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Student perceptions of the undergraduate research experience: what do they think they really gain and how much influence does it have?

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Abstract: *This paper explores the benefits that undergraduate science students perceive as a result of participating in an undergraduate research experience (URE) and explores the possible influences that UREs have on the future career directions of students. Authentic undergraduate research experiences in science play an important role in providing context to student learning and providing a sense of being a 'scientist'. There has been, however, some concern over the validity of the claims made relating to the extent of the impact that research experiences have on undergraduate students. This paper focuses on a new Summer Research Scholarship experience and reports on some of the findings from a 2008/2009 pilot study that investigated student perceptions of their undergraduate research experiences as 2nd year students studying within science.*

Introduction

It is widely accepted that authentic undergraduate research experiences in science play an important role in providing context to student learning and providing a sense of what it means to be a 'scientist' (Boyer 1998). There has been, however, some concern over the validity of the claims made relating to the extent of the impact that research experiences have on students. Seymour, Hunter, Laursen and Deantoni (2004) carried out an extensive literature review focussing on a search for examples of well-designed program evaluations. They found examples in the literature to be rare and, more disturbingly, that research findings based securely within sound evaluation strategies to be even rarer. Many researchers within this field have taken up the challenge of designing effective evaluation tools, and undertaking comprehensive studies, to understand more clearly the advantages to student learning of research experiences. Recent literature indicates that many authors are now concentrating on establishing credible instruments for assessing student benefits (Seymour et al. 2004), measuring the extent of the impact of research experiences (Lopatto 2004, 2007), and even moving beyond this to look in a meaningful way at the student experience (Robertson and Blackler, 2006) and even how experiences differ in an international multi-institutional comparison (Turner et al. 2008).

The Seymour study (2004) focussed on a common model of undergraduate research – the 'research apprenticeship' model. This study aimed to 'clarify the nature and value of this common type of undergraduate research experience' (Seymour et al. 2004; p.500). Through the analysis of 76 student interviews the researchers were able to categorise the student gains into seven different kinds of benefits, including personal/professional gains; 'thinking and working like a scientist'; gains in various skills; clarification/confirmation of career plans; and enhanced career/graduate school preparation. These researchers were then able to use these categories of benefits to design a survey instrument for wider use. It is the survey instrument of Seymour et al. which was adapted for use within this study.

The current study

The study described in this paper investigated undergraduate research experiences (UREs) as one mechanism enhancing the teaching-research nexus. The conceptual framework for the study drew on the characterisation by Healey (2005a) of research experiences along two dimensions with experiences moving from students as observers of research through to students as active participants

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'undertaking' inquiry-based learning (see Figure 1). This framework has been modified slightly through the work of Elsen, Visser-Wijnveen, van der Rijst, and van Driel (2009) where they further refined the terminology to show a movement from 'teacher focussed' to 'student-focussed'. According to Healey, authentic UREs are located in the top (student focussed) right hand quadrant with students actively involved in solving a research question. Healey also proposed that it is within this quadrant of activity that 'students are likely to gain the most benefit from research in terms of depth of learning and understanding' (Healey 2005b).

This study gathered rich data on students' perceptions of their experiences whilst undertaking a short undergraduate research project. For many students the experience would have held many aspects which were new – the students may have been new to the concept of 'research', new to the knowledge of the research topic, new to the culture of research and even new to the independence of thought and actions required of them. *The difficulty in a study of this type is to determine benefits of which even the participant remains unaware.* This study is not only looking at the benefits the students perceive, which may be positive, but also at the development of skills, learning and attitudes which are less tangible and less obvious to the student.

