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Using industry professionals in undergraduate teaching: Effects on student learning

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Introduction

Tutorials are a common complementary method of achieving student engagement with material covered in lectures, as students achieve deeper understanding by being involved in small group discussions. However, in an attempt to provide students with a taste of everything the industry has to offer, the Centre for Forensic Science at the University of Western Australia has until 2014 conducted its undergraduate unit, *Mysteries of Forensic Science*, as a series of seminars by current industry professionals. This approach was implemented initially as a good opportunity to expose undergraduate students to many fields of forensic science from practising industry professionals. While links between universities and industry are largely seen as beneficial, particularly in research and development, simply inserting industry professionals into the role of undergraduate teacher may not be an effective way to introduce students to a subject area.

In 2014 it was decided to introduce tutorials to the unit, to provide students with an opportunity to discuss and clarify material covered in lectures, as well as to allow for continuous feedback both from the teacher and peers. However, the desire to retain the diversity of industry professionals as speakers meant that only five tutorials could be introduced over the semester, with the entire cohort of students in attendance at each. It seemed that the lecture/tutorial format and the seminar series were incompatible.

The purpose of this study was to evaluate an undergraduate unit taught almost entirely by industry professionals and the effect this had on student learning. Further, recommendations for the further restructuring of the unit for 2015 have been made based on student feedback, and are applicable to any undergraduate course having close ties to industry, and considering utilising these ties to expose undergraduate students to industry professionals.

Background

Lecture/tutorial format

The traditional, didactic format of lecturing in university teaching has been defined as "…the continuous exposition by one person for approximately 50 minutes to a largely passive recipient audience." (Butler, 1992). This form of information dissemination has been the principal mode of conveying information to large audiences since the beginning of history, and continues to be the most common method of teaching adults (Bligh, 1972). The reasons for this are many, and mostly have to do with the economy of lecturing. In terms of time and university funding, a single lecture to a large group is far more economical, from the perspective of a university (Costin, 1972). Depending on the objectives of the lecturer, lecturing can be an effective method of teaching, having been found to be as effective as any other form of information dissemination (Bligh, 1972). However, if the objective of the lecturer is to go further than the simple dissemination of knowledge, into promoting thought, changing attitudes, or teaching behavioural skills, lecturing has been found to be relatively ineffective, due to its passive nature (Bligh, 1972).

In order to augment lectures to achieve information dissemination as well as the promotion of thought, change of attitudes and teaching of behavioural skills, other approaches to teaching need to be included (Brown, 1989, p. 458). This augmentation can be included in the lecture itself, involving some form of student participation, at the very least by providing students with a printed handout (Butler, 1992), and ideally by presenting a completely interactive lecture (Steinart & Snell, 1999). However, the most commonly used augmentation to lectures, for the purposes of

providing student interaction and participation in small group discussions, is the tutorial (Sweeney, O'Donoghue & Whitehead, 2004). Tutorials give students the opportunity to practise and apply their learning, and motivate students to think creatively about issues raised in lectures (Keddie & Trotter, 1998; Sharma, Millar & Seth, 1999; Widdison & Pritchard, 1995). Tutorials also give teachers an opportunity to continuously check students' understanding through student feedback (Dawson, 1998; Race, 2001). This interaction is argued to be vital to the students' learning process (James, 1978), as the teacher becomes a facilitator to learning, in contrast to the more traditional, didactic role of the lecturer (Cox, Clark, Health & Plumpton, 2000; Gremler, Hoffman, Keaveney & Wright, 2000; Hake, 1998; Margetson, 1999). Attendance at tutorials has been found to improve student learning. For example, Sharma, Mendez and O'Byrne (2005) saw a marked improvement in exam results from students who attended tutorials, particularly in exam questions that were deemed qualitative concept questions.

