

From the International Desk

Undergraduate Research and Inquiry-based Learning: Is There a Difference? Insights from Research in New Zealand

In recent years prominent higher education leaders have called for a strengthening of the links between research and teaching and the incorporation of research and inquiry into the undergraduate curriculum (e.g., Boyer Commission 1999; Brew 2003; Healey and Jenkins 2009; Rowland 2006). From some perspectives, “undergraduate research” and “inquiry” are not centrally explicit elements of undergraduate education in New Zealand. However from other perspectives, one can argue that there is strong and growing interest in incorporating undergraduate research and inquiry into the mainstream of undergraduate education in New Zealand for all or at least for many students—and that these developments are relevant to the U.S. undergraduate research movement.

But what do we mean by undergraduate research and inquiry? The Council for Undergraduate Research (www.cur.org) initially defined undergraduate research as:

An inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline.

However, Beckman and Hensel (2009) challenged this definition and explored a range of meanings of undergraduate research. Table 1 shows the different dimensions they considered. This expansion of the possibilities of undergraduate research away from the requirement for original research is more attuned to the wider definition of undergraduate research espoused, for example, by Healey (2005) and Jenkins and Healey (2010), who also include the term “inquiry” alongside undergraduate research. They suggest that there are four main ways in which students could experience undergraduate research and inquiry:

- Research-led: learning about current research in the discipline
- Research-oriented: developing research skills and techniques
- Research-based: undertaking research and inquiry
- Research-tutored: engaging in research discussions

Beckman and Hensel’s (2009) broadened conceptualization of undergraduate research is aligned with research-based teaching in which students undertake research and inquiry. They concluded that “there is no one correct definition. One size does not fit all” (p.44), and suggested that institutions should develop their own definitions in line with their missions and cultures.

Table 1: Continua of dimensions of undergraduate research (Beckman and Hensel 2009:40) with last two rows added by Healey and Jenkins (2009,69).

Student, process centered	↔	Outcome, product centered
Student initiated	↔	Faculty initiated
All students	↔	Honors students
Curriculum based	↔	Co-curricular fellowships
Collaborative	↔	Individual
Original to the student	↔	Original to the discipline
Multi-or interdisciplinary	↔	Discipline-based
Campus/community audience	↔	Professional audience
Starting year one	↔	Capstone/final year
Pervades the curriculum	↔	Focused

The New Zealand Context

New Zealand, with a population of only about four million, currently has a tertiary (postsecondary) education landscape consisting of eight universities, 19 polytechnics, three wananga (established by Maori for mainly Maori students), 39 industry training organisations and 734 private training establishments. Although the universities, polytechnics, and wananga can all grant degrees, the universities are the main degree-granting bodies. The bachelor’s degrees typically take three years to complete, but there are also some four-year degrees. More capable students often take an “honours” degree, which involves a further year of study at the postgraduate level and typically includes a research dissertation. All the universities offer postgraduate degrees, including certificates, diplomas, masters, and doctorates. In 2009, 52 percent of all full-time equivalent or FTE tertiary students were studying at either undergraduate or postgraduate level, with approximately 127,680 FTE students enrolled in universities (Ministry of Education 2010).

The government invests about \$4 billion annually in tertiary education, or about \$2.8 billion in U.S. dollars. The main governmental agencies overseeing the tertiary sector are the Ministry of Education, which sets the policy, and the Tertiary Education Commission, which is responsible for implementing policy and monitoring performance of the providers. Funding from the New Zealand government is the largest single source of income for universities, with this funding allocated based on a combination of enrollment (but moving toward being based on insti-

Table 2: Overview of recent research examining inquiry-based learning (IBL) in undergraduate education in New Zealand.