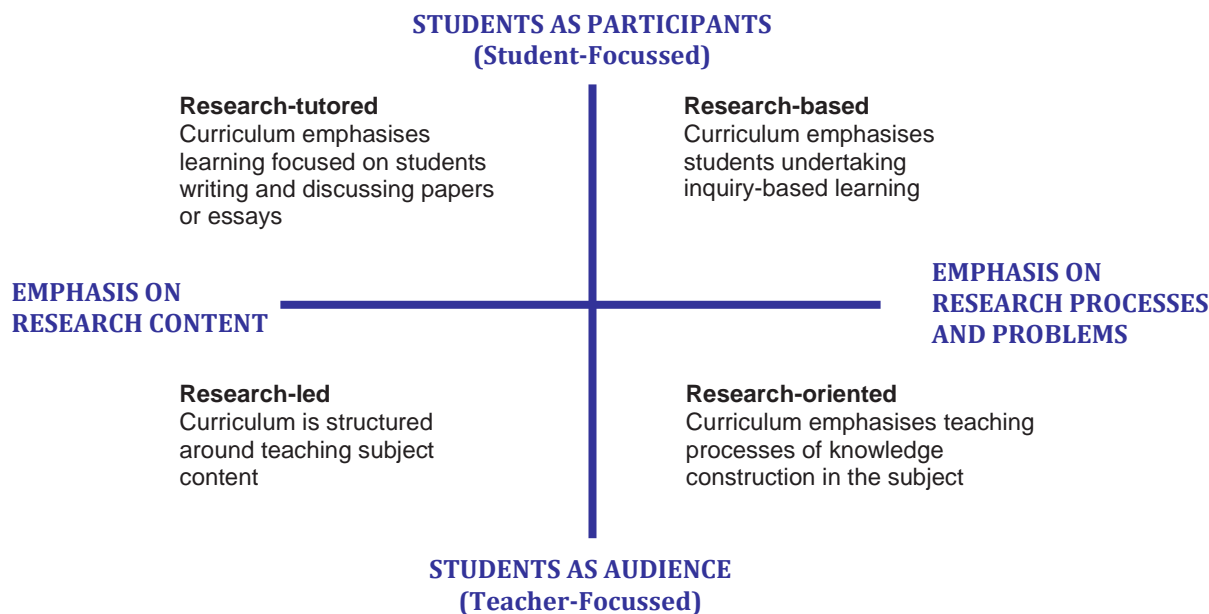


Figure 1 Undergraduate research experiences within the teaching research-nexus (based on Healey 2005b with minor modifications as presented by Elsen et al. 2009)

The Research Questions

This study has attempted to contribute to our understanding of the benefits of undergraduate research programs through the investigation of student perceptions of the benefits gained from their research experience and through comparison of these experiences to previously published research (Seymour et al. 2004). The research addressed the following questions:

1. What benefits did undergraduate students experience from their participation in the Summer Research Scholarship URE?
2. How did these benefits compare with those reported in previous research?
3. To what extent did participation in the URE impact on students' future career decisions?

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Methods

Choice of URE model

The 'summer vacation research' model can be described as a research experience in which an undergraduate student undertakes a supervised, independent research project for a prescribed number of weeks (usually 6 to 8 weeks). Within Science this is not a new model at this institution, however there has never been a comprehensive study of student benefits associated with such an experience. This model was chosen for study for two significant reasons – first, it is a widely recognisable model across the higher education sector and across many disciplines; and second, within this particular institution, this model had recently received significant institutional support in the form of a new scholarship program targeting large numbers of students. The model had not previously been underpinned by a strong foundation of evidence to support the benefits attributed to the student experience. The access to data to support the success of this program is of interest to the institution and also of interest to the wider community of research intensive universities looking at increasing the quality of the undergraduate student research experience.

Participants

This study focussed on undergraduate students enrolled in a third year summer semester course, usually undertaken by students between the second and third years of a three year Bachelor of Science (BSc) degree. While the students were predominantly enrolled in a BSc degree program many other programs were also represented (e.g., B Biomedical Science). Participation in the online survey was voluntary with all students enrolled in the course contacted via email and given the opportunity to complete an online survey. De-identified data were obtained.

Data Source

An online survey developed by Seymour and co-workers (2004) was selected for use and permission was obtained to adapt their evaluation instrument for the institutional and Australian context of this study. The survey, designed for studying the benefits derived from UREs, was shortened and a number of changes made regarding the terminology used. The data obtained consisted of closed and open-ended responses to survey questions. Within the survey the closed response questions were of 2 types: type 1 provided a list of statements and respondents selected any that applied to them, and type 2 provided a list of statements and respondents indicated on a Likert Scale the degree to which they were 'satisfied' or the degree to which they 'gained'. For example, part of the survey reads:

Question 9 Gains in THINKING AND WORKING LIKE A SCIENTIST: How much did you gain in the following areas as a result of your (course code) research experience?

