FACULTY OF SCIENCE

submission to the

BACHELOR OF SCIENCE

REVIEW

2015

Faculty of Science
The University of Queensland
Photography: The image on the front cover and most images at the start or finish of each chapter are original photographs, by Ms Delphia Manietta, who graduated from the BSc (Hons) in 2012. The image at the beginning of Chapter 6 was taken by incoming science exchange student Benjamin Newbery, on Fraser Island, Queensland. The images of the UQ 1914 science camp and 1953 UQ chemistry laboratory are from UQ Archives. All images are used with the permission of the owners.
FOREWORD

For many at UQ, graduation ceremonies are one of the highlights of the academic year. Each year, we see many thousands of new graduates walk across the stage to collect their degree, with a far stronger body of knowledge, understanding and maturity with which to address the challenges they will face into the future. We offer many degree programs at UQ, but one of the most diverse in terms of fields of study and largest in terms of enrolments and graduations, is the Bachelor of Science (BSc) – the subject of this review.

Science is the pursuit of knowledge and rational understanding of the world (universe) in which we live, based on a broad and powerful set of testable hypotheses, observations and rational deductions. For thousands of years humanity has sought and valued scientific knowledge and understanding, perhaps in part for its inherent beauty and logic, but primarily for the ability it provides to understand, predict, and, to a highly beneficial extent, take control of our circumstances in and interactions with the world. Take a moment to look around you – which parts of your surroundings are not the result of an application of some scientific discovery or understanding?

The University of Queensland has been teaching Science for the century or so since it was established, and I have no doubt it will continue to do so for many decades to come. When our generation did our science degrees, the lecture theatre and library were the places where we accessed knowledge. More recent advances in technology mean that access to knowledge (but perhaps not understanding and wisdom) is now ubiquitous. Relative to the lifetime of a university, or even the tenure of a member of staff, this change is so rapid and recent that it seems unlikely that we yet have a comprehensive understanding of how to best reap its benefits either for our students or ourselves.

We, then, are the current custodians at UQ of an activity that remains durable and valuable on timescales of decades or even centuries. Within the BSc, our job is to impart the essence of a body of scientific knowledge that is at the same time consistent and long-lived, but also modern and rapidly expanding. External reviews are an important mechanism to ensure that our offerings remain of the highest quality and relevant to our students and the needs of the contemporary community. We welcome this opportunity to present our work for such scrutiny, and to receive and act on the advice arising from this review.

This faculty submission documents our current efforts to deliver a UQ science education which is of the highest quality, broad, relevant, and informed by excellent scientific research. The submission is the culmination of efforts by many people over the last 18 months or so, who generously committed their time and thoughts to this important review. It also reflects the efforts of a large body of academic and professional staff in the Faculty of Science and across most other UQ Faculties, who work tirelessly to deliver this large, diverse and premier degree. I express my sincere gratitude to all of you.

Professor Stephen Walker
Executive Dean, Faculty of Science
The University of Queensland
ACKNOWLEDGEMENTS

Many people have contributed to the preparation of this Faculty of Science submission to the BSc review over the last 18 months. These include: the motivated and thoughtful individuals who attended some or all of the regular review meetings and provided the ideas that are (hopefully) reflected in this document; the academic staff who ran teaching-research projects to enhance and measure student learning; the many students who responded to surveys and provided insights; professional staff within the Faculty of Science who collected and analysed relevant data; members of the broader university community, in particular from The Institute for Teaching and Learning Innovation (TaLi) and Management Information Section; and those people who modified and improved the documents. All of these contributions are very gratefully acknowledged.

The most recent BSc review took place in 2006. It was a comprehensive (and at times gruelling) process, but that review without doubt provided the basis for the current strong BSc at UQ, and indeed fostered much of the collegiality and goodwill shown by so many participants. The previous review was ably led by Professor Michael McManus, who continues to take a very active interest in the BSc and is always keen to provide insights and ideas. We hope that, when the next review is held, people will look back at our contribution as appreciatively as we look back at Mick’s.

THIS DOCUMENT

Chapter 1 provides overall highlights of the BSc, a brief introduction to the review, the terms of reference and a list of suggestions from the Faculty of Science for consideration by the review panel.

Chapter 2 introduces the broader context, vision and values underpinning the UQ BSc. A short history of the BSc is presented, followed by a summary of the 2006 review recommendations and subsequent changes. Finally, we describe the consultative processes for the current review.

Chapter 3 presents a range of data for the BSc and related degrees, including degree structure, areas of specialisation, entry requirements, enrolment trends, dual degrees and governance structures.

