The Advanced Study Program in Science: challenging, motivating and inspiring our best science students

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

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

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

Introduction

It is widely accepted that an interactive, enquiry-based approach to learning provides the most meaningful and lasting learning experience for students. It is similarly acknowledged that, within science, undergraduate research experiences are pivotal in providing context to student learning and providing a true sense of what it means to be a 'scientist'. A critical challenge in generalist degrees such as the Bachelor of Science or Bachelor of Arts is to provide context and relevance to student learning. Students in degrees that lead to professions such as dentistry, engineering, medicine see themselves as professionals in training, with clear goals and contexts for learning. For students in science who want to explore seriously a career as a scientist (not necessarily the majority of students), authentic research experiences enable them to see themselves as scientists in training, a framework in which they can integrate their other study. There is now a considerable body of evidence to support the benefits of undergraduate research experiences on the contextual learning of the students (Bauer and Bennett 2003; Lopatto 2004) and on the professional development and career choices of students (Hunter, Laursen and Seymour 2006; Russell 2006). The Advanced Study Program in Science (ASP) at The University of Queensland (UQ) goes beyond the simple models of undergraduate research experience and offers excellent students an integrated, three year program designed to enrich their undergraduate experience and induct them into the community of scientists.

The initiative commenced at the University of Queensland in 2001. It was stimulated principally by the Boyer Commission Report, published in 1998 (Boyer Commission 1998). The report provided an incisive critique of undergraduate education in research-intensive universities in the US. The clear recommendation was that research-intensive universities should endeavour to integrate genuine research experiences into their undergraduate degrees and introduce undergraduate students to the culture and methods of research early in their degrees. The Advanced Study Program was designed to achieve these goals, at least for a cohort of high achieving, highly motivated students. The program was also designed to address issues, consistently identified through student surveys and focus groups, which indicated that very able students are often bored and under-challenged, especially in their first year at university; that limited encouragement is given to these students to expand their career horizons in science and beyond; and that insights into the research culture, through mentoring and access to research laboratories, are not available until late in the undergraduate degree.

The ASP is distinct from other programs for high achieving students in several significant respects: students are not encouraged to accelerate their studies or to specialise at an early stage, in fact study beyond science is strongly encouraged, the students are not isolated or removed from the general cohort of students, the program spans the entire three years of the degree with the first and second year units graded Pass/Fail.

This paper will provide a description of the major elements of the program and provide some evidence of the impact the program is having on the retention of our brightest students in science.

Project description

The Advanced Study in Science Program accepts 40-50 commencing Bachelor's degree students with an Overall Position (OP) of 1-3 each year (QLD Studies Authority 2004). An OP1-3 equates to the top 3.55% of school leavers or the equivalent ranked student who is not entering directly from school. The cohort is chosen through a process of written application and interview. The students are chosen based on their genuine interest in perusing science as a career, their enthusiasm for scientific enquiry and their ability and willingness to participate in the group activities that are key to the program. While the program is ideally a three year experience, the opportunities to enter throughout first year and at the beginning of second year allow us to identify students who are excelling in the new university environment and find their passion for science ignited by their tertiary studies. Students are required to maintain a GPA of >5.5 out of 7 in order to stay in the program. This requirement is designed to protect students from taking on the extra commitment required by the ASP if they are struggling to achieve well in their other courses.

The program is designed with these clearly defined aims:

- to provide an enriched learning experience to **inspire, motivate and challenge** a group of science students with high aspirations, ability and enthusiasm;
- **to assist student in developing behaviours essential to science research**: multidisciplinary approach to problem solving, original thinking, careful planning, reflection and communication with peers**;**
- to facilitate and encourage the **development of this small cohort of students into a learning community** of like-minded colleagues who will provide both academic and social support for each other through their entire undergraduate degree and beyond;
- **to introduce students to the culture of authentic scientific research**, establishing direct and immediate links between undergraduate teaching and the world class research occurring at UQ by facilitating genuine, hands-on research experience earlier and more often than in the standard degree program**;** and

- **to provide a sense of purpose and focus for the three year undergraduate degree** by exposing the students to the enormously varied postgraduate and career opportunities available through science and the rewards of a career in research.

The ASP is a coordinated series of courses and activities that comprise less than one quarter of a student's annual load. The first semester component of each year includes voluntary, not for credit activities such as informal seminars and meetings with scientists and science camps aimed at building the cohort identity. The second semester of each year is a course for credit (one quarter of the total load for the semester). The activities within each year of the program are designed to complement and extend the previous year's activities. The seminar series in each year progress from an impressive introduction into the world of research by UQ's leading lights designed to inspire and engage the first year students, to personal accounts of the career journeys of up-and-coming researchers who offer practical advice about the pitfalls and highlights of embarking on a research career, and culminating with attendance in third year at research seminars at which scientists present their findings to an audience of their peers – an important step in the students' initiation into the research fraternity. By the third year, students have progressed to being able to converse with some degree of confidence with world class scientists in an informal setting ('Meet the Speaker' lunches). Figure 1 summarises the structure of the three year program.