	No gain	A little gain	Good gain	Great gain	Did not experience
Understanding how research is done					
Understanding how to collect scientific data					

Anonymous student survey responses were obtained. Of the 86 students enrolled in the course, 54 students completed the survey, a participation rate of 63%.

Results

What benefits did undergraduate students experience from their participation in the Summer Research Scholarship URE?

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Within the survey students were asked 'How much did you gain' within three areas: 'Gains in thinking and working like a scientist', 'Gains related to research work' and 'Gains in becoming a scientist'. Students were asked to rate the 'level of gain' they felt they achieved in specific areas.

Gains related to 'thinking and working like a scientist'

More than 80% of students believed they had made *good* or *great* gains in 10 out of the 11 'thinking and working like a scientist' areas. This was an encouragingly high result showing that overall students had made substantial gains in many important areas. Some of the areas which students rated as the areas in which they had made *good* or *great* gains included: 'understanding how research is done', 'extending my knowledge', 'understanding the theory and concepts guiding my research project' and 'interpreting results from analysing scientific data'. When asked to rate their level of gain in the area 'Extending my knowledge' 67% of students felt they had made a *great* gain, and 91% felt they had made a *good* or *great* gain. This result was the highest registered for any of the areas investigated. The one category in which less than 80% of students made a *good* or *great* gain was the category 'understanding the connections among scientific disciplines'. This acknowledgement by students of a slightly lower 'gain' may indicate the possibly narrow nature of some research projects undertaken by the students which did not offer them the opportunity to expand across disciplines.

Gains related to 'research work'

In the question on gains related to research work, more than 85% of students reported *good* or *great* gains in areas such as: 'confidence in my ability to do research', 'comfort in discussing scientific concepts with my supervisor' and 'confidence in my ability to do well in future science courses'. The results also showed however that there were 2 respondents who reported *no gain* in these same areas and 5 students who reported *little gain*.

Gains in 'becoming a scientist'

This question elicited the greatest variation in student responses as it more directly related to the tasks each student had undertaken. The results illustrate the diversity of experiences for students within their individual research experience. For the small number of generic areas investigated (such as 'ability to work independently' and 'understanding what everyday research work is like') it was again possible to see that students reported a very high level of perceived gain. Figure 2 shows just some of the areas investigated.

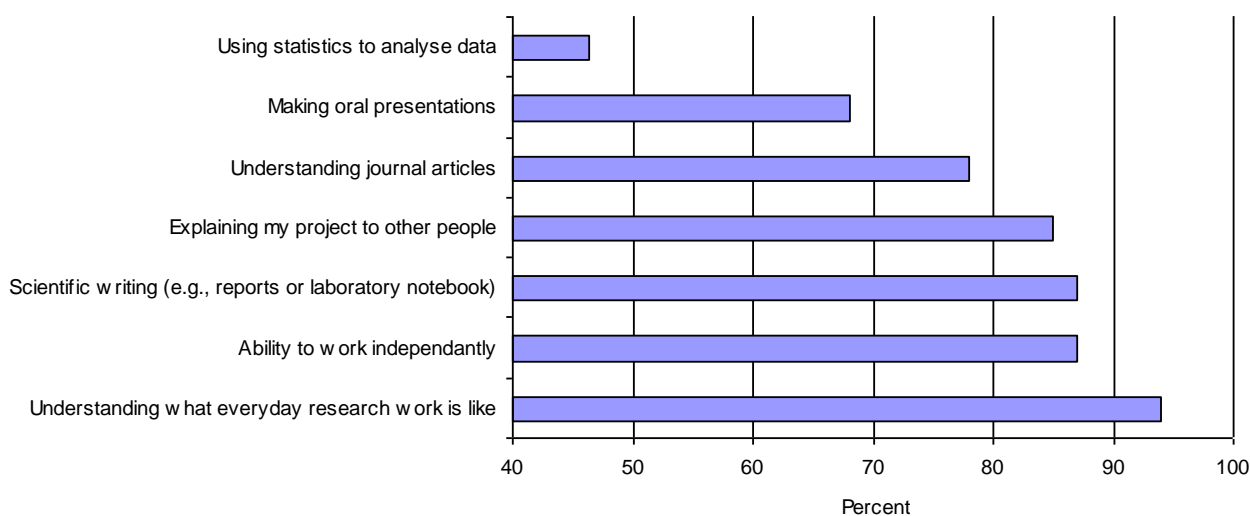


Figure 2 Student reported gains related to 'becoming a scientist'

