning of science. *Learning and Instruction*, **12**(2), 189-212.

This study investigates the construction of explanations in a social science-learning situation, in which 18 university students participated. The science-learning task which implicitly modelled design principles for science instruction in school contexts was derived from kitchen chemistry where the students investigated in small groups the nature of five solid samples of different cooking ingredients. The instructional goal of the learning situation was to develop the students' conceptions of solubility, the activity itself involved collaborative inquiry and experimentation. The study follows a three-step research design: pre-test, intervention and post-test, in order to highlight the students' explanations around the concept of solubility and their elaboration in social activity. A specific discourse analysis method was developed for the study, to investigate the mechanisms of explanation-building in small-group discourse. The data for the study were collected by means of videotapes, direct observations, transcriptions and questionnaires clarifying the students' explanations for dissolving. The study introduces an analytic tool for untangling the processes of explanation-building in collaborative inquiry which takes a synchronous and diachronic approach to communicative and cognitive processes of student discourse. The analysis highlights the reciprocal relationship between the nature of explanations and the students' communicative processes in the evolving discourse. The data analysis shows that the negotiation processes around the concept of solubility consisted of diverse interpretations, varying from informal explanations to formal explanations, and from descriptive reasoning to causal reasoning. The results of the students' pre- and post-tests indicate that the social science-learning situation provided the students with opportunities to elaborate their explanations for dissolving, and reflecting practical, theoretical and applied understanding.

Kirkpatrick, D. and Fuller, R. (1995) The challenge of peer assessment. In Summers, L. (Ed.), *A Focus on Learning*. Proceedings of the 4th Annual Teaching Learning Forum, Edith Cowan University, February 1995. Perth: Edith Cowan University. 146-149 [Available at URL: <http://cleo.murdoch.edu.au/asu/pubs/tlf/tlf95/kirkp146.html>].

The use of peer assessment as an alternative to lecture assessment is an option which is being considered more frequently as we seek ways to relieve demands on lecturers' time. The decision to adopt peer assessment is not one which should be made lightly and there are many issues to consider. In this workshop we will get the group to:



- investigate reasons for adopting peer assessment techniques
- identify pitfalls and potential weaknesses of peer assessment
- identify the contributions that peer assessment can make to the learning process
- and generate discussion of ways of implementing peer assessment effectively

We will provide a bibliography of relevant literature.

We intend this workshop to be exploratory so that participants can share their own experiences and questions about peer assessment and work towards identifying ways of making peer assessment a workable alternative assessment technique.

Lawless, C. (2000) Using Learning Activities in Mathematics: workload and study time. *Studies in Higher Education*, **25**(1), 97-111.

Workload, here taken as the time taken to study course materials, is recognised as an important factor influencing the quality of student learning. This study surveyed the time taken on learning activities by students studying five Open University distance taught mathematics and computing courses. Most students made a serious effort on the activities, taking an average of 1 hour for each. Given the number of activities in course materials, this means that taking them seriously will take students more time overall than the time allocated by course designers. Students whose approach to studying was mainly to learn the subject were more likely to take activities seriously and to spend longer on them than students whose approach was mainly to pass the course. One course had computer-based activities and these took significantly longer than the text-based activities in the other courses.

Lea, M. (2001) Computer Conferencing and Assessment: new ways of writing in higher education. *Studies in Higher Education*, **26**(2), 163-181.

This article reports upon MA students' use of computer conferencing in an online course, and examines the ways in which students draw upon asynchronous conference discussions in their written assignments. It argues that we can usefully regard these electronic environments as a resource that does more than provide the context for collaborative learning. The technology enables a reflexivity in student learning which has not been possible before, enabling students to benefit from the learning of their peers online and to draw upon this in the construction of their own individual disciplinary knowledge, as explicated in their own written argument. The article explores how computer conferencing can give students the opportunity to rehearse discipline-based debates and then exploit these as rhetorical resources in their written work; students use the voices of their peers in ways traditionally reserved for authoritative published authors. In order to explore the relationship between students' use of computer conferencing and their assessed written work, the article draws upon a variety of theoretical perspectives which are concerned with both texts and practices.

Livingstone, D. and Lynch, K. (2000) Group Project Work and Student-centred Active Learning: two different experiences. *Studies in Higher Education*, **25**(3), 325-345.

