



Undergraduate Research and Inquiry within Zoology:

identifying the opportunities and investigating the student benefits.

(Stage 1 Report)

By

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A preliminary report from research conducted by Dr Paula Myatt (The University of Queensland) at the University of Tasmania in association with Professor Sue Jones (School of Zoology, University of Tasmania) and supported by a University of Tasmania Visiting Scholar grant.

Background

It has been established that student learning is greatly enhanced as a result of student engagement through research and inquiry based learning. There is also a continuing emphasis on increasing the ways in which we link research and teaching within higher education. During this program of work we examined the question – *To what extent are undergraduate students exposed to research and inquiry experiences within the School of Zoology at the University of Tasmania and what are the student benefits?*

In 2005 the School of Zoology undertook an ambitious program of incremental steps to foster an improved appreciation of research by undergraduate students in Zoology. This current research project examined not only the opportunities which were introduced as ‘incremental steps’ but also looked for new opportunities available to students (Stage 1). Importantly, Stage 2 of this project will investigate of the impacts from this cohesive set of activities by examining benefits reported by students.

To examine undergraduate research experiences (UREs) and the impact of UREs, this research project utilised a mixed methodology approach of qualitative interviews and surveys with research and teaching staff in Stage 1, combined with a quantitative survey instrument (Stage 2) administered to second and third year Zoology students. This work builds on similar student benefit research at The University of Queensland, whilst providing an insight into the unique features of zoology education at the University of Tasmania.

A Definition of Undergraduate Research

Within the literature there is a wide diversity of what is or is not defined as undergraduate research. Much of the debate is centred on the nature of the student activity and about the “newness” of the knowledge discovered. For the purposes of this study we defined undergraduate research as:

“An inquiry or investigation conducted by an undergraduate student or group of students that makes an original contribution to the discipline or to the individuals involved.” (Adapted from Beckman and Hensel, 2009)

This definition excludes research interactions where students are inactive or “passive” (Healey 2005) such as in research seminars or research journal discussions, however it does include active participation in research activities where the students are seeking the answers to a research questions – whether in the laboratory, the field or the library. Figure 1 illustrates a framework which can be used to examine and explain the diversity of possible UREs (see Appendix 1).

There is no “correct definition” (Beckman and Hensel, 2009) for undergraduate research, but it is essential to define this term in line with our own aims and with the goals of the institution (Spronken Smith, 2010). Importantly we also defined undergraduate research to include research activities where the students uncovered knowledge that was original (new) to them although not necessarily new to the discipline. This is an important distinction and one which we made purposefully. The researchers felt strongly that the student’s gains were dependant on a combination of features - the scientific authenticity of the task, the student’s sense of ownership of the research project and the student’s independence in performing it. These features did not include the newness, or otherwise, of the knowledge discovered.

Summary of Research Opportunities Identified

In the process of examining the research opportunities available to Zoology students it was apparent that there exists within this School a positive culture of the integration of research and teaching creating research opportunities for students. Within this study it was not possible to examine every

research-related opportunity available to students. Some of the opportunities not examined are listed in Table 1. These broader student opportunities form an important element of the overall context of the study, and they illustrate an obvious emphasis on scaffolding essential science skills and experiences. There is a culture of placing ‘research’, in its many forms, in the student’s path.

Table 1 Additional research-related activities available for Zoology students

Research related activity	Target students	Specific/unique attributes
<i>Reach into Research</i> seminar series	undergraduate and postgraduate students.	Invited guest lecturers from organisations outside of the university; safe environment for student questions.
<i>Reach into Research</i> website	undergraduate and postgraduate students; general community.	provides information of careers and examples of current research in contemporary media.
<i>Scribble and Babble</i> websites	Undergraduate students across the University.	online resources focussing on written and oral communication skills for specific academic disciplines.
<i>Nexus</i> undergraduate student research journal	Undergraduate students across science.	celebrates excellence in student research through the opportunity to publish manuscripts in an authentic science environment.

The main focus of this study, however, was the identification and examination of active research opportunities engaging Zoology students - both inside and outside of the curriculum. Table 2 lists the 11 activities identified and examined in this study. These examples show a large diversity of opportunities available to students, some voluntary but most embedded as compulsory assessment tasks within Zoology units. The tasks are listed in Table 2 beginning with tasks available in the first year of a standard zoology course of study and moving through opportunities available in second and third year and finishing with a voluntary opportunity which is available across all years. (The general descriptions in Table 1 are complemented by details of each activity provided in Table 3.)