For the purposes of this study, the lecture/tutorial format is considered as the 'traditional' university teaching model, specifically involving a weekly lecture and a weekly tutorial (Dowling, Godfrey & Gyles, 2003). The lecture is in the form of a large group didactic lecture, in which key information is disseminated, while the tutorial facilitates small group discussion on the information presented in the lecture. Along with this traditional lecture/tutorial format, are related resources available to students, specifically lectures recorded and available online, a unit reader or textbook, and frequent feedback from a familiar tutor. With the vast majority of undergraduate courses taught in this format, students come to expect the format and associated resources in all of their units.

University-industry links

Universities worldwide are adapting to a demand for relevant, real-world, industry-based research, training and education. As part of the commercialisation and commodification of universities due to a shift from universities as elite institutions to mass recruiters, a significant point of university branding and marketing is work-integrated learning (WIL) and job-ready graduates (Ali-Choudhury, Bennett & Savani, 2008). The importance of work-integrated learning is increasing in universities at the expense of purely disciplinary-based education, as employers demand industry ready graduates (Harman, 2004). In most cases, this is reflected in university-industry collaborations in graduate research and education rather than undergraduate, with increasing links to industry found to be a positive for graduate research students (Harman, 2004). To date, very little study has been done on the effects of university-industry links in undergraduate teaching and learning.

From the point of view of industry, new knowledge and technologies cannot always be developed in-house due to the fast pace required of such developments to keep a particular commercial organisation competitive. The attainment of such knowledge and technologies from external sources such as universities has long been identified as beneficial to a firm in a competitive industry (Conner & Prahalad, 1996; Hamel, 1991). The more competitive the industry, the less time and resources a firm can spend on developing and innovating new ideas and technologies (Lambe & Spekman, 1997; Swan & Allred, 2003). The link between universities and industry can be crucial to a firm's success, and is increasingly used in industry (Mowery & Shane, 2002; Perkmann & Walsh, 2007). Industry partners who utilise university collaborations have been found to not only value the finished product, that is, the university-developed technology, but also the capacity building and learning which is facilitated by the industry-university relationship (Perkmann & Walsh, 2007).

In terms of research, universities and industry collaboration in research commercialisation is becoming more and more common, from a peripheral activity to an important source of major funding for universities, when government funding of research may be in decline (Bokor, 2012; Cyert & Goodman, 1997; Meyer-Krahmer and Schmoch, 1998). It has been found that apart from securing additional research funding, universities highly value the bi-directional exchange of knowledge with researchers in industry (Meyer-Krahmer & Schmoch, 1998). Links between university and industry are also of benefit to students, particularly research students, as it has been found that research students who have collaborated with industry partners benefit from industry funding, professional development opportunities and better access to training, equipment and supervision (Harman, 2004). For example, in an initiative designed by government to produce industry-ready research graduates, make graduates more attractive to industry, and to promote university-industry collaborations, the Australian Cooperative Research Centres were founded. These centres promote research and development in partnership with industry, to strengthen the link between research organisations and industry (Harman, 2004). Conversely, universities may find themselves competing with industry both in research commercialisation and in specialised training, such as the accounting industry, which already offers such specialised qualifications as Certified Practising Accountant (CPA) (Bokor, 2012).

In terms of undergraduate teaching and learning, universities are becoming more industry focused, with aims to produce job-ready graduates with applicable, industry relevant training (Choy & Delahaye, 2009). As a result, traditional university teaching practices have had to be expanded to allow for work-integrated learning, in which students learn skills and knowledge that is directly applicable to their future in the workforce. Choy and Delahaye (2009) found that during the development and implementation of a 'boutique' curriculum catering to the Queensland Community Services and Health Workforce Council, work-integrated learning provided students with deep learning and an appreciable direct application of that learning to the workplace. The steps taken in order to create this curriculum required flexibility in the university in relation to curriculum design whilst maintaining academic standards, extensive input from the organisation in terms of required content and that the learning is appropriate and applicable to workplace culture. In sum, the process proved to be complex and time consuming, but the end product was beneficial to students, and the relationship between the university and the organisation involved (Choy & Delahaye, 2009).