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To what extent did participation in the URE impact on students' future career decisions?

Within the survey students were asked to reflect upon their career plans before participating in the research experience. They were then asked to compare their intentions before the research experience to their intentions at the point of completing the research experience. Interestingly the number of students considering a *career* in science, mathematics or engineering before the research experience and after the experience remained unchanged at 28. However the number of students intending to *enrol in Honours* increased from 39 students before the research experience to 45 afterwards. This was a substantial and unexpected increase. Often students who elect to enrol in research experiences are actually those already committed to a possible career in science (as the data reflect) however it appears that the research experience itself has moved the student career decision making towards the direction of postgraduate research.

Analysis of the open ended student responses offers an explanation of these data. Thirty-five students commented on the way in which their research experience had influenced their thinking about future career plans. There comments fell into 3 broad categories:

- i. the URE reinforced their earlier choice to undertake Honours (51%; n=18);
- ii. the URE gave them positive experiences and confidence which supported their idea of embarking on a research career (including Honours) (40%; n=14); and
- iii. the URE experience had changed their plans such that they were now considering Honours (9%; n=3).

The students' comments highlighted a high degree of confusion and anxiety over what a research Honours program entails and the positive role of the URE. Comments such as:

'I realised that Honours wasn't going to be scary and unachievable.'

'I was unaware of what an honours year would involve before I met other people in my lab.'

'It provided me with a clearer perspective on what would be expected of me, what I can expect in an honours year.'

Other student comments provide an insight into the transformations which occurred in the students whose career plans changed as a result of their research experience. Comments such as:

'I wasn't 100% sure I wanted to do honours or even a PhD but after doing (course code) I'm positive I'll be doing Honours.'

'I am now considering doing this simply to keep my options open for my future career. I learnt so much and found doing only 6 weeks in a lab a really rewarding experience, a whole year would undoubtedly be even better!'

Discussion

This study investigated undergraduate research experiences as one mechanism enhancing the teaching-research nexus. The study looked not only at the benefits perceived by the students, but also at the development of skills, learning and attitudes which were possibly less tangible and less obvious, and asked the research questions: What benefits did undergraduate students experience? How did these benefits compare with those reported previously? And, to what extent did participation in the URE impact on students' future career decisions?

The results presented above clearly demonstrate the high levels of gains acknowledged by students undertaking a URE – gains in areas such as knowledge extension, understanding research, interpreting results, confidence in ability to undertake research and understanding what everyday

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research work is like. This is in line with the high levels of gains reported by students in the Seymour study (2004) – where 91% of all students referenced gains from their experiences. In the study reported here, as in the Seymour study, few negative assessments were offered. There is a need however to examine the few instances which were reported where a small number of students reported little gain or no gain in crucial areas.

In regards to the extent to which the URE impacted on students' future career decisions, the results showed that URE participation moved the student career decision making towards the direction of postgraduate research. Not only did the data show a real increase in the number of students considering enrolling in postgraduate Honours, but also the qualitative comments indicated a strong role for the URE in reinforcing students' career decisions and in refining their understanding of the meaning of a research career. The substantial increase in students considering a career in research was unexpected and in contrast to results obtained in other studies (Seymour et al. 2004).

The results of this study strongly support the role of research experiences within undergraduate science programs and vindicate the institution's decision to strongly support this model. This undergraduate research experience provides increased benefits to students and encourages more students into postgraduate research careers. Future research in this area will need to focus on the longer term and lasting effects of research experiences, and to look across different disciplines to understand more fully the impact of the research experience in whatever form 'research' may take.

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