UniServe Science Bibliography

Reading Supplements for

Conference: Motivating Science Undergraduates: Ideas and Interventions

October 1 & 2, 2009
The University of Sydney

Bibliography 2009

UniServe Science has compiled this bibliography on 'Motivating Science Undergraduates: Ideas and Interventions' from the Web and the following journals:

- Research in Science & Technological Education
- Higher Education Research & Development
- Review of Educational Research
- International Journal of Science Education
- Journal of Research in Science Teaching
- Symposium Proceedings Science UniServe Science 2007
- Personality and Individual Differences

Bibliographies prepared for previous UniServe Science Conferences are available online from http://science.uniserve.edu.au/workshop/

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Biggs, J.B.(1989). Approaches to the enhancement of tertiary teaching. *Higher Education Research & Development,8(1)*, pp.7-25. Retrieved July 3, 2009, from http://dx.doi.org/10.1080/0729436890080102

Recent research in the areas of cognitive psychology and student learning involves changed conceptions of the natures of learning and of teaching, with promising implications for the enhancement of tertiary teaching. A model of learning is presented, proposing that the teaching context, students' approaches to learning, and the outcomes of learning, form a system in a state of equilibrium. Three approaches to enhancing teaching follow from the model: additive, interactive, and contextual. Additive approaches ignore both students' approaches to learning and the institutional context, and are relatively ineffective. Genuine improvements in student learning involve interactive and contextual approaches to teaching, which can be activated through appropriate staff development.

Blanchfield, J., McGraw, E., Bulmer, M., Thier, R., Byers, H., Myatt, P., et al. (2007). The Advanced Study Program in Science: challenging, motivating and inspiring our best science students. *Symposium Proceedings Science Teaching and Learning Research including Threshold Concepts September 2007 (pp.134-139).* Sydney, UniServe Science.

The Advanced Study Program in Science is an enrichment program for science students at The University of Queensland (UQ) which targets highly motivated, high achieving students with an interest in research and a career in science. The program is coordinated across the full three years of the degree with the core aims of:

• providing a cohort experience with a group of like-minded individuals which becomes a closely bonded learning community throughout the undergraduate experience and beyond;
• exposing motivated and interested students to the research culture of the university and the myriad of career opportunities in science;
• allowing these students to gain genuine research laboratory experience earlier and more intensely than in a regular undergraduate degree program; and
• challenging these students to develop complex problem solving skills.

The program has an enrolment of approximately 40 students per year and these students participate in a number of cohort building exercises including science camps, team assignments and social activities. The students gain academic credit for three specific courses, one in each year, which consist of seminar attendance, research projects, discussion groups and advanced laboratory exercises. The results of the research projects completed in second and third year are presented within an authentic science context at an Annual Undergraduate Research Symposium as either oral or poster presentations. The Advanced Study Program has been very successful in providing immediate and accessible links between the science research occurring at UQ and the undergraduate learning environment.

Bibliography 2009

Busato, V.V., Prins, F.J., Elshout, J.J., & Hamaker, C. (2000). Intellectual ability, learning style, personality, achievement motivation and academic success of psychology students in higher education. *Personality and Individual Differences, 29*, pp.1057-1068. Retrieved June 26, 2009, from
http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6V9F-412RS3P-4-1&_cdi=5897&_user=115085&_orig=search&_coverDate=12%2F31%2F2000&_sk=999709993&view=c&wchp=dGLbVzb-zSkWz&md5=c86f9f36749fa559260c3ab8a74dd3eb&ie=/sdarticle.pdf

This study is directed towards an integration of intellectual ability, learning style, personality and achievement motivation as predictors of academic success in higher education. Correlational analyses partly confirmed and partly disconfirmed our expectations in a sample of 409 first-year psychology students. Consistent with the literature, intellectual ability and achievement motivation were associated positively with academic success. For the meaning directed, reproduction directed and application directed learning style, no positive association with academic success could be detected. The undirected learning style, however, appeared to be a consistent negative predictor. For the Big Five personality factors (extraversion, agreeableness, conscientiousness, neuroticism and openness to experience), a consistent, positive association for conscientiousness with academic success was found. The very first examination at the university came out as the most important predictor for academic success, even after two and three years of study. The implications of the results are discussed in relation to the literature and the policy of the Dutch Ministry of Education.