	Research objective	Research approach	Research methods	Sample	Associated publications
1	To provide examples of IBL	Case studies	Mixed methods: qualitative (interviews and focus groups) and quantitative (surveys) data	10 cases from three institutions: Canterbury University (Engineering, Sociology, & Communication Disorders); Christchurch Polytechnic Institute of Technology (Fashion Design, Outdoor Education, Radio Broadcasting); University of Otago (Political Communication, Endocrinology, Field Ecology, Ecology Degree)	10 cases - Spronken-Smith <i>et al.</i> (2008b) Ecology Degree - Spronken-Smith <i>et al.</i> (2010c) University of Canterbury cases – O’Steen (2008)
2	Does IBL strengthen the links between teaching and research?	Meta-analysis	Mixed methods: qualitative (interviews and focus groups) and quantitative (surveys) data	Subset of above: three cases from the University of Otago (Political Communication, Endocrinology, Field Ecology)	Spronken-Smith and Walker (2010)
3	Does IBL enhance learning processes and outcomes?	Meta-analysis	Quantitative survey data	15 cases from four institutions—including the three institutions and disciplines in row 1 (except for the Ecology Degree at Otago), plus four courses from Victoria University of Wellington (Architecture, History, Psychology, International Business) and two more from the University of Otago (Physical Geography courses)	Spronken-Smith <i>et al.</i> (2010a)
4	What helps and hinders the effective use of IBL?	Meta-analysis	Mixed methods: qualitative (interviews and focus groups) and quantitative (surveys) data	10 cases from 3 institutions – (same as in row 1)	Spronken-Smith <i>et al.</i> (2008) Spronken-Smith <i>et al.</i> (2010b)

tutions’ student retention and completion rates) and research performance (Ministry of Education 2010).

In New Zealand, on the part of government officials at least, there has been a strong cultural perception that teaching and research are interconnected. For example, the New Zealand Education Amendment Act of 1990 stated that at universities “research and teaching are closely interdependent and most of their teaching is done by people who are active in advancing knowledge” (Jenkins *et al.* 2003, 143). Given the increasing emphasis on research performance in the universities (linked to funding), current typical workload models for faculty members promote a 40:40:20 split of research, teaching, and service. Unlike the universities, polytechnics and wananga have traditionally not been intensively engaged in research, focusing instead on teaching—particularly at the certificate and diploma levels. In recent years, though, some have focused more on awarding undergraduate degrees and offering some postgraduate study. However, with changes in government

funding linked to research productivity, some staff members at polytechnics and wananga are under increasing pressure to gain external research funding and to publish. Nevertheless, for most polytechnic and wananga staff their work involves heavy teaching loads and, given the often vocational focus of the institutions, some time to remain current in their professional practice.

The New Zealand Universities Quality Audit focused on the teaching-research nexus in 2000 and asked institutions to report on how the nexus was manifested on their campuses. Soon after, the Tertiary Education Strategy mandated “a research culture within which undergraduates learn to take a research-based approach to their lifelong educational development” (Ministry of Education 2002, 60). Thus there is a clear imperative for the mainstreaming of research in undergraduate education, rather than providing research programs for a small number of elite students. In line with this policy, a substantial research grant was awarded to a team to document and

analyze the use of inquiry-based learning (IBL) in undergraduate education in New Zealand. But what is IBL and how does it relate to undergraduate research and inquiry? To answer these questions, this article will explore key findings from this government-funded project.

The Research

The project was undertaken by a collaborative team with researchers from the University of Otago (Rachel Spronken-Smith and Rebecca Walker), the University of Canterbury (Billy O'Steen), Christchurch Polytechnic Institute of Technology (Julie Batchelor and Helen Matthews), and Victoria University of Wellington (Thomas Angelo, who is now at La Trobe University). The study involved collecting data for 14 cases of inquiry-based learning, 10 of which are presented in a web-based report available at: <http://akoatearora.ac.nz/projects/inquiry-based-learning>. Besides describing and evaluating these case studies, meta-analysis of the cases enabled exploration of some key questions (Table 2), including whether the teaching-research nexus can be strengthened through IBL and how different types of IBL relate to learning outcomes. In addition, a major focus for the research was to refine understandings of IBL.

Defining inquiry-based learning plagued the research team from the outset. We had great difficulty distinguishing the main features of IBL and how it differed from problem-based learning (PBL) and undergraduate research. Fortunately, the literature provided some guidance. For example, the elements of IBL that researchers (e.g., Justice *et al.* 2007; Kahn and O'Rourke 2004; Lee *et al.* 2004; Prince and Felder 2006; Weaver 1989) seemed to agree upon included:

- Learning being stimulated by a question or issue,
- Teaching in a student-centered approach with the teacher as a facilitator,
- Learning by doing,
- A move towards self-directed learning, and
- Constructing new knowledge and understanding by students.