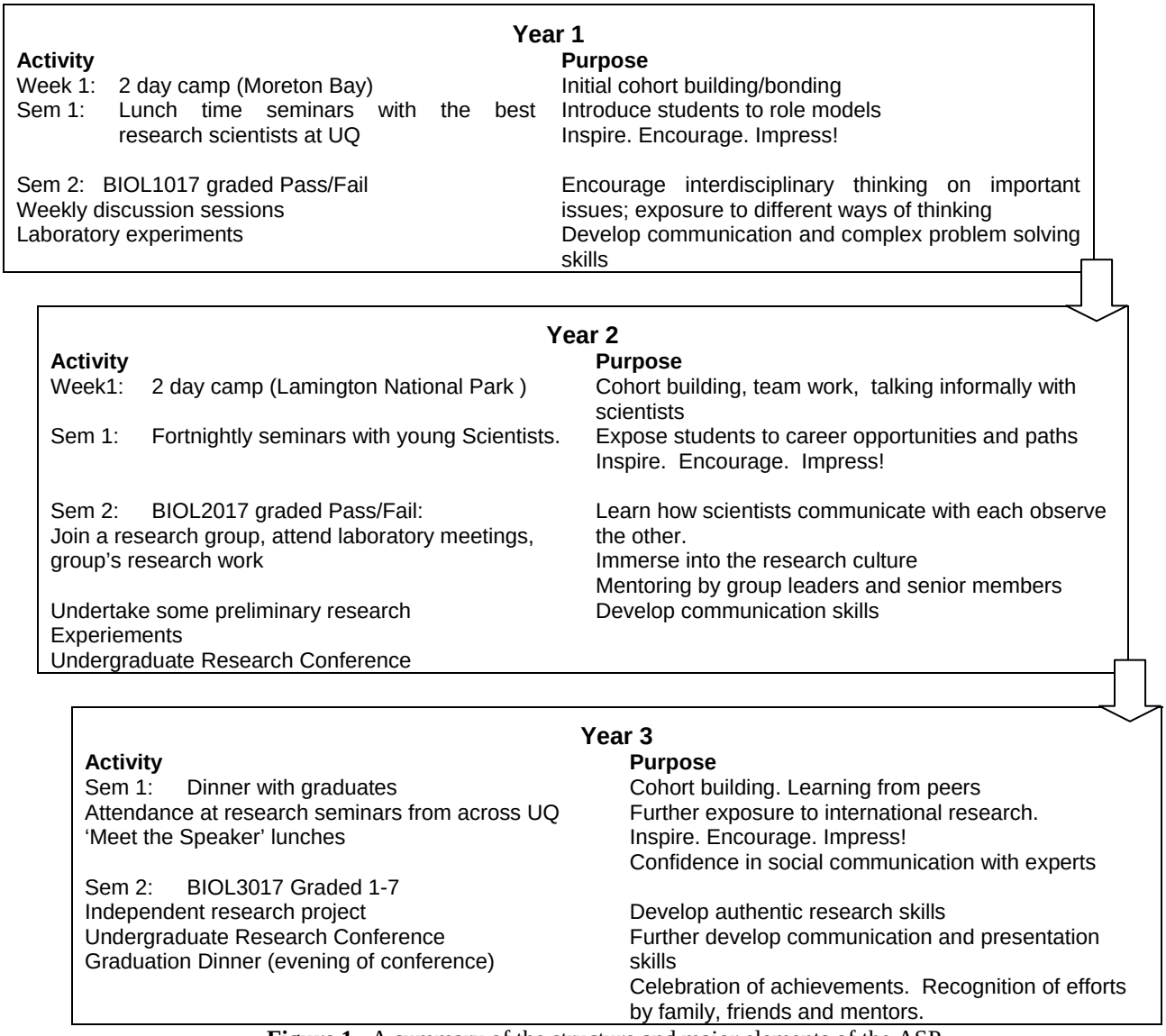

Figure 1. A summary of the structure and major elements of the ASP

Details of key activities

The camps

The two camps are critical cohort building exercises and are enormously popular with students. The first takes place at the end of Week 1 of Semester 1 and the second in Week 2 of Semester 1 of second year. They include getting to know you activities, expert talks on the local environment, field collection trips, discussion sessions on a controversial scientific topic and time for fun - swimming, bushwalking, a movie and more.

BIOL1017 discussion sessions

The second semester discussion sessions are designed to make students tackle big problems using an interdisciplinary approach with different perspectives across the sciences and humanities. Experts argue impacts of and possible solutions to complex problems. The problems deal with medical, environmental and social issues and are refreshed each year. Table 1 provides two examples of topics discussed in 2006 and the contributors involved.

Table 1. Two topics discussed as part of BIOL1017 in 2006

Topic	Contributors
Energy for the future	Dr Hamish McGowan (School of Geography, Planning and Architecture) Dr Paul Meredith (School of Physics) Dr Geoff Walker (School of Information Technology and Electrical Engineering) Dr. Paul Massarotto (School of Engineering)
Human development and Sexuality	A/Prof. Clive Moore (School of History, Philosophy, Religion & Classics) Professor Peter Koopman (Institute for Molecular Bioscience) Dr Kate Gibson (Queensland Clinical Genetics Service.)