As demonstrated, it is widely observed and accepted that university-industry relationships are increasing. The nature of these relationships is highly variable, from partnerships to research and develop new technologies for use in industry, to training of those already in the workforce, to providing students with opportunities to graduate from university 'work-ready'. Due to this variability in university-industry relationships, their management can prove to be difficult, especially as each relationship is unique (Choy & Delahaye, 2009; Cyert & Goodman, 1997; Perkmann & Walsh, 2007). The variety of industries involved and a lack of protocol for expansion for unit coordinators, lecturers and tutors can lead to difficulties in effectively implementing work-integrated learning in undergraduate courses. Thus, many undergraduate courses may seek to take advantage of industry links without established protocols. This paper details a case-study of one such undergraduate course.

Mysteries of Forensic Science unit background

The *Mysteries of Forensic Science* (FNSC2200) unit at The University of Western Australia is the only undergraduate unit offered by the Centre for Forensic Science (CFS). The aim of the unit is to introduce undergraduate students to the many fields within the forensic sciences represented by

practising industry professionals, and to introduce them to opportunities in postgraduate study and research at CFS. The unit is a 'broadening' unit and is not in itself expected to lead to job opportunities, nor does it form part of the requirements for any particular major.

As CFS has expanded through the addition of academics in new fields within forensic science (for example, food science, digital forensics), FNSC2200 has become more and more broad. In an attempt to include information from every academic and every facet of forensic science which the Centre has to offer, FNSC2200 has become something of a seminar series, with 26 one hour lectures over 13 weeks, spoken by a minimum of 16 different lecturers. As a result, there are minimal opportunities for students to discuss and clarify topics raised in lectures, and there is no single lecturer who is a "familiar face" to whom they can direct their enquiries.

Student feedback results over the past few years have indicated students' dissatisfaction with this format, which is also reflected in their marks for assessments and the final exam. In the long term, this is also a concern for CFS, as it may result in fewer undergraduate students with an interest in the forensic sciences matriculating through to the Graduate Certificate, Graduate Diploma, Masters and PhD offered at the Centre.

In an effort to combat this, the unit is being redeveloped with students' concerns in mind, whilst maintaining established ties to industry. Lectures have been pared down to only four lectures each in each of five main topics in the forensic sciences – anthropology, archaeology/entomology, chemistry, DNA analysis, and crime scene investigation. Remaining contact hours were given to the introduction of five tutorials, one for each of the main topics. It was hoped that the tutorials will allow students to revise each topic, facilitate discussion and give feedback to the unit coordinators from assessment in the form of an in-class quiz.

Methodology

Research sought to compare student enjoyment, understanding and value in the same unit from the old seminar style format to the new, simpler format. In order to achieve this, two questionnaires were developed, one for 2014 students of FNSC2200 and one for past students. Two hundred and seventeen students responded to the questionnaire, 38 students from pre-2014 cohorts, and 179 from the 2014 cohort. The questions were the same, with the exception of question two, in which the tense was adjusted depending on the survey. The questions asked were as follows:

1. I found lectures to be engaging and interesting
2. Tutorials were/would have been a beneficial addition to the lectures
3. I had adequate opportunities for discussion, clarification and feedback
4. I was encouraged to participate
5. The lecture complemented one another
6. I value learning from practicing industry professionals
7. I would have preferred an overview of more fields within the forensic sciences
8. I would have preferred a more in depth understanding of the core fields of the forensic sciences
9. I would like to pursue studies in forensic science at the postgraduate level
10. Overall, I am glad I chose this unit

Students were asked to indicate their agreement with the above statements on a five-point Likert scale from strongly to strongly agree and unable to comment. Two open questions were then asked of the students:

1. What were the best aspects of FNSC2200?
2. Please list any suggestions that will help improve FNSC2200.

The 2014 students completed a paper survey in class during a tutorial in order to maximise student responses. The past student survey was administered online through *Survey Monkey*, with an email invitation to participate sent to past students' university email accounts. All surveys were anonymous and completed voluntarily.