Regarding the latter point, a key question of interest was whether the knowledge had to be new to teachers as well, that is, should students be undertaking inquiries that would generate new disciplinary knowledge? For example, PBL, particularly in medical contexts, focuses on students' learning an existing body of knowledge. Was this in keeping with inquiry?

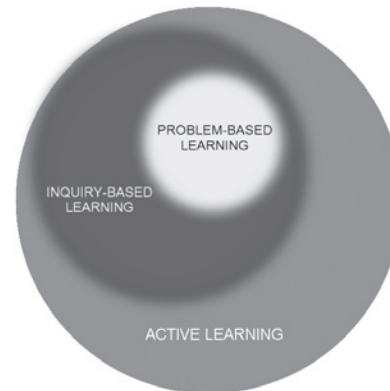


Figure 1: Relation between problem-based learning and inquiry-based learning in the realm of active learning (Spronken-Smith *et al.* 2008a).

We aligned ourselves with the research that I and colleagues published in 2008(a) conceptually placing PBL as a subset of IBL, and both under the umbrella of active learning (Figure 1).

Paralleling our research, Philippa Levy and her team at the Centre for Inquiry in the Arts and Social Sciences at Sheffield University were exploring student conceptions of IBL (Levy 2008, 2009; Levy and Petrulis 2007; Wood and Levy 2009). Their research suggested two different *framings* of IBL—information-oriented or discovery-oriented. In information-oriented IBL, students were exploring questions that sought already existing answers, while in discovery-oriented IBL, they were undertaking original research and participating in building new disciplinary knowledge. Levy and her team further distinguished types of IBL based on who generated the questions (students or teachers), while in our research, we had formulated three *modes* of IBL: structured (in which teachers provide the question as well as a method for addressing it); guided (in which teachers provide the question but students are self-directed in terms of exploring the question); and open (in which students generate the question and determine how to answer it).

The meta-analysis of three cases of IBL (structured, guided, and open) that I and Rebecca Walker conducted (2010) found that in an open, discovery-oriented IBL course, there were very strong links between research and teaching for both students and teachers. In a guided information-oriented IBL course, there was only a moderate nexus, and in a structured information-oriented IBL course, there was little evidence of a link

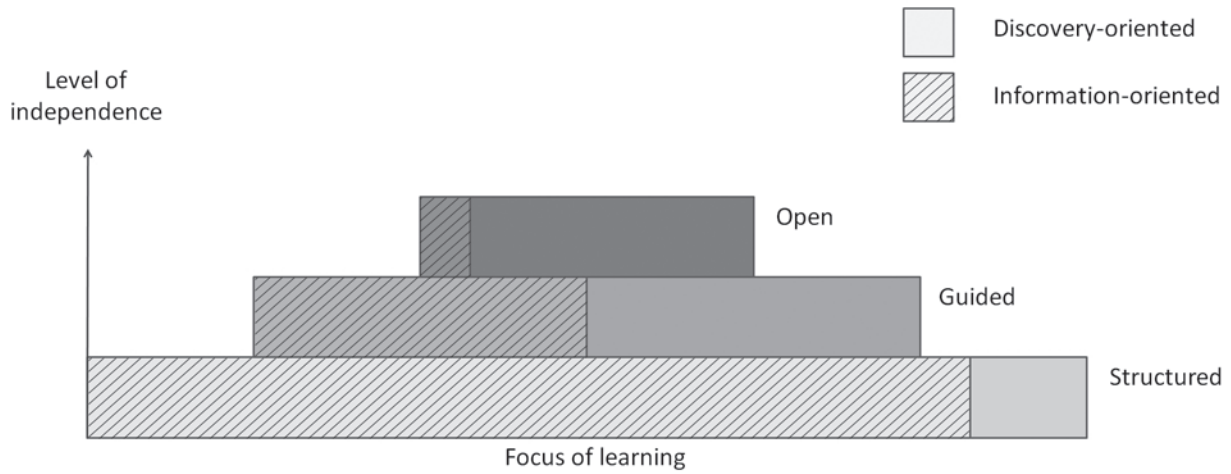


Figure 2: Conceptual model showing the relation between focus of learning, level of independence (or conversely scaffolding) and the potential for a strong research-teaching nexus (Spronken-Smith and Walker 2010).