Student-led review sessions follow each discussion after a week of research and synthesis. A laboratory or computer-based activity accompanies each discussion, designed to challenge the students far beyond their regular courses. Students are encouraged to document what they understand in each presentation, how it links to other courses which they are studying, and also where their gaps in understanding are.

The research laboratory immersions

The genuine research experience in both second and third year is a key aspect of the course. In each case the student seeks out a research leader and becomes an active member of their choice of group through attendance at laboratory meetings, seminars, and mentoring by a member of the research team. In the third year of the program the students must select a different group from the one they joined in second year. This is an important requirement as it encourages diversification and 'experience' rather than 'indoctrination into a particular group'.

The Undergraduate Research Conference

The Undergraduate Research Conference is held on the first Saturday in October each year and is a central, community event for the program. The conference serves as a forum for second and third year students to present the results of their research projects as either oral (10 minutes) or poster presentations. Prominent university researchers and the Vice Chancellor or nominee give opening and closing addresses. First year Advanced Study students serve as moderators/chairs for all sessions. Through this mechanism, first year students are exposed to the type of ambitious projects that they may undertake in future years. The conference is a unique event that allows all stakeholders in the program, students, mentors, coordinators, parents, partners and families to come together and celebrate the students' achievements. The research conference is a very important means of communication within the science community, and the development of skills in writing abstracts, scientific papers, giving presentations and answering questions are all vital in producing successful research scientists for the future.

Impact of the ASP on graduate destinations

In the current climate of reduced interest in science by students and the continuing evidence of a 'flight from Science' (Illing 2007), the ASP provides an innovative and integrated approach to stem that flight. One indicator of the program's impact therefore, is the rate at which the students choose to progress to Honours, the voluntary, research intensive fourth year of the BSc program. For simplicity, student numbers have been tracked as a cohort from their commencing year. As mentioned previously, the ASP accepts student with an OP score of between 1 and 3 with this equating to the top 3.55% of school leavers or the equivalent. In Table 2, therefore we have compared the movement into Honours, the research intensive fourth year of the BSc, of our ASP students with the total cohort of BSc students with an OP1-3. We also include, for reference, the rate at which the total graduating BSc cohort from 2003 moved directly to Honours in the fourth year. It is clear from these data that the number of students choosing to continue into Honours is significantly and considerably higher in the ASP cohort than for non-ASP students of similar academic ability. While it is true that the selection process for the ASP may target students who are more likely to continue into honours, the marked and sustained difference in the number of students continuing shows that the program is making a significant impact in this area. It should be noted that the larger number of four year dual degree students in the 2004 cohort decreased the pool of students able to progress to Honours in 2007.

Table 2. Graduate destinations of the three graduated ASP cohorts

	ADVANCED STUDY			**OP1-3 STUDENTS IN TOTAL COHORT**			**TOTAL BSC COHORT**
Commencing cohort year	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**	**2003**
Number graduating 3 years later*	22	18	22	73	85	82	293
Number (%) proceeding to Honours in the year following graduation	19 (79%)	15 (83%)	10 (45%)	36 (49%)	36 (42%)	21 (26%)	63 (24%)
MBBS (Medicine)	2**	3	2	NA	NA	NA	53
Left university with BSc	6	0	2	NA	NA	NA	138
Not graduated (includes dual degree students)		1	8	NA	NA	NA	27

NA = Data not available

* Total enrolment in BIOL3017 lower than the original intake of 40 due to students exiting from end of 2nd year or dual degree students deferring 3017 until 4th year.

**One student enrolled in MBBS/PhD

Following Honours, graduates of the ASP have moved readily into prestigious PhD programs at UQ and beyond, including transition to Harvard University, University of Arizona, Australian National University, and University of Melbourne.

While it is a feature of third year enrolments that on average ~50-60% choose to maintain participation in the program to Year 3, the research experience facilitated within the second year of the ASP allows some students to determine that research is not where their future lies. They are then able to alter their study course when it is still possible to change the emphasis of their degree. We consider this a good outcome in view of the many other possibilities that arise over three years, and our goal of assisting students to make informed career choices.

It is often the case that the ASP students have previously been the only person in their school or peer group with a genuine interest in science. For many of our students, therefore, the ASP provides the first opportunity to interact with peers who share their interest in science and understand and even encourage their passion for research and knowledge. Through this programme we send these exceptional students the strong message that at the University of Queensland their talents and enthusiasm will be recognised, applauded and nurtured. The positive effect this important, though less tangible, aspect of the program has on the self esteem and social development of some of these students is transforming.

Conclusion

The Advanced Study Program in Science is an innovative curriculum design that provides an enriched undergraduate experience for a small group of highly motivated and hard working science students. We have created a program that addresses the academic, intellectual, social and pastoral needs of these students. The program is enormously influential in these students' academic progress and career choices. The Advanced Study Program is highly successful in providing immediate and accessible links between the science research occurring at UQ and the BSc undergraduate learning environment. Evaluation continues to show that through the Advanced Study Program in Science our brightest students are challenged, motivated and inspired during their undergraduate science degrees.

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