de Jesus, H.P., de Souza, F.N., Teixeira-Dias, J.J.C., & Watts, M. (2005). Organising the chemistry of question-based learning: a case study, *Research in Science & Technological Education,23(2)*, pp.179-193. Retrieved June 15, 2009, from
http://dx.doi.org/10.1080/02635140500266419

Designing inquiry-based-learning with and for university students develops problem-solving skills and logical reasoning, as well as reflective thinking. It involves working as a member of a team, questioning, being creative, shaping the skills for continued intellectual development. It is argued that inquiry-based group work is one of the most important learning experiences because it enables the exploration of theoretical ideas and conceptual change. This paper presents results about the use of students' questions to shape these processes. This research involved one group of three students developing a mini-project on 'thermochemistry of fitness'. Data were collected through participant observation of group meetings and of meetings with the tutor, through semi-structured interviews with members of the group and the group as a whole, through an analysis of the questions asked by the group in the development of the project (oral and written) and through an oral presentation by the students. The results show that the questions formulated during the development of group miniprojects performed several important functions in the structure of the students' work, such as organizing ideas, delimiting the scale of the project, identifying and reflecting on the many strands and sources of information, and reflecting on the project as a whole. The questions have contributed to students' engagement in the discipline, bringing an increase of interaction between teacher and students, an increase in the confidence and trust of the students in the asking of

questions, and therefore an increase in the quality of classroom interactions in the learning and teaching of chemistry.

Gungor, A., Eryilmaz, A., & Fakioglu, T. (2007). The relationship of freshmen's physics achievement and their related affective characteristics. *Journal of Research in Science Teaching 44(8),* pp.1036-1056. Retrieved July 7, 2009, from http://www3.interscience.wiley.com/cgi-bin/fulltext/114211945/PDFSTART

The purpose of this study was to determine the best-fitting structural equation model between the freshmen's physics achievement and selected affective characteristics related to physics. These characteristics are students' situational interest in physics, personal interest in physics, aspiring extra activities related to physics, importance of physics, importance of electricity, physics course anxiety, physics test anxiety, physics achievement motivation, student motivation in physics, self-efficacy in physics, self-concept in physics, and locus of control. The researchers developed the affective characteristics questionnaire that consisted of 12 subdimensions, and has 53 items related to these subdimensions. The questionnaire was applied to 890 freshmen physics students at the universities in Ankara. Two models were tested: a unidimensional model and a multidimensional model. However, a third model, which is more similar to the multidimensional model, exhibited the best fit for the freshmen. Moreover, the results revealed that achievement motivation was the most influential affective characteristic on physics achievement. On the other hand, motivation in physics had a negative influence
on physics achievement in the model, and the influence of the students' attitudes towards physics was not statistically significant. Thus, one should especially pay attention to the students' achievement motivation in physics if the aim is to increase students' physics achievement.

Hassan, Ghali. (2008). Attitudes toward science among Australian tertiary and secondary school students. *Research in Science & Technological Education, 26(2),* pp.129-147. Retrieved June 15, 2009, from http://dx.doi.org/10.1080/02635140802034762

The main purpose of this study was to investigate the factors that might be associated with students' attitudes towards science. The participants were 1745 students from secondary schools and universities across Australia. The results of factor analysis, descriptive statistics, Tukey's post hoc test and correlation analysis demonstrate that there were statistically significant differences between male and female students. Finally, the study provides a valid and reliable instrument. Implications of this study for future research are also discussed.