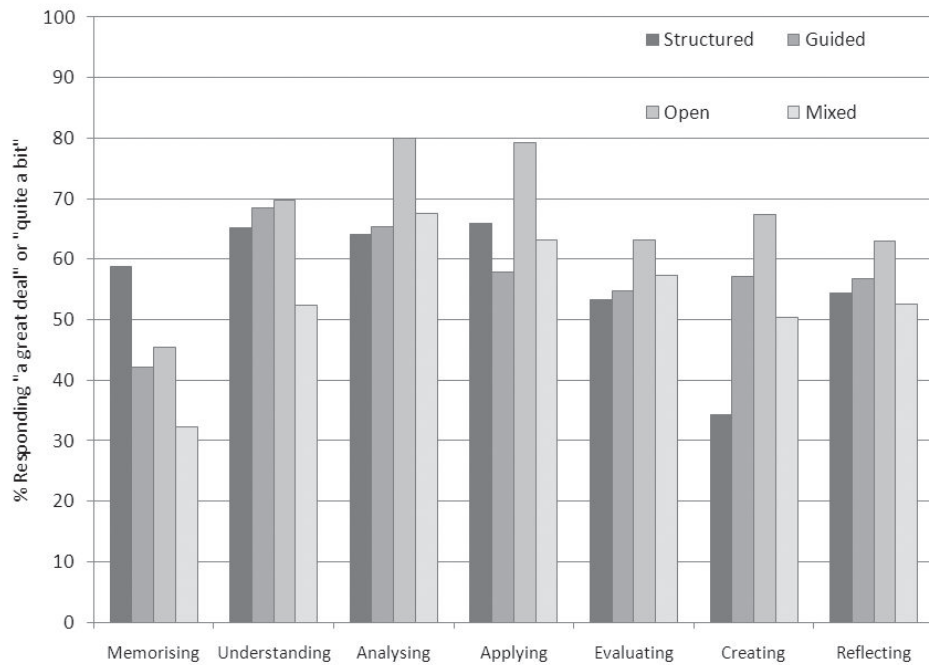


Figure 3a: The influence of (a) mode of IBL and (b) framing of IBL, on type of learning encouraged (Spronken-Smith et al. 2010a).

between research and teaching. Regarding the structured IBL course, the main objective of the course was to develop clinical skills; thus there was no intent to develop research skills. Our analysis led to the generation of a model showing the relation among level of independence (i.e., mode of inquiry), focus of learning (using Levy's 2009 framing of information-oriented or discovery-oriented IBL), and potential strength of the research-teaching nexus (Figure 2).

The greatest potential for a strong research-teaching nexus occurs with open, discovery-oriented IBL, in contrast to structured, information-oriented IBL, which potentially has few links between research and teaching. However, note that with careful design a structured, information-oriented IBL course could be used to build inquiry and research skills.

Figure 2 provides a useful tool to conceptualize inquiry-based learning, particularly in relation to problem-based learning and undergraduate research. In the model, IBL is seen to embrace a range of teaching approaches. For example, PBL is typically more structured and, in medical contexts, often focuses on students learning an existing body of knowledge. Thus, in the model, PBL could fall under information-oriented, structured IBL. Conversely, students could be engaged in open, discovery-oriented IBL, in which they generate a research question and undertake primary research to explore the question—arguably a central goal of some types of undergraduate research. However, inquiry could encompass a plethora of tasks in both information-oriented and discovery-oriented frameworks and in a variety of modes, particularly to build research skills and capability.

Walker and I constructed the model in a stepped, podium fashion to reflect the desire that graduates should attain the highest level before graduation, though we caution that it is not necessary to assume that structured and guided IBL should precede open IBL. While that is one possible pathway of embedding IBL into a degree program, we suggest that there is a strong argument for exposing students to open IBL in their first year of university education (see for example, Healey and Jenkins 2009; Justice *et al.* 2009; Wood and Levy 2009).