This article compares two experiences of group-based student projects in a Geographical Information Systems (GIS) degree and in Geography degree modules. The two authors adopted group projects from similar motivations, and used available materials to guide them through this process. Subsequently, they have come to reflect on the experience and to examine the theoretical dimensions of such an approach in more detail. There seems to be a discrepancy between the literature, which emphasises a growing interest in the socio-educational value of group-based and active learning, and the concerns voiced by both students and academics regarding the practical implications of such approaches. Analysis of grades and questionnaires tends to support the literature and belie the criticisms, which the authors see as 'myths', possibly motivated by a defensive attitude to the whole learning process. The conclusions are that, if care is not taken in the design and execution of such projects, then the problems that may ensue can reinforce the 'myths'. However, if carefully and appropriately designed and managed, team-based learning is a valuable experience.

Lockyer, L., Patterson, J. and Harper, B. (1999) Measuring Effectiveness of Health Education in a Web-based Learning Environment: a preliminary report. In Bain, J. (Ed.), *Higher Education Research and Development*, **18**(2), 233-246.

Driven by claims of efficacy, flexibility, and resource effectiveness, higher education is increasingly utilizing the Web as an instructional tool. The claims for pedagogical effectiveness are often just that – claims – and appear not to have been proven in the reality of subject presentation and evaluation. Thus, it is necessary, to examine assumptions regarding the benefits of Web-based instruction in terms of effectiveness. This article discusses aspects of an investigation which examined and compared the effectiveness of HIV/AIDS related collaborative tutorial activities carried out in both a Web-based learning environment and a face-to-face class situation within an undergraduate health education subject. Effectiveness of the pedagogical strategy, and the different learning environments were measured in terms of observed

learning outcomes and reported perceptions of the learners regarding their learning experience. Preliminary results based on measured learning outcomes related to the subject matter, HIV/AIDS, demonstrated that collaborative learning activities were significantly more effective in the Web-based environment than the class environment. Additionally, the vast majority of learners perceived the Web-based environment to be as effective or more effective than the face-to-face, class environment in terms of facilitating their understanding of the issues explored in the subject.

Magin, D. (2001) Reciprocity as a Source of Bias in Multiple Peer Assessment of Group Work. *Studies in Higher Education*, **26**(1), 53-63.

Concerns about the use of peer ratings for assessment purposes are manifold. The issues which are raised by practitioners and researchers, and findings based on recent studies addressing these issues, are outlined. One of the most persistent criticisms is that peer ratings in group settings are prone to bias, resulting in unfairness of mark outcomes. The bias is seen to arise as a result of friendships and social interactions accompanying group task activities. Support for the belief that the validity and fairness of peer ratings are vitiated by 'relational effects' is found in the literature on small group behaviour and interactionist theory. Empirical studies in these two areas operationalise relational effects in what is termed 'reciprocation' – the tendency for two people who are involved in rating each other to be influenced in their rating behaviour by social interactions between the two. The effect of this on rating outcomes, referred to as 'reciprocity effects', is seen to be a major source of bias. The study reported here analyses a data set of multiple peer ratings which had been used as part of the assessment for a subject in community medicine. The analysis is based on cell-by-cell correlation analysis of reciprocal (rater/ratee) pairs, enabling an estimate of the proportion of the variance in scores accounted for by 'reciprocity effects'. The effect was found to be negligible, accounting for only 1% of the variance. Implications for practitioners and for small group behaviour research are discussed.

Magin, D. and Helmore, P. (2001) Peer and Teacher Assessments of Oral Presentation Skills: how reliable are they? *Studies in Higher Education*, **26**(3), 287-298.

This article reports findings on the reliabilities of peer and teacher summative assessments of engineering students' oral presentation skills in a fourth year communications subject. The context of the study is unusual, in that each oral presentation was subject to multiple ratings by teams of students and teams of academic staff. Analysis of variance procedures were used to provide separate estimates of inter-rater reliability of assessments by peers and teachers for classes in four succeeding years. Teacher ratings were found to have substantially higher levels of inter-rater agreement than peer ratings. Generalising over the four years, it would require the averaging of between two and four peer ratings to match the reliability of single teacher assessments. However, the estimates of individual rater reliability for teachers, based on the intra-class correlation coefficient, were moderately low (0.40 to 0.53). It is concluded that the reliability of summative assessments of oral presentations can be improved by combining teacher marks with the averaged marks obtained from multiple peer ratings.