An overarching characteristic of the UREs examined was the aim of researchers and teachers to capture an authentic experience for their students. The authenticity was either inherent in the activity or was crafted as part of the learning design to ensure authenticity and thereby increase the effectiveness of the learning environment. The levels of authenticity encountered included:

- students in the field for 5 days immersed in data gathering and research methods;
- scientific posters used as an assessment task but with a final presentation of all student posters at a student conference-like event with an invited audience, food and informal discussions;
- a scientific report submitted as a research paper manuscript, styled to a discipline specific journal and including student scaffolding activities on writing and using the journal’s *Guide to Authors*;
- a research conference paper presentation used as a method to introduce students to a research topic;
- research projects based in research laboratories and with existing research groups; and
- volunteer opportunities to participate in the research of others as an ‘apprentice’ scientist.

In many of the tasks examined student engagement was encouraged through empowering students to identify their own research questions within a broader research topic. The opportunity to engage students in this process not only assists in increasing their motivation but also enhances their critical thinking skills as they determine possible research questions within the confines of the topic. In these situations student’s choices were usually checked to confirm the validity and appropriateness of their selections. Students were frequently asked to define research questions, articulate proposed

ways for answering those questions, conduct experiments or collect data, analyse data and write appropriate discussion pieces in support of their original aims. These steps replicate the scientific process and enable students to gain an in-depth (and very real) appreciation of scientific research. Of course it should be noted that researchers and teachers reported that this level of authenticity also meant students encountered the unpredictable nature of science research. The authentic nature of gathering primary data, in particular, can offer unexpected challenges and lead to unexpected learning outcomes. In cases where students accessed existing data sets, however, it is important to note that in these cases the data was 'real' (that is, not fabricated but generated through research) and this still enabled a level of authenticity to be achieved.

Table 2 Examples of active research opportunities engaging Zoology students

	Course/title of activity	Target students	Specific/unique attributes
a	KPZ163 Ethics workshop task (in <i>Ecology</i>)	1 st year students	<i>(still awaiting data)</i>
b	KZA215 Information literacy and critical analysis task (in <i>Tasmanian Fauna</i>)	2 nd year students	Students are asked view a conservation-message video clip and critically analyse the message focussing on the scientific 'facts' presented.
c	KZA212 Scientific manuscript task (in <i>Functional Biology of Animals</i>)	2 nd year students	Students hear an authentic research conference presentation, are provided with an authentic data set and then design their own research questions, analyse data and produce a manuscript.
d	KZA225 <i>Biology & Society</i> (Prior to 2010 this unit was <i>Evolution, Ecology & Society</i>)	2 nd year students	A unit which focuses on critical analysis of the literature to enable discussion of contentious issues and synthesis of points of view.
e	KZA360 five-day field excursion (in <i>Conservation Biology & Wildlife Management</i>)	3 rd year students	Students experience a 5-day immersion in a research context to experience a very real research environment, with the positive and negative experiences that arise.
f	KZA355 Group research project (in <i>Freshwater Ecology</i>)	3 rd year students	Students self-select into research topic groups, devise research questions, propose methodologies and carry out the research.
g	KZA301 Group research project with oral presentations (in <i>Behavioural Ecology</i>)	3 rd year students	<i>(still awaiting data)</i>
h	KZA350 Research poster task (in <i>Reproduction & Endocrinology for Conservation</i>)	3 rd year students	A capstone experience within a unit; students draw on their previous learning, research a related conservation issue, synthesise the available research and produce a scientific poster within an authentic science conference environment.
i	KZA304 <i>Zoology Research Project</i>	3 rd year students	Students work in a research laboratory environment with a researcher on a defined project for a whole semester.
j	Undergraduate Zoology Research Volunteers Program	1 st , 2 nd & 3 rd year students	Students can choose from a range of authentic opportunities and participate in a non-threatening environment with a variety of 'real' scientists.
k	Summer Research Scholarships	2 nd year students moving into 3 rd year	A Faculty-wide program of scholarships; students complete a small research project or research experience within a research group over 6-8 weeks and write a report on their experience.

It should be noted that the Volunteer Program is a particularly interesting student learning opportunity. Within this program existing researchers (staff and postgraduate students) advertise for volunteer students to assist them in their research, usually in the field. In these experiences the undergraduates are apprentice scientists – their URE could not be more ‘authentic’.

Summary of URE Characteristics

In investigating the UREs available to Zoology students it is useful to not only examine the individual opportunities but also, as an overview, investigate the opportunities as a whole. Through such an overview it is possible to observe any trends across the years of an undergraduate degree and also observe any trends in the particular characteristics to which the students are being exposed. It is important to remember, however, that this research was specifically investigating UREs in which the students were active participants (see Appendix 1).