So how does the model in Figure 2 relate to undergraduate research? If the commonly held view (at least in the United States) of undergraduate research is that it is something done by selected students, often during summer research programs, then this would fall under either guided (faculty members

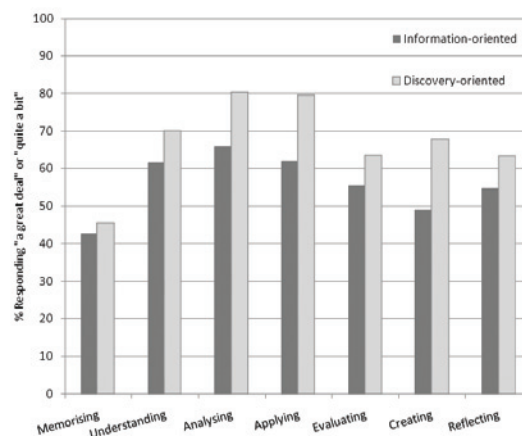


Figure 3b: The influence of (a) mode of IBL and (b) framing of IBL, on type of learning encouraged (Spronken-Smith *et al.* 2010a).

provide the research question) or open (students generate the question) discovery-oriented inquiry. However, if a wider view of undergraduate research, such as that purported by Beckman and Hensel (2009) were adopted, then undergraduate research would be akin to our definition of IBL. That is, it would include a range of experiences that seek to develop research capability, ranging from very structured, product-oriented activities to open, process-oriented activities.

The model presented in Figure 2 infers that the most desirable type of IBL is the open, discovery-oriented variety. But how do we know that this type of IBL is more desirable in terms of student-learning outcomes? Colleagues and I (Spronken-Smith *et al.* 2010a) used a survey to explore students' perceptions of learning outcomes in inquiry-based courses. As Table 2 shows, the survey was administered to 940 students across 15 inquiry-based courses. Although not providing comparative data for more traditionally taught courses, the survey results were strongly supportive of inquiry-based approaches incorporating sound practices, both in terms of providing desirable learning processes and enhanced learning outcomes. When analyzed by *modes* of inquiry (Figure 3a), there was a clear hierarchy, with open IBL generally rated more highly than guided and then structured IBL. Regarding *framing* of inquiry (Figure 3b), the results indicate that courses using discovery-oriented inquiry were more highly rated than information-oriented inquiry.

Overall, the most highly rated course design was open, discovery-oriented IBL. Furthermore, analysis revealed that the conceptual model shown in Figure 2 could also be used to



Third-year undergraduate ecology students from the University of Otago involved in the research-design phase for examining the sexual selection of Damselflies, during an open, discovery-oriented inquiry course.

illustrate the relations among the focus of learning, level of independence, and enhanced learning outcomes; not only does the darker shading infer a stronger research-teaching nexus, but it also infers better learning outcomes. Thus our findings affirm the role of open-discovery oriented IBL—similar to some of the elite types of undergraduate research—in developing higher-order learning outcomes. However, the role of structured and guided forms of IBL should not be underestimated and indeed may be essential in terms of a student’s development of inquiry and research skills. Moreover, it is likely that all forms of IBL have a greater likelihood of developing better inquiry and research skills, compared to those developed in traditionally taught courses, but such a proposition requires further research.

Conclusion

Research in New Zealand has contributed to the growing international literature on the use of inquiry in undergraduate education. Aside from providing useful case studies of how to teach using inquiry, the research has added to the sparse theoretical base for IBL and has allowed exploration of the relation between IBL and undergraduate research. The broader definition of undergraduate research provided by Beckman and Hensel (2009) is more inclusive of the range of possibilities for developing research capability and might gain wider acceptance and usage by faculty members who are not fortunate enough to have access to grants for summer research programs. This broader definition is akin to our definition of IBL, with an important caveat: IBL necessitates a student-centered approach by definition, even for more structured, information-oriented forms, while undergraduate research need not be student-centered. For example, undergraduate research could be faculty-directed with students acting as laboratory assistants, with little input into the direction or shape of the research, and few gains in terms of learning outcomes beyond developing technical skills. But this is a pessimistic view, and indeed

one that likely does not prevail. One would hope that students undertaking faculty-directed research would be involved centrally in decisions throughout the research process, so that they would achieve a more desirable set of learning outcomes.