Marshall, D., Summers, M. and Woolnough, B. (1999) Students' conceptions of learning in an engineering context. *Higher Education*, **38**, 291-309.

Research on student learning in higher education has highlighted the central role that students' conceptions of learning play in influencing their approaches to learning. This article reports on a study of conceptions of learning among engineering students on a one-year foundation course. Students were interviewed about their conceptions of teaming at three intervals during their academic year. The data was analysed using a phenomenographic perspective and from the data five qualitatively different conceptions of teaming were identified. The resulting characterisation of these conceptions of learning is presented using excerpts from the interviews and some implications for student learning are discussed.

McNaught, C., Whithear, K. and Browning, G. (1999) Systems Not Projects: focusing on evaluating overall student experience, rather than isolated innovations. In Bain, J. (Ed.), *Higher Education Research and Development*, **18**(2), 247-259.

The article describes evaluation of the Veterinary Bacteriology, and Mycology problem-based learning multimedia project at the University of Melbourne over a period of seven years. The design of the initial project will be described, together with learning benefits that short-term evaluations revealed – including better information management skills improved higher order cognitive skills, increased interest in the subject, better collaborative learning skills, better written and oral communication skills and better computer skills. All very impressive. However, follow-up studies with staff and students in clinical years of the veterinary course indicated clearly that the positive benefits were not sustained in the long term, as this was a once-off experience for students. We clearly needed a new approach. Since 1995, the institutional climate, opportunities provided by new technologies and international links have shifted the policy in the Faculty of Veterinary



Science towards the development of online problem-based subjects, hopefully enabling students to have a much greater exposure to a problem-based learning approach.

Mulder, I., Swaak, J. and Kessels, J. (2002) Assessing group learning and shared understanding in technology-mediated interaction. *Educational Technology & Society*, **5**(1). [Available at URL: [http://ifets.massey.ac.nz/periodical/vol\\_1\\_2002/mulder.html](http://ifets.massey.ac.nz/periodical/vol_1_2002/mulder.html)].

Without shared understanding, hardly any group learning takes place. Though much has been written about the essence of shared understanding, less is known about how to assess the process of reaching shared understanding. Therefore, the study focuses on ways of assessing shared understanding. A conceptual framework is described that makes a distinction between the process of reaching shared understanding and the resulting shared understanding. The conceptual ideas lead to a coding scheme for observing the processes of shared understanding and to the definition of product measures, among others a scale to assess perceived shared understanding. Then an empirical study is presented, in which the model is applied. A major conclusion is that it was hard to find reflective utterances in the protocols although the coding scheme provided for them.

Newton, D. P., Newton, L. D. and Oberski, I. (1998) Learning and Conceptions of Understanding in History and Science: lecturers and new graduates compared. *Studies in Higher Education*, **23**(1), 43-58.

Understanding is greatly valued in higher education. It is more likely to be achieved when lecturers and students agree on what counts as understanding. History and science lecturers' conceptions of understanding were compared with recent history and science graduates' conceptions of understanding. Whilst there was some agreement amongst students and lecturers about the nature of understanding in these subjects, there was the potential for a mismatch of conceptions which could reduce the effectiveness of teaching and the quality of learning. What lecturers and recent graduates saw as support for and evidence of understanding is also described. Clarification of what is to count as understanding in a given context should be amongst the principles for supporting students' learning. Some suggestions are made which could reduce the likelihood of an unnoticed mismatch of conceptions of understanding.

Pitman, A. J., Gosper, M. and Rich, D. C. (1999) Internet based teaching in geography at Macquarie University: An analysis of student use. *Australian Journal of Educational Technology*, **15**(2), 167-187.

The design of a first year course with enrolments of about 400 students which is delivered using information technology via the Internet or Intranet is reviewed. The course is composed of a variety of information technology based applications including course materials, bulletin boards, email, quizzes, access to the World Wide Web and multimedia packages linked together using a single Internet browser interface. Access statistics through the entire course were collected hourly over the sixteen weeks of semester and separated on the basis of gender and final grade. Statistical analysis is presented which shows that different groups of students access the course in different ways. Performance in the course is statistically related to the number of times the student accesses the package. We find no evidence that males are advantaged or disadvantaged compared to females through the use of information technology although females appear to use the communications part of the course more than males. Based on the access statistics, we make recommendations on the components which seem to be well received by students and we note some components which will require more careful integration into a teaching program. Overall, the delivery of a first year course via information technology works well provided the components are carefully integrated into the course framework.