The data in Table 3 are a record of the responses from the research and teaching staff who were interviewed. The URE characteristics surveyed are based on a survey developed by David Lopatto, Grinnell College, USA (Lopatto 2008). The power of this table is in providing an instant overview of the diversity of opportunities which are available to students within Zoology – whilst remaining cognisant of the fact that only *active* UR opportunities were examined. (The survey utilised a 0-3 scale where 0=no emphasis; 1=minor emphasis; 2=moderate emphasis; 3=major emphasis).

The data in Table 3 indicate a diversity of opportunities available to students. Many opportunities involve the need for data collection and data analysis. There is a strong prevalence in the use of primary literature and an emphasis on written outcomes – such as reports and scientific papers. The data indicates there are fewer opportunities for oral presentations or the presentation of assessment tasks through posters. There also appeared to be fewer opportunities for students to peer critique or assess other student’s work. The UREs represented in this table indicate a high level of diversity of tasks available for students to work in groups or individually on authentic tasks with authentic outcomes.

It should be noted that Table 3 does not represent all student activity in units but only those activities which are considered to be research activities.

Table 3...Characteristics of UREs studied. (Note: The diversity of characteristics listed in this survey is indicative of the diversity of characteristics possible when using a broad definition for undergraduate research. The more narrow definition of this study is reflected in the trends in the data.)

Characteristics of the UR Activity	Emphasis (0-3)										
	a	b	c	d	e	f	g	h	i	j	K
A scripted lab or project in which the students know the expected outcome.	0	0	1	0	0	0	0	0	0	0	0
A lab or project in which only the instructor/supervisor knows the outcome.	2	0	2	0	0	0	0	0	0	0	0
A lab or project where no one knows the outcome.	1	0	1	0	3	3	3	2	3	3	3
At least one project that is assigned and structured by the instructor/supervisor.	1	2	3	2	2	2	0	1	1	3	2
A project in which the students have some input into the research process and/or what is being studied.	2	3	2	3	2	3	3	3	3	0	2
A project entirely of student's own design.	2	1	0	2	1	1	3	1	0	0	0
Students work individually.	0	2	3	2	1	2	0	0	2	2	2
Students work together as a whole class.	1	0	0	3	1	0	0	0	0	0	0
Students work in small groups.	3	2	0	3	2	3	3	3	0	2	1
Students become responsible for a part of the project.	3	0	3	3	2	3	2	1	3	0	0
Students read primary scientific literature.	2	3	3	3	2	3	3	3	3	0	1
Students write a research proposal.	1	0	0	0	0	1	2	0	3	0	0
Students collect data.	0	0	0	0	3	3	3	0	3	3	3
Students analyze data.	0	0	3	0	3	3	3	0	3	0	1
Students present results orally.	2	0	0	3	0	0	3	2	0	0	0
Students present results in written papers or reports.	3	3	3	3	3	3	3	0	3	0	3
Students present posters.	0	0	0	0	0	0	0	3	0	0	0
Students critique the work of other students.	2	0	0	2	0	0	3	3	0	0	0
Students listen to lectures.	0	0	0	0	2	0	3	0	0	0	0
Students read a textbook.	0	0	1	0	0	0	1	0	0	0	0
Students work on problem sets.	0	0	0	0	0	0	1	0	0	0	0
Students take tests in class.	0	0	0	0	0	0	0	0	0	0	0
Students discuss reading materials in class.	2	0	0	3	0	1	0	0	0	0	0
Students maintain lab/field notebooks.	2	0	2	0	3	1	3	0	3	0	1
Students learn computer modelling.	0	0	0	0	2	0	0	0	0	0	0

a KPZ163 Ethics workshop task

b KZA215 Information literacy and critical analysis task

c KZA212 Scientific manuscript task

d KZA225 *Biology and Society*

e 5-day field excursion (within KZA360 *Conservation Biology & Wildlife Management*)

f KZA355 Group research projects (within *Freshwater Ecology*)

g KZA301 Group research with oral presentations

h KZA350 Research poster task

i KZA304 *Zoology Research Project*

j Undergraduate Zoology Research Volunteers

k Summer Research Scholarships

Discussion

This project aimed to investigate the research opportunities available to undergraduate students within the School of Zoology, first through the detailed examination of the diversity of activities available and second through the identification by students of their perceived benefits. This preliminary report contains only the findings related to the examination of research opportunities available, with the data pertaining to student benefit still to be obtained. Information was gathered from research and teaching academic staff through interviews and a survey and indicated the existence of a wide variety of well designed research opportunities for undergraduate students. The opportunities are available across the year levels and, importantly, are available both inside and outside of the curriculum. Many of these undergraduate research experiences (UREs) are embedded within courses thereby exposing all students, and not just a select group, to the experiences.