The findings presented here result from a study across only four institutions, including three universities and one polytechnic. From this small sample it was apparent that there were distinct differences in the way inquiry was embraced and promoted at these two types of institutions. In the universities, inquiry was seen as something innovative and often quite challenging to embed, while in the polytechnic, with a much stronger teaching culture, learning through inquiry was often a preferred mode of instruction with widespread support. Future research would do well to explore these institutional differences, and indeed to include wananga (Maori institutions). The study also had a small sample size, 14 inquiry-based courses, and this meant that disciplinary differences in the use of IBL could not be teased out. Further research should explore disciplinary differences and the relative impact of different forms of IBL and undergraduate research.

Acknowledgements

The national project was funded by a New Zealand Ministry of Education “Teaching Matters Forum” grant under contract 3651-005/5.

References

- Beckman, Mary, and Nancy Hensel. 2009. Making explicit the implicit: defining undergraduate research. *CUR Quarterly* 29(4):40-44.
- Boyer Commission. 1999. *Reinventing undergraduate education: A blueprint for America’s research universities*. Stony Brook, New York: Carnegie Foundation for the Advancement of Teaching.
- Brew, Angela. 2003. Teaching and research: New relationships and their implications for inquiry-based teaching and learning in higher education. *Higher Education Research and Development*. 22(1):3-18.
- Healey, Mick. 2005. Linking research and teaching: Exploring disciplinary spaces and the role of inquiry-based learning. In *Reshaping the university: New relationships between research, scholarship and teaching*, ed. R. Barnett. Maidenhead, Berkshire:

Society for Research into Higher Education & Open University Press.

Healey, Mick, and Alan Jenkins. 2009. Developing undergraduate research and inquiry. Research Report to the Higher Education Academy, York, UK: Higher Education Academy. Available from http://www.heacademy.ac.uk/assets/York/documents/resources/publications/DevelopingUndergraduate_Final.pdf (accessed 5 March, 2010).

Jenkins, Alan, Rosanna Breen, Roger Lindsay, and Angela Brew. 2003. *Re-shaping higher education: Linking teaching and research*. London: Routledge-Falmer.

Jenkins, Alan, and Mick Healey. 2010. Undergraduate research and international initiatives to link teaching and research. *CUR Quarterly* 30(3):36-42.

Justice, Christopher, James Rice, and Wayne Warry. 2009. Academic skill development—Inquiry seminars can make a difference: Evidence from a quasi-experimental study. *International Journal of Scholarship of Teaching and Learning* 3(1):1-23.

Justice, Christopher, James Rice, and Wayne Warry, Sue Inglis, Stepania Miller, Sheila Sammon. 2007. Inquiry in higher education: Reflections and directions on course design and teaching methods. *Innovative Higher Education* 31(4): 201 – 214.

Kahn, Peter, and Karen O'Rourke. 2004. Guide to curriculum design: enquiry-based learning. URL: http://www.heacademy.ac.uk/resources/detail/id359_guide_to_curriculum_design_ebl (accessed 5 March, 2010).

Lee, Virginia S., David B. Greene, Janice Odom, Ephraim Schechter, and Richard W. Slatta. 2004. What is inquiry-guided learning? In *Teaching and learning through inquiry: A guidebook for institutions and instructors*, ed. Virginia S. Lee, 3-16. Sterling, Virginia: Stylus.

Levy, Philippa. 2009. Inquiry-based learning: a conceptual framework. Centre for Inquiry-based Learning in the Arts and Social Sciences, University of Sheffield. Available at: <http://www.sheffield.ac.uk/content/1/c6/09/37/83/CILASS%20IBL%20Framework%20%28Version%204%29.doc> (accessed 5 March, 2010).