These survey responses were then compared in order to evaluate the effect of adding tutorials to a previously lecture only unit and the importance students placed on lectures given by industry professionals, and the effect of this dominance of lecturers from outside the university on their learning. Responses to the first ten questions are presented as percentage of respondents who selected each level of agreement to each statement. Responses to the two open ended questions have been presented as word clouds, with each word's size relative to its prevalence in the responses.

Results

No significant difference was found between responses from past students and students from the 2014 cohort (Table 1), and so the following results have been amalgamated for the two groups. The reason for the lack of a significant change in opinion from one unit format to another can be explained by the size of the change in format. Only five tutorials were introduced over the semester, and due to staff and time constraints, no repeat tutorials could be run, and so rather than facilitating small group discussion, the tutorials were more focused on assessment and housekeeping between the unit coordinator and the entire cohort.

Table 1: Percentage agreement to the ten survey statements
between pre-2014 students and 2014 students

Question	Disagree (%)		Neutral (%)		Agree (%)	
	pre-2014	2014	pre-2014	2014	pre-2014	2014
1	5.26	7.26	2.63	18.99	92.11	72.63
2	13.16	17.88	18.42	22.91	68.42	59.22
3	55.26	32.4	18.42	40.22	26.32	27.37
4	34.21	34.64	23.68	39.66	42.11	25.7
5	18.42	12.29	21.05	33.52	60.53	53.07
6	2.63	2.79	2.63	10.06	94.74	87.15
7	52.63	28.49	31.58	38.55	15.79	32.4
8	21.05	18.99	21.05	32.4	57.89	48.04
9	47.37	44.69	21.05	30.17	31.58	24.58
10	15.79	6.15	0	20.11	84.21	72.63

Agreement to statements

Students' agreement to the ten statements are detailed in Figure 1. The three statements that received the most positive agreement from students were one, six and ten: I found lectures to be engaging and interesting; I value learning from practising industry professionals; and, overall, I am glad I chose this unit. The three statements that received the most negative agreement from students were three, seven and nine: I had adequate opportunities for discussion, clarification and

feedback; I would have preferred an overview of more fields within the forensic sciences; and, I would like to pursue studies in forensic science at the postgraduate level. These results indicate that students found the unit to be engaging and interesting, particularly those lectures given by practising industry professionals. However, students did not feel that they needed the broad overview of forensic sciences that they received, but would rather focus on the core fields of forensic science (for the purposes of this unit, defined as crime scene investigation, forensic anthropology/archaeology, forensic DNA analysis, forensic chemistry and forensic entomology). These core fields could perhaps be better covered by Centre for Forensic Science staff.

	1	2	3	4	5	6	7	8	9	10
■ Unable to Comment	0.28	2.91	2.43	1.40	1.12	0.00	1.68	0.84	6.26	0.28
■ Strongly Agree	43.99	27.64	2.79	8.53	17.15	67.69	10.17	22.18	10.57	50.01
■ Somewhat Agree	38.38	36.18	24.05	25.37	39.65	23.26	13.92	30.79	17.51	28.40
■ Neither Agree nor Disagree	10.53	17.75	26.89	30.28	26.17	6.34	33.39	25.89	19.35	9.78
■ Somewhat Disagree	3.07	12.81	24.25	23.57	7.94	0.84	32.78	17.87	24.69	3.55
■ Strongly Disagree	3.19	2.71	19.58	10.85	7.42	1.87	7.78	2.15	21.34	7.42

Question number

Figure 1: Respondents' agreement to the ten statements above

Responses to open ended questions

Responses to the two open ended questions confirmed and clarified the results of the ten previous statements. These responses are detailed in Figures 2 and 3. Seventy-one students specifically mentioned the lectures given by police officers as the best aspect of the unit, with a further fourteen mentioning industry professionals and seven mentioning lectures given by experts. This gives a total of 42.4% of students who responded to the question "What were the best aspects of FNSC2200?", with a specific mention of industry professionals, experts or the police force.