Hofstein, A., & Kempa, R. F. (1985). Motivating strategies in science education: Attempt at an analysis. *International Journal of Science Education ,7(3),* pp.221-229. Retrieved July 3, 2009, from http://dx.doi.org/10.1080/0140528850070301

The question of how science education can be conducted so that it has a motivating effect upon the learner is considered. A distinction is proposed between interest arousal which

can be brought about by an appropriate selection and structuring of subject matter included in a curriculum; and motivational enhancement which, it is suggested, is brought about by the choice of pedagogical strategies that are in accord with students' intrinsic motivational patterns. In relation to the latter, an analysis of the types of motivational pattern is presented. Their implications for the choice of educational strategies in science education are also discussed

Laoui, T., & O'Donoghue, J. (2008). Development of a support environment for first year students taking materials science/engineering. *Research in Science & Technological Education, 26(1)*, pp.93-110. Retrieved June 15, 2009, from http://dx.doi.org/10.1080/02635140701847553

This paper is based on the experience acquired in teaching materials science/engineering to first year university students. It has been observed that students struggle with some of the fundamental materials concepts addressed in the module/course. This applies to delivered lectures but extends to the incorporation of tutorial sessions provided after lectures. Moreover, when students miss a lecture or seminar the acquisition and application of knowledge and concepts becomes problematic. Consequently, or perhaps inevitably, these students perform poorly in their assessments and their motivation for the subject suffers. A careful analysis of this situation and of the nature of interaction and engagement was performed to gain an insight into the reasons for this lack of performance. A common factor is that students do not dedicate sufficient time for reading and consolidation using the chapters/sections prescribed after each topic. They also do not attempt solving tutorial problems outside the formal contact hours. This reflection and personal evaluation is difficult to administer, resource intensive and yet potentially enables each student to monitor and evaluate their own learning and understanding. A multimedia learning technology-based environment was created in which students could engage. This was located within the University of Wolverhampton Virtual Learning Environment (VLE) called WOLF. The students were able to progress independently but with access to tutor and peer support, help and advice. The use of non-text animations and structures was used and seen as fundamental by the students in enhancing the taught course and in developing a deeper understanding of complex atomic and crystal structures.

Minasian-Batmanian, L.C., Lingard, J., & Prosser, M. (2006). Variation in Student Reflections on their Conceptions of and Approaches to Learning Biochemistry in a First-year Health Sciences' Service Subject. *International Journal of Science Education, 28(15)*, pp.1887-1904. Retrieved July 3, 2009, from http://dx.doi.org/10.1080/09500690600621274

Many factors affect students' learning approaches, including topic conceptions and prior study. This research, undertaken after a first-semester compulsory subject, explores students' conceptions of biochemistry and how they approached their studies. Students (n=151) completed an open-ended survey analysed phenomenographically. Those with cohesive conceptions were found to be more likely to adopt deeper approaches to study than those with fragmented conceptions, a result unaffected by various demographic parameters. Compared with earlier research, a semester of study increased the percentage of students

with a cohesive view, with no concomitant change in learning approaches, suggesting that cohesive conceptions are a necessary but not sufficient criterion for deep learning outcomes. Compared with results for a science major subject, more of the students with cohesive conceptions used surface approaches. This may reflect a regression to safe surface approaches when faced with an unfamiliar topic or high total workload driving a strategic approach to learning. It could also reflect a perception that this material is only a tool for later application. The present findings indicate the crucial importance, when university studies begin, of enabling students to build an overarching conception of the topic's place in professional practice. This concept building should be applied across the entire curriculum to emphasise application and integration of material (key graduate attributes). Improved conceptions may provide crucial motivation for students to achieve deeper learning, especially in these foundation service subjects. These essential changes to the learning context may also better prepare students for increasing self-directed/life-long learning.

Moos, D.C., & Azevedo, R. (2009). Learning With Computer-Based Learning Environments: A Literature Review of Computer Self-Efficacy. *Review of Educational Research; 79(2)*, pp.576-600. Retrieved July 3, 2009, from http://rer.sagepub.com/cgi/reprint/79/2/576

Although computer-based learning environments (CBLEs) are becoming more prevalent in the classroom, empirical research has demonstrated that some students have difficulty learning with these environments. The motivation construct of computer-self efficacy plays an integral role in learning with CBLEs. This literature review synthesizes research that has empirically examined factors related to computer self-efficacy and the relationship between computer self-efficacy, learning outcomes, and learning processes with CBLEs. Results indicate that behavioural and psychological factors are positively related to computer self-efficacy. Students who receive behavioural modeling report significantly higher computer self-efficacy than do students who receive the more traditional instruction-based method when learning with CBLEs. Computer self-efficacy is related both to learning outcomes and to learning processes with CBLEs. This review also offers theoretical and methodological issues for future research in the area of computer self-efficacy.