Levy, Philippa. 2008. "I feel like a grown-up person": first-year undergraduates' experiences of inquiry and research. Working Paper, CILASS Third Mondays Research Seminar Series, 17th November 2008. Available at: <http://www.sheffield.ac.uk/cilass/resources/thirdmondays.html> (accessed 5 March, 2010).

Levy, Philippa, and Robert Petrusis. 2007. Towards transformation? First year students, inquiry-based learning and the research/teaching nexus. In: *Proceedings of the Annual Conference of the Society for Research into Higher Education (SRHE)*, 11-13 December 2007, Brighton, UK. Available at: <http://www.sheffield.ac.uk/cilass/resources/respub.html> (accessed 5 March 2010).

Ministry of Education. 2010. *Tertiary Education*. Available at: <http://www.minedu.govt.nz/NZEducation/EducationPolicies/TertiaryEducation.aspx> (accessed 5 March 2010).

Ministry of Education. 2002. *Tertiary education strategy 2002/07*. Wellington: Ministry of Education.

O'Steen, Billy. 2008. Are Dewey's ideas live and well in New Zealand undergraduate education? Kiwi case studies of inquiry-based learning. *The Journal of Experiential Education* 30(3): 299-303.

Prince, Michael J., and Richard M. Felder. 2006. Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education* 95(2):123-138.

Rowland, Stephan. 2006. *The enquiring university*. Maidenhead: McGraw Hill.

Spronken-Smith, Rachel, JO Bullard, Waverly Ray, Carolyn Roberts, and Artimus Keiffer. 2008a. Where might sand dunes be on Mars? Engaging students through inquiry-based learning in geography. *Journal of Geography in Higher Education* 32:71-86.

Spronken-Smith, Rachel, Rebecca Walker, Julie Batchelor, Billy O'Steen, Tom Angelo, and Helen Matthews. 2008b. Inquiry-based learning. Prepared for the New Zealand Ministry of Education, July 2008. URL: <http://akoatearora.ac.nz/projects/inquiry-based-learning> (accessed 5 March, 2010).

Spronken-Smith, Rachel, and Rebecca Walker. 2010. Can inquiry-based learning strengthen the links between teaching and disciplinary research? *Studies in Higher Education*. In press.

Spronken-Smith, Rachel, Rebecca Walker, Julie Batchelor, Billy O'Steen, and Tom Angelo. 2010a. Evaluating student perceptions of learning processes and intended learning outcomes under inquiry approaches. *Assessment and Evaluation in Higher Education*. In press.

Spronken-Smith, Rachel, Rebecca Walker, Julie Batchelor, Billy O'Steen, and Tom Angelo. 2010b. Enablers and constraints to the use of inquiry-based learning in undergraduate education. *Teaching in Higher Education*. In prep.

Spronken-Smith, Rachel, Rebecca Walker, Kath Dickinson, Gerry Closs, Janice Lord, and Tony Harland. 2010c. Redesigning a curriculum for inquiry: an Ecology case study. *Instructional Science*. In prep.

Weaver, Frederick S., ed. 1989. *Promoting inquiry in undergraduate learning. New directions for teaching and learning*. San Francisco, Jossey-Bass Inc.

Wood, Jo, and Philippa Levy. 2009. Inquiry-based learning pedagogies in the arts and social sciences: purposes, conceptions and models of practice. In *Proceedings of Improving Student Learning (ISL)*, 1-3 September 2008, University of Durham, Durham, UK.

Rachel Spronken-Smith

Higher Education Development Centre
 University of Otago
 PO Box 56
 Dunedin, NEW ZEALAND
 rachel.spronken-smith@otago.ac.nz

Rachel Spronken-Smith is an associate professor in higher education and geography and head of the Higher Education Development Centre at the University of Otago, NZ. She taught and conducted research in physical geography for many years before becoming a researcher in the field of higher education. Her main research interests now include inquiry-based learning, the teaching-research nexus, and women in academia, as well as continuing climatology research. The main aspects of her academic work in recent years include co-convening programs in women's professional development at Otago, teaching postgraduate courses in tertiary teaching, teaching in the professional-development program for academic staff, and teaching undergraduate and postgraduate geography courses.