Conversely, responses to the request "Please list any suggestions that will help improve FNSC2200" consisted overwhelmingly of suggestions to what has been categorised as 'traditional' lecture/tutorial format aspects of university teaching and learning. Sixty-three respondents mentioned smaller, more frequent tutorials, 48 suggested all lectures be recorded and made available to students. Similarly, 24 respondents suggested more online, Learning Management System materials, with a further 20 specifically suggesting weekly readings or at least lecture

notes be made available to students. In total 83.8% of respondents suggested 'traditional' lecture/tutorial format aspects be included in Mysteries of Forensic Science.
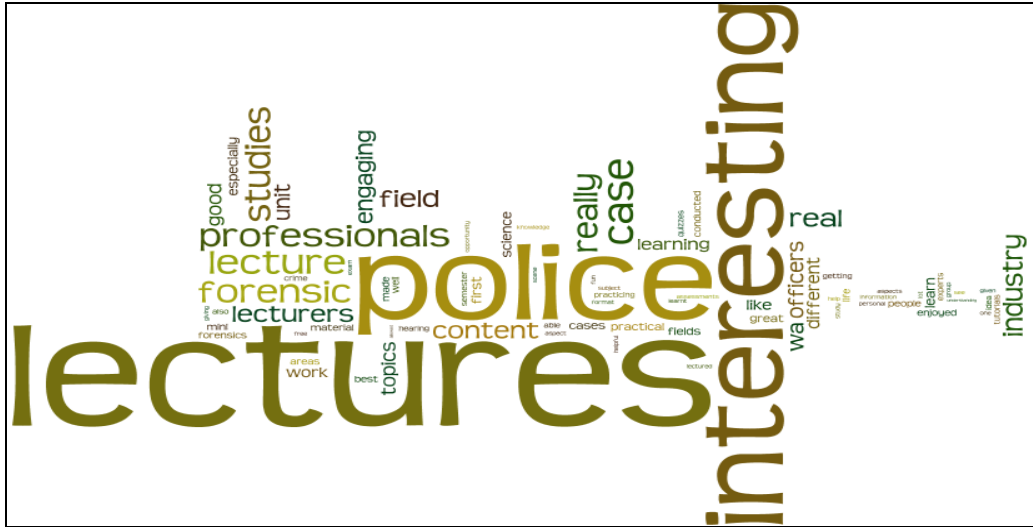

Figure 2: *Wordle* word cloud indicating the most common terms students used in response to "What were the best aspects of FNSC2200?"
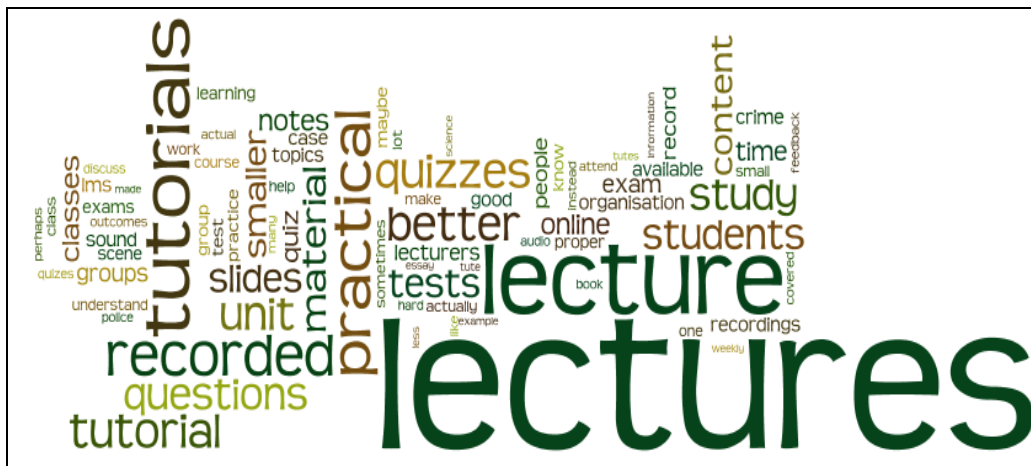