Prosser, M., Walker, P. and Millar, R. (1996) Differences in students' perceptions of learning physics. *Physics Education*, **31**(1), 43-48.

Recent research on student learning in higher education has highlighted the effect that students' perceptions of the nature of learning and understanding of their discipline has on their consequent understanding of the subject matter. This present project grew out of a programme aimed to help first-year students in physics develop their ideas on the nature of physics and how to study it. One of the issues to emerge from that project was the need to develop a more detailed understanding of students' perceptions, to be used both in further planning of the programme and in its evaluation. This paper reports on the results of that study. It involved a before (340 students) and after (110) survey of first-year physics students at the University of Sydney. They were asked to complete an open-ended response survey, including questions on how they go about studying physics and what they thought the study of physics was about. A phenomenographic methodology was used to identify categories of description for each of the questions. The paper will describe the categories in some detail and the distribution of responses across the categories. It will also discuss a number of issues to emerge from the study and some implications for the practice of teaching physics.

Reeves, T. C. and Laffey, J. M. (1999) Design, Assessment, and Evaluation of a Problem-based Learning Environment in Undergraduate Engineering. In Bain, J. (Ed.), *Higher Education Research and Development*, **18**(2), 219-232.

The article describes the design, evaluation, and results of an innovative undergraduate engineering course at the U.S. Air Force Academy (USAFA). The course, ENGR 110 Introduction to Engineering, is a problem-based learning environment in which freshmen students work in teams to solve problems integral to a "Mission to Mars", that is, getting to Mars, constructing a research site on Mars, and developing a renewable power source there. In addition to traditional knowledge and skill objectives, the course focuses on "higher order" outcomes such as framing and resolving ill-defined problems; communicating via multiple media; exhibiting intellectual curiosity; and developing a rich conceptualisation of engineering. The course is described in terms of a set of pedagogical dimensions for problem-based learning environments. Several cognitive assessment methods were used to assess student achievement and evaluate the effectiveness of the course. Results included statistically and educationally significant differences in "problem-solving" between two classes of ENGR 110 students and two control classes of sophomore engineering students.

Rillero, P. and Gallegos, B. (1998) Databases: A Gateway to Literature in Mathematics and Science Education Research. In Malone, J. A., Atweh, B. and Northfield, J. R. (Eds), *Research and Supervision in Mathematics and Science Education*. Mahwah, New Jersey: Lawrence Erlbaum Associates, 323-349.

Huge databases exist for literature and information in almost every professional field of study. "End-users need to be aware of these sources and have the skill to exploit the information environment effectively ... or they will become its peasants" (Omaji, 1994, p. 46). With the increasing sophistication of computer hardware and software, it has become easier to rapidly find a needle of information in a haystack of data. These needles of information point researchers to information that enables them to understand a field, design research projects, write grant proposals, and develop theories. The ease of using some databases may make novices feel like experts. This can be advantageous because it gives confidence in conducting searches. The confidence may, however, be a disadvantage if it prevents novices from learning more efficient and effective techniques. A study of ERIC searches by faculty members and graduate students indicates they are finding only one-third of the items that would be useful for their topics (Lancaster, Elzy, Zeter, Metzler, and Low, 1994). Furthermore, inefficient searches waste time. Few people have the time to wade through a few hundred records from a poorly designed search - full of unneeded items and missing relevant records. Science and mathematics education researchers must know how to efficiently access information in literature databases, and which databases are important and relevant for their research. This chapter begins with a discussion of the benefits of using databases for finding material for science and mathematics education research. The structure of databases is described and generalities of searching and retrieving database information are discussed. Database searches are further illustrated by examples from the world's largest and most used educational database - the Educational Resources Information Center (ERIC) database. In the quest to maximize the procurement of information and minimize the investment of time and money, the following areas are explored: free text searches, controlled vocabulary, narrowing and broadening searches, finding instruments, and finding printed materials from their bibliographic records. The ERIC example will be a springboard into an annotated bibliography of other key databases for mathematics and science education researchers. The chapter concludes with a discussion of the Internet - an unorganized, ever-changing, and rapidly growing database. Tools and techniques for searching this database are described, and pointers to Internet resources are presented.