UREs often aim to provide an authentic view of a career in research, especially in the sciences. Within Zoology the authenticity of many tasks is not only high but also often enhanced by an effort to re-create authentic environments in which to embed the tasks themselves. For example, the student production of a scientific poster as an authentic science research outcome was further enhanced by creating a “conference environment” in which students presented their posters.

The Volunteer Program was also noted as an important student learning opportunity with undergraduates participating in the research of others as ‘apprentice scientists’. This particular opportunity appeared to be a simple yet highly valuable opportunity which should be easily transferable as a URE model across other disciplines.

The diversity of tasks available, the occurrence across the years of the degree program and the effort to re-create scientific processes (in research) and scientific outcomes (in communication) creates a significant culture of research for undergraduate students within the teaching of Zoology.

Planned Future Outcomes

Future outcomes from this study will include:

- Presentation at Teaching Matters 2010
- Abstract to be submitted to HERDSA Conference 2011
- Research paper to be submitted to a peer reviewed education journal with working title “Integration of research activities into an undergraduate curriculum: a casestudy”, with co-authors Dr Paula Myatt and Professor Sue Jones.

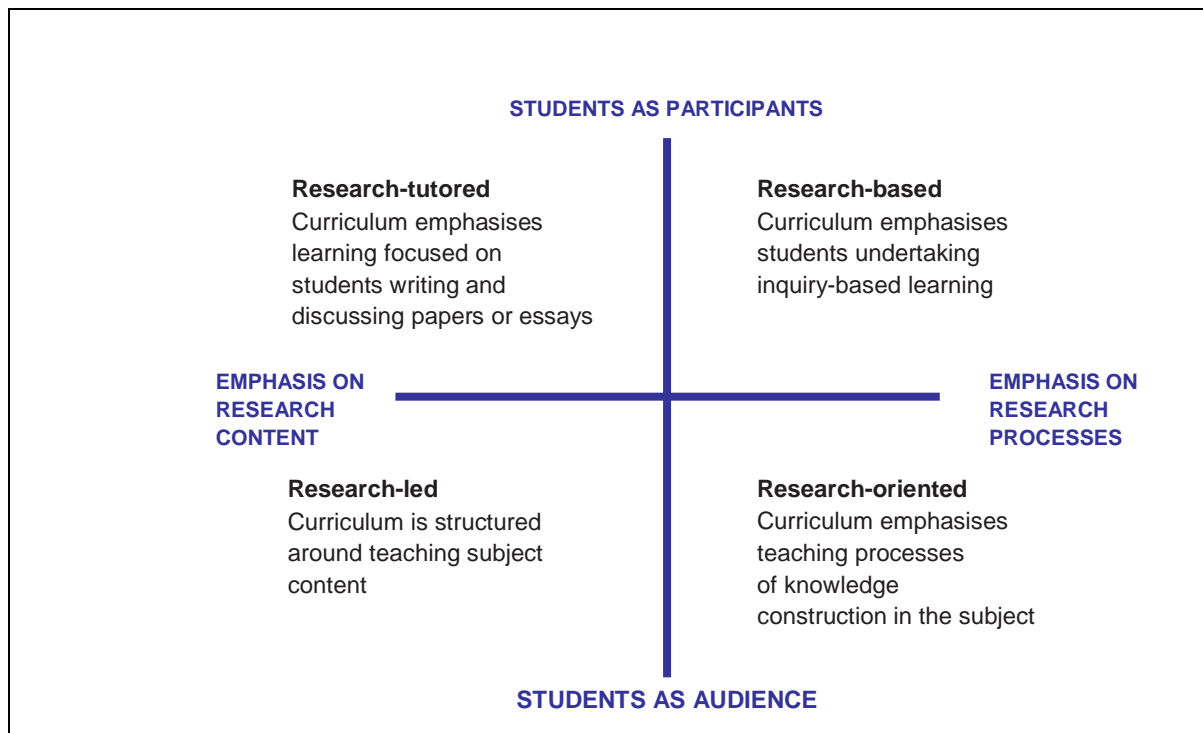
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Appendix 1

Figure 1 A Framework useful in examining the diversity of possible activities defined as “undergraduate research” (from Healey 2005 ^a)



^a. Healey, M. (2005) Linking research and teaching exploring disciplinary spaces and the role of inquiry-based learning, in Barnett, R. (ed.) *Reshaping the university: new relationships between research, scholarship and teaching*, pp.30–42. Maidenhead: McGraw-Hill/Open University Press.