Figure 3: *Wordle* word cloud indicating the most common terms students used in response to "Please list any suggestions that will help improve FNSC2200"

Discussion

Results from the administered survey clearly show that students of FNSC2200, Mysteries of Forensic Science, find lectures given by industry professionals to be important, engaging and interesting. Students recognise the importance of university-industry links and appreciate the opportunity to learn from those practising in the field that they may want to go into after university.

However, it has also been found that the removal of those aspects of university teaching which were sacrificed to allow for a maximum amount of guest lectures from practising forensic professionals have negatively affected students' experience in the unit. In response to the survey questions, students acknowledge that they require the flexibility of recorded lectures available online, a unit reader or text and frequent small group tutorials to facilitate discussion, clarification and feedback.

The positives and negatives of the unit, as seen by students, are in fact linked. Lectures could not always be recorded and made available online due to sensitive material. To combat this, students were told that attendance at lectures was compulsory, however lecture attendance was not recorded and many students felt it was unreasonable to expect them to be able to attend all lectures, as reflected in written feedback. The number of visiting lecturers teaching the unit, who would not always be able to provide a lecture topic in advance of the semester, made the compilation of lecture notes or a unit reader difficult. Time constraints, due to the number of lectures over the semester, meant that only five tutorials could be included, and staff constraints meant that repeat tutorials were not possible. As such, tutorials took place infrequently, with the entire cohort present (about 200 students) and could not adequately facilitate small group discussion.

A compromise clearly needs to be reached between two extremes of undergraduate teaching: a seminar series style format which showcases many facets of the subject and the university's close ties to industry, and a lecture/tutorial style format taught by one lecturer. Both styles have their advantages and disadvantages for student learning and are ideally combined to give the most advantages to students. This case study has shown that students require frequent small group discussion and flexibility, and that they appreciate engaging with industry professionals.

Recommendations

The recommendations borne out of this case study and relevant for any undergraduate course that utilises close ties to industry are:

- Divide the course into sections and have the unit coordinator give an introductory lecture to each section. In this case, the sections would be each of the five core fields of forensic science. This introductory lecture would be complemented with a chapter from a textbook to read and in-class discussion. Further, it will allow students to understand the context of guest lectures.

- Have the unit coordinator introduce each guest lecturer, reminding students of where the guest lecture fits into what they learnt in the introductory lecture, providing continuity and allowing students to become familiar with the unit coordinator, who they will go to for help if needed.

- Rigorous communication with guest lecturers throughout the year is required to maintain continuity between lectures and to compile a unit reader for students. If each lecturer suggests one journal article or book chapter which would complement or demonstrate what they will say in a lecture, students can benefit from further clarification and resources to study from. Providing each guest lecturer with a copy of the introductory lecture for their section of the course will allow them to understand where they might fit into that section, and to lecture accordingly.

- Frequent small group tutorials have been demonstrated to be beneficial to student learning. In this case study, it has been shown that students also recognise the importance of small group discussion. Weekly tutorials should not be sacrificed for further guest lectures.

Conclusion

University-industry links are growing ever stronger and more varied, as the benefits to both parties are increasingly recognised. As a follow-on effect, universities are increasingly marketing themselves to potential undergraduate students as offering courses that produce real world, job-ready graduates from such innovative teaching techniques as work-integrated learning. As a result, the ties between universities and industry are being increasingly utilised to provide teaching and experience to undergraduate students, in addition to postgraduate research.