Scouller, K. (1998) The influence of assessment method on students' learning approaches: Multiple choice question examination versus assignment essay. *Higher Education*, **35**, 453-472.

A sample of 206 second-year Education students completed questionnaires on issues relating to their preparation for and perceptions of two methods of assessment of the same course: an assignment essay and an end-of-course multiple choice question (MCQ) examination. The questionnaire required a simultaneous response for each assessment method to statements focusing on their learning approaches, their perceptions of the levels of intellectual abilities being assessed, and their preference for either the assignment essay or MCQ examination as an assessment method of the course and the reasons for their choices. The above variables were analysed in relation to each other and to performance outcome in both assessment tasks. Results suggest distinct patterns according to assessment method. Students were more likely to employ surface learning approaches in the MCQ examination context and to perceive MCQ examinations as assessing knowledge-based (lower levels of) intellectual processing. Poorer performance in the MCQ examination was associated with the employment of deep learning strategies. In contrast, students were more likely to employ deep learning approaches when preparing their assignment essays which they perceived as assessing higher levels of cognitive processing. Poorer performance in the assignment essays was associated with the employment of surface strategies. The implications of these findings are discussed.



Seymour, E. (2001) Tracking the Processes of Change in US Undergraduate Education in Science, Mathematics, Engineering, and Technology. *Science Education*, **86**(1), 79-105.

This paper describes some features in the changing landscape of activities intended to improve both quality and access in science, mathematics, engineering, and technology (SMET) undergraduate education. Observations are offered from the viewpoint afforded by my work – broadly over the last 10 years – both as a researcher, and as an evaluator for projects related to the improvement of undergraduate SMET education. Over that period, I have watched the landscape change – some issues, at first prominent, have diminished in importance; some are emergent; and yet others lie on the horizon. I have also observed that actions in pursuit of various reform goals reflect a variety of theories about how change can be accomplished that are not necessarily complementary. This short history of shifts in the focus of our efforts, and in our beliefs about how they may be achieved, is offered as a framework for discussion of these nationwide endeavors and as an aid in considering next steps.

Svec, M. (1999) Improving Graphing Interpretation Skills and Understanding of Motion Using Micro-computer Based Laboratories. *Electronic Journal of Science Education*, **3**(4). [Available at URL: <http://unr.edu/homepage/crowther/ejse/svec.html>].

The purpose of this study is to examine the relative effectiveness of the traditional lab method and the microcomputer-based laboratory (MBL) for improving student understanding. Three areas of achievement were examined: graphing interpretation skills, interpreting motion graphs and understanding of motion. The nonequivalent control-group design was selected with the treatment group conducting using MBL activities and the control group employing traditional laboratories. All the students were enrolled in introductory college physics classes. Item analysis revealed both control and treatment groups confused position, velocity, acceleration, and distance, velocity, and acceleration-time graphs on the pre-test. On the post-test, the control group scores improved only slightly. The treatment group demonstrated a less thorough understanding than the control on the pre-test, but the treatment group outperformed the control group on the post-test. Effect sizes were 0.78, 1.71 and 0.88 for graphing interpretation skills, interpreting motion graphs and conceptual understanding of motion respectively. Results indicate that MBL laboratories are more effective than traditional lab for improving students' graphing interpretation skills, interpreting motion graphs and their understanding of motion. MBL is an effective tool for challenging students' naive beliefs.

Taylor, J., Woodman, M., Sumner, T. and Blake, C. T. (2000) Peering Through a Glass Darkly: Integrative evaluation of an on-line course. *Educational Technology & Society*, **3**(4). [Available at URL: [http://ifets.massey.ac.nz/periodical/vol\\_4\\_2000/taylor.html](http://ifets.massey.ac.nz/periodical/vol_4_2000/taylor.html)].

In this study we describe a wide-spectrum approach to the integrative evaluation of an innovative introductory course in computing. Since both the syllabus, designed in consultation with industry, and the method of presentation of study materials are new, the course requires close scrutiny. It is presented in the distance mode to a class of around 5,000 students and uses a full range of media: paper, broadcast television, interactive CD-ROM, a Web-oriented programming environment, a Web site and computer conferencing. The evaluation began with developmental testing whilst the course was in production, and then used web-based and paper-based questionnaires once the course was running. Other sources of data, in the form of observation of computing conferences and an instrumented version of the Smalltalk programming environment, also provide insight into students' views and behaviour. This paper discusses the ways in which the evaluation study was conducted and lessons we learnt in the process of integrating all the information at our disposal to satisfy a number of stakeholders.