Palmer, D. (2005). A motivational view of contructivist-informed teaching. *International Journal of Science Education, 27(15)*, pp.1853-1881. Retrieved July 3, 2009, from http://dx.doi.org/10.1080/09500690500339654

Constructivist and conceptual change perspectives on learning have given rise to a number of models of constructivist classroom teaching. Motivation has been recognized as an important factor in the construction of knowledge and the process of conceptual change, so one could expect that motivation strategies would be integral components of constructivist-informed teaching. The purpose of this paper was to examine, by literature review, the extent to which motivation strategies have been included in extant models of constructivist-informed teaching. The study involved the development of a list of motivation strategies, based on current motivation constructs. Several constructivist-

informed teaching models were then analysed. It was found that these models were rather limited in the extent to which they had explicitly integrated motivation. It was also found that some aspects of the models were not entirely in accord with current views of motivation. Finally, a motivational model of constructivist-informed teaching was developed and its three components were described.

Waks, S., & Merdler, M. (2003). Creative thinking of practical engineering students during a design project. *Research in Science & Technological Education, 21(1),* pp.101-121. Retrieved June 15, 2009, from http://dx.doi.org/10.1080/02635140308343

Creativity in engineering design had become an economic necessity and not merely the privilege of unique individuals. The search for new, innovative and effective ideas in engineering design stands in center of daily creative performance. This search requires sensitivity to gaps of knowledge and information, and the ability to evoke numerous, different and unique ideas about engineering problems. The source of such information or knowledge can be either extrinsic-such as provided by an instructor or expert or intrinsic, which might involve transformation from one field or context to another. Furthermore, interaction with an exterior source as well as developing an inherent drive, have an impact on the motivation to perform creatively. This article, which is based on a study conducted among Israeli practical engineering students, deals with the variations in creative thinking during various stages of a design project and the relation between creative thinking and motivation factors.

Zeegers, P. (2004). Student learning in higher education: a path analysis of academic achievement in science. *Higher Education Research & Development, 23(1),* pp.35-56. Retrieved June 23, 2009, from http://dx.doi.org/10.1080/0729436032000168487

Learning outcomes in higher education are of considerable interest to students, teaching staff, researchers, tertiary education institutions and funding authorities. To improve the quality of learning outcomes may require a better understanding of what happens in the learning process from the perspective of the learner. This study makes use of a number of current instruments for the evaluation of student learning to explore aspects of learning outcomes in terms of academic achievement. The students evaluated were either in their first year of study (n=194) or in the third year of their course (n=118). A causal mode of learning outcomes was developed for each group and evaluated using the PLSPATH program to explore the impact of student-related causative factors. A number of these factors were shown to have a direct effect on student academic achievement, as measured by annual grade point average (GPA), with some consistency across two year-levels. The most important factor in predicting academic performance for both groups was students' prior academic performance. Approaches to learning and English language skills were also shown to have some predictive value. Students' metacognitive skills and self efficacy, though showing strong inter-relationships with other factors, did not show a direct effect on academic achievement.

Zusho, A., Pintrich, P.R. & Coppola, B. (2003). Skill and will: the role of motivation and cognition in the learning of college chemistry. *International Journal of Science Education,25(9)*, pp.1081-1094. Retrieved July 3, 2009, from http://dx.doi.org/10.1080/0950069032000052207

This study investigated how students' level of motivation and use of specific cognitive and self-regulatory strategies changed over time, and how these motivational and cognitive components in turn predicted students' course performance in chemistry. Participants were 458 students enrolled in introductory college chemistry classes. Participants' motivation and strategy use were assessed at three time points over the course of one semester using self-report instruments. Results showed an overall decline in students' motivational levels over time. There was also a decline in students' use of rehearsal and elaboration strategies over time; students' use of organizational and self-regulatory strategies increased over time. These trends, however, were found to vary by students' achievement levels. In terms of the relations of motivation and cognition to achievement, the motivational components of self-efficacy and task value were found to be the best predictors of final course performance even after controlling for prior achievement.