This study demonstrates a case in which industry professionals were perhaps over-utilised as undergraduate teachers, with a detrimental effect on student learning due to the sacrificing of lecture/tutorial benefits such as small group discussion, recorded lectures and a unit reader. Results indicated that students appreciate and acknowledge the benefits of learning from practising industry professionals; however, they overwhelmingly supported the reintroduction of tutorials, recorded lectures and a unit reader. It has been found that rather than one extreme or another, that is; a seminar series style format of guest lecturers versus an entirely unit coordinator lectured unit, ideally the benefits of both are provided to students. This can be achieved by reaching a balance between guest lectures and lectures from the unit coordinator, increased communication with guest lecturers to ensure continuity and to create a unit reader, and frequent small group tutorials.

Acknowledgments

References

Ali-Choudhury, R, Bennett, R & Savani, S 2008. University marketing directors' views on the components of a university brand. *International Review on Public and Nonprofit Marketing,* vol. 6, no. 1, pp. 11-33. http://dx.doi.org/10.1007/s12208-008-0021-6

Bligh, D 1972. *What's the use of lectures?* Harmondsworth: Penguin.

Bokor, J 2012. *University of the future*. Melbourne: Ernst and Young.

Brown, G A 1989. Lectures and lecturing. In T Husen & T N Postlethwaite (Eds), *International encyclopaedia of education: Research and studies.* Supplementary Vol. 1. Oxford: Pergamon Press.

Butler, J A 1992. Use of teaching methods within the lecture format. *Medical Teacher,* vol. 14, no. 1, pp. 11-25. http://informahealthcare.com/doi/abs/10.3109/01421599209044010?journalCode=mte

Choy, S C & Delahaye, B L 2009. University-industry partnership for pedagogy: Some principles for practice. Paper presented at the 16th World Association for Cooperative Education Conference, Vancouver. http://waceinc.org/papers/vancouver/Australia/Choy,%20Delahaye.pdf

Conner, K & Prahalad, C K 1996. A resource based theory of the firm: Knowledge versus opportunism. *Organization Science*, vol. 7, no. 5, pp. 477-501. http://dx.doi.org/10.1287/orsc.7.5.477

Costin, F 1972. Lecturing versus other methods of teaching: A review of research. *British Journal of Educational Technology*, vol. 33, no. 1, pp. 4-31. http://dx.doi.org/10.1111/j.1467-8535.1972.tb00570.x

Cox, E S, Clark, W P, Health, H & Plumpton, B. 2000. Key facilitation skills for effective online discussion groups: Herding cats through Piccadilly Circus. *International Distance Education and Open Learning Conference Adelaide* University of South Australia, 11-13 September. http://pandora.nla.gov.au/pan/24005/20020403-0000/www.com.unisa.edu.au/cccc/papers/refereed/paper11/Paper11-1.htm

Cyert, R M & Goodman, P S 1997. Creating effective university-industry alliances: An organizational learning perspective. *Organizational Dynamics*, vol. 24, no. 4, pp. 45-57. http://dx.doi.org/10.1016/S0090-2616(97)90036-X

Dawson, S 1998. *Effective tutorial teaching*. Melbourne: RMIT Publishing.

Dowling, C, Godfrey, J M & Gyles, N 2003. Do hybrid flexible delivery teaching methods improve accounting students' learning outcomes? *Accounting Education: An International Journal*, vol. 12, no. 4, pp. 373-391. http://dx.doi.org/10.1080/0963928032000154512

Gremler, D, Hoffman, D, Keaveney, S & Wright, L 2000. Experiential learning exercises in services marketing courses. *Journal of Marketing Education*, vol. 22, no. 1, pp. 35-44. http://dx.doi.org/10.1177/0273475300221005