Tiberghien, A., Viellard, L., Le Maréchal, J. and Millar, R. (2001) An analysis of labwork tasks used in science teaching at upper secondary school and university levels in several European countries. *Science Education*, **85**(5), 483-508.

This article describes the results of a study of the similarities and differences in laboratory tasks used in science education at upper secondary school and university level, in the three main science subjects, in seven European countries. The data source for the study was a collection of 75 laboratory instruction sheets for use at school level in five countries, and 90 for use at university level in six countries, selected as being typical of practice in these countries. The tool used for analysis was a map (or classification system) for labwork tasks. Whilst some differences are noted between the science subjects and between educational levels, the dominant impression from this analysis is of similarity across educational levels, science subjects and countries. Some coding categories arise only very infrequently, suggesting that some possible designs of labwork task are very seldom used. The findings indicate the potential usefulness of this classificatory "map" as a tool for monitoring practice and for raising questions about the use of labwork in science education.

Trigwell, K., Prosser, M. and Waterhouse, F. (1999) Relations between teachers' approaches to teaching and students' approaches to learning. *Higher Education*, **37**, 57-70.

This paper reports on an empirical study which shows that qualitatively different approaches to teaching are associated with qualitatively different approaches to learning. More specifically, the results indicate that in the classes where teachers describe their approach to teaching as having a focus on what they do and on transmitting knowledge, students are more likely to report that they adopt a surface approach to the learning of that subject. Conversely, but less strongly, in the classes where students report adopting significantly deeper approaches to learning teaching staff report adopting approaches to teaching that are more oriented towards students and to changing the students conceptions. The study made use of a teaching approach inventory derived from interviews with academic staff, and a modified approach to learning questionnaire. These conclusions are derived from a factor and cluster analysis of 48 classes (involving 46 science teachers and 3956 science students) in Australian universities. The results complete a chain of relations from teacher thinking to the outcomes of student learning. Previous studies have shown relations between teachers' conceptions of teaching and learning and their approaches to teaching. Numerous studies have shown correlations between students' deeper approaches to learning and higher quality learning outcomes. The results reported here link, these two sets of studies. They also highlight the importance, in attempts to improve the quality of student learning, of discouraging teacher-focused transmission teaching and encouraging higher quality, conceptual change/student-focused approaches to teaching.

Tynjälä, P. (1998) Traditional Studying for Examination versus Constructivist Learning Tasks: do learning outcomes differ? *Studies in Higher Education*, **23**(2), 173-189.

Students' learning outcomes on an educational psychology course which involved studying three textbooks were compared between a constructivist class without a final examination and a traditional class concluding with an examination. The constructivist group (n = 16) studied the coursebooks with the help of writing assignments, discussed their assignments in groups and wrote an essay. The control group (n = 23) read the books on their own, attended lectures and took an examination. Learning outcomes were investigated (1) as the students' subjective learning experiences; (2) as changes in the students' learning conceptions; and (3) as measured by a traditional examination in which the students had to answer two questions. Although the constructivist group students did not have to take the examination as a basis of their course grade, they were asked to answer the questions in order to provide research material. All students in both groups described their learning in terms of knowledge acquisition. The constructivist group students emphasised the development of their thinking more than did the students in the control group. They also developed more constructivist conceptions of learning. Examination answers were longer in the control group, but the answers of the constructivist group students included more classifications, comparisons, evaluations and generalisations and their SOLO (Structure of the Observed Learning Outcome) level was higher than in the control group. It is concluded that a constructivist learning environment seems to produce higher-level learning outcomes more efficiently than traditional teaching.

Wagner, E. and DiBiase, W. (2001) Development and Evaluation of a Standards-Based Approach to Instruction in General Chemistry. *Electronic Journal of Science Education*, **(6)**1. [Available at URL: <http://unr.edu/homepage/crowther/ejse/ejsev6n1.html>].

Operation CHEM1251 is an on-going project designed to implement a Standards-based approach to instruction in the general chemistry curriculum at the University of North Carolina at Charlotte. The project is a collaborative effort between the Department of Chemistry and the Department of Middle, Secondary, and K-12 Education. Implementation of such an approach has shown an increase in both student performance and attitude toward chemistry. A Standards-based approach to instruction includes, but is not limited to, block scheduling the entire enrollment of one lecture class into the same laboratory sections and learning experiences structured in a learning cycle format. Analysis of the data gathered during this project indicates that this is the first time in five years that any day-time first semester general chemistry course section scored significantly higher than other concurrent sections on both departmental exams and the American Chemical Society's Nationally Standardized End of Semester Exam.

Wilkins, L. C. and Dabke, K. P. (1995) Peer Marking in Undergraduate Assessment: Applications and Outcomes in a Management and Communications Course for Engineers. *Australasian Journal of Engineering Education*, **6**(1).

Peer marking has a number of applications to effective professional practice in engineering, notably in monitoring performance where external assessment of specific learning is not feasible on a regular basis. By approaching assessment as an aspect of professional development, commencing from the earliest stages of undergraduate formation, the engineering student is encouraged to view him/herself as an active participant in a flexible process where assessment is not just something that is done to you. Electrical and computer systems engineering students in a management unit were asked to



assess the oral presentations of class members. In a follow up survey of student perceptions of peer marking, 92% of the group agreed with the statement 'By assessing other students I learnt how to make a better presentation myself'. While reliability of the procedure remains questionable, the exercise indicated significant learning benefits for all groups and specifically for those with an international student component. These benefits were related to using a variety of flexible assessment procedures, including peer marking where appropriate.

Willcoxson, L. (1998) The Impact of Academics' Learning and Teaching preferences on their Teaching Practices: a pilot study. *Studies in Higher Education*, **23**(1), 59-70.

This study investigated factors underlying the approaches to teaching and the teaching strategies adopted by lecturers in four distinct academic disciplines. It examined the relationship between the way academic staff like to learn and the way they like to teach and the reasons they use the teaching strategies they adopt in lectures. It also examined the relationship between academics' perceptions of their teaching and their students' perceptions of their teaching and investigated the relationship between academics' perceptions of what students do in lectures and their students' reports of what they do in lectures. Results suggest little enthusiasm for lectures as a teaching or learning method, but few attempts by academics to depart from the traditional lecture method, even amongst those with a personal preference for learning in groups. Marked contrasts were found between lecturer and student reports of the teaching strategies used in lectures and lecturer and student reports of student activity in lectures.

Williams, D. (1998) A Framework for Thinking About Research in Mathematics and Science Education. In Malone, J. A., Atweh, B. and Northfield, J. R. (Eds), *Research and Supervision in Mathematics and Science Education*. Mahwah, New Jersey: Lawrence Erlbaum Associates, 1-18.

In the opening chapter of the NCTM handbook on *Research in Mathematics - Education*, Begle and Gibb (1980) gave their view of the main purpose of research in that discipline: "Simply stated, there is a need to understand better how, where and why people learn or do not learn mathematics" (P. 8). The crucial word in this definition is, of course, "understand". In the chapter, I discuss some of the different ways that have been developed for thinking about what it means to "understand" something in mathematics or science education. The chapter begins with a discussion of some of the ways in which approaches to research in education have been classified (for example, "basic" vs. "applied" and "qualitative" vs. "quantitative"). This then leads on to considerations of what counts as "knowledge" in the field of education, and what happens as a result of that knowledge. In the final part of the chapter, these ideas are drawn together in a five-fold classification of different methods of inquiring in education, based on whether the principal source of evidence is reasoning, observation, representation, dispute, or ethical values.

Zariski, A. (1996) Student Peer Assessment in Tertiary Education: Promise, Perils and Practice. In Abbott and Willcoxson, (Eds), *Teaching and Learning Within and Across Disciplines*, Perth: Murdoch University, 189. [Available at URL: <http://carmen.murdoch.edu.au/~zariski/peer1.html>].

This paper first discusses some of the theoretical pedagogical issues related to the use of student peer assessment in university teaching and canvasses the suggested strengths and weaknesses of such practice. It then outlines the author's experience with introducing peer assessment as part of the formal assessment in a law unit including observations of the apparent effect on grades achieved and student evaluations of the subject.