Hake, R R 1998. Interactive engagement versus traditional methods: A six thousand student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, vol. 66, no. 1, pp. 64-74. http://dx.doi.org/10.1119/1.18809

Hamel, G 1991. Competition for competence and inter-partner learning within international strategic alliances. *Strategic Management Journal*, vol. 12, no. S1, pp. 83-103. http://dx.doi.org/10.1002/smj.4250120908

Harman, K M 2004. Producing 'industry-ready' doctorates: Australian Cooperative Research Centre approaches to doctoral education. *Studies in Continuing Education*, vol 26, no. 3, pp. 387-404. http://dx.doi.org/10.1080/0158037042000265944

James, R L (1978). The tutorial. In R B King (Ed.), *Tutoring*. Perth: Research Unit in University Education, The University of Western Australia.

Keddie, J & Trotter, E 1998. Teaching note: Promoting participation — breathing new life into the old technology of a traditional tutorial: a teaching note. *Accounting Education*, vol. 7, no. 2, pp. 171-181. http://dx.doi.org/10.1080/096392898331243

Lambe, C J & Spekman, R E 1997. Alliances, external technology acquisition, and discontinuous technological change. *Journal of Product Innovation Management*, vol. 14, no. 2, pp. 102-116. http://dx.doi.org/10.1111/1540-5885.1420102

Margetson, D 1999. A critical analysis of the view that the tutor's role in problem‑based learning is to facilitate rather than teach. In *Conference papers, Australian Association for Research in Education*, Melbourne, 29 November - 2 December. http://www.aare.edu.au/data/publications/1999/mar99377.pdf

Meyer-Krahmer, F & Schmoch, U 1998. Science-based technologies: University-industry interactions in four fields. *Research Policy*, vol. 27, no. 8, 835-851. http://dx.doi.org/10.1016/S0048-7333(98)00094-8

Mowery, D C & Shane, S 2002. Introduction to the special issue on university entrepreneurship and technology transfer. *Management Science*, 48, v-ix. http://dx.doi.org/10.1287/mnsc.48.1.0.14277

Perkmann, M & Walsh, K 2007. University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews*, vol. 9, no. 4, pp. 259-280. https://dspace.lboro.ac.uk/dspace-jspui/handle/2134/3074

Race, P. (2001) *The lecturer's toolkit.* London: Kogan Page.

Sharma, M D, Mendez, A & O'Byrne, J W 2005. The relationship between attendance in student-centred physics tutorials and performance in university examinations. *International Journal of Science Education*, vol. 27, no. 11, pp. 1375-1389. http://dx.doi.org/10.1080/09500690500153931

Sharma, M D, Millar, R & Seth, S 1999. Workshop tutorials: Accommodating student-centred learning in large first year university physics courses. International Journal of Science Education, vol. 21, no. 8, pp. 839-853. http://dx.doi.org/10.1080/095006999290327

Steinart, Y & Snell, L S 1999. Interactive lecturing: strategies for increasing participation in large group presentations. *Medical Teacher,* vol. 21, no. 1, pp. 37-42. http://dx.doi.org/10.1080/01421599880011

Swan, K S & Allred, B B 2003. A product and process model of the technology-sourcing decision. *Journal of Product Innovation Management*, vol. 20, no. 6, pp. 485-496. http://dx.doi.org/10.1111/1540-5885.00044

Sweeney, J, O'Donoghue, T & Whitehead, C 2004. Traditional face-to-face and web-based tutorials: A study of university students' perspectives on the roles of tutorial participants. *Teaching in Higher Education*, 9, 311-323. http://dx.doi.org/10.1080/1356251042000216633

Widdison, R & Pritchard, F 1995. An experiment with electronic law tutorials. In *10th BILETA Conference Electronic Communications,* 30-31March, Business School, University of Strathclyde, Glasgow. http://www.bileta.ac.uk/content/files/conference%20papers/1995/An%20Experiment%20with%20Electronic%20Law%20Tutorials.pdf