Chapter 4 presents descriptive, trend, and benchmarking data on BSc student cohorts in terms of entry, progression in the degree, and graduation rates. Diversity and internationalisation are discussed along with data on student satisfaction with BSc courses. Data on honours and post-graduate study are also presented.

Chapter 5 considers graduate level learning outcomes and graduate employability. Data from national and local surveys are presented, with detailed benchmarking against other institutions.

Chapter 6 provides insight into learning and teaching in the BSc. This includes information on recognised teaching excellence, high impact learning activities, the role of technology in learning, teaching approaches, assessment and infrastructure.

Chapter 7 outlines several suggested changes to the degree structure. These include prerequisite courses, compulsory courses, interdisciplinary courses, specialisations within the degree, capstone courses, honours, specialist degrees and the Bachelor of Advanced Science (Honours).

Finally, appendices present a range of ancillary information.
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CHAPTER 1: OVERVIEW

Chapter 1 provides overall highlights of the BSc, a brief introduction to the review, the terms of reference and a list of suggestions from the Faculty of Science for consideration by the review panel.

1.1 The Bachelor of Science (BSc)

- Is UQ’s second largest degree in terms of student enrolments, with around 1600 students entering each year, and total Equivalent Full Time Student Load (EFTSL) of 4600 in the BSc, or its dual programs, or the Bachelor of Advanced Science (Honours).
- Is the most diverse of UQ’s degree offerings. It is taught at St Lucia and Gatton campuses, includes 26 majors (taught across five faculties), and is offered as a dual degree with ten other programs (taught across five faculties).
- Is by far the most preferred Queensland program for higher achieving students who wish to study a science degree, with a strong system of entry prerequisites and the highest entry rank of any science degree in Queensland.
- Is an important component of UQ’s strategy of attracting high achieving students.
- Is by far the most popular choice of a “first degree” for intending UQ medicine students.
- Has shown increases in enrolments and graduations of around 70% over the last five years.
- Has a strong honours program, with the number of honours graduations increasing by 25% over the last five years.
- Provides a strong science education, with all students completing at least one major and undertaking at least 1/4 of their study in third year science courses.
- Aims to meet student needs by balancing science depth with great flexibility, choice and breadth by offering courses in many science discipline areas whilst allowing students to complete up to 1/3 of their study as non-science electives.
- Undergoes program review approximately every seven years, with continuing monitoring and upgrade between formal review cycles.
- Aims for all graduates to achieve an identified list of graduate learning outcomes.
- Incorporates high impact learning initiatives, including blended learning, undergraduate research experiences, learning communities, technology innovations and active learning.
- Is taught by research-active academic staff members, many of whom lead competitively funded teaching and learning projects, and have received Australian and institutional teaching excellence awards.
- Elicits very high, and increasing, student feedback, with 85% of surveyed UQ science graduates satisfied with their overall development of generic skills, and 80% satisfied with the overall teaching quality and experiences in the program.
- Produces graduates suited to a range of careers and with strong earning capacities.
- Has strong governance, by major coordinators, the Faculty of Science Teaching and Learning Committee, the Faculty of Science Board of Studies, and a program coordinator.
- Is a “high expectation, high support” program, in which academic expectations are high and assessment is rigorous, but students are given extensive support with their learning and with any difficulties they encounter.
- Is a degree for which many of the contributing UQ staff feel a great deal of professional satisfaction and pride.
CHAPTER 1: OVERVIEW

The BSc is a flagship degree program of The University of Queensland (UQ). The future focus for the BSc is to develop graduates who thrive on the pursuit of excellence, who rise to current and future challenges and aspire to be leaders of the future. Thus, the BSc will provide a curriculum that engages students and enables them to achieve a series of well-defined, appropriate graduate learning outcomes. As a result, graduates will be highly valued in a wide range of employment areas including science based professions and scientific research.

This review process has demonstrated clearly that UQ, and the Faculty of Science in particular, provide a robust and collegial academic environment in which ideas are debated, innovations trialed (and retained or removed as appropriate), staff are mutually supportive, and there is a strong attitude of genuine caring about student success, with high expectations and rigorous academic standards coupled with a belief in providing high levels of support to students. This environment has not arisen by chance, but is built on a foundation of highly professional, reflective staff, with supportive and effective leadership.

One of the hallmarks of modern tertiary education is the rapid pace of change. There is immense and increasing diversity in students’ academic preparation, interests, study approaches and aspirations after graduation. There is a revolution in teaching approaches, particularly around the balance of on-line versus face-to-face activities, how to best leverage teaching knowledge with teaching skills, and adopting approaches that best support the ways that modern students learn. The BSc, and those teaching into it, must be prepared to change what we are doing and how we do it.

With this in mind, in this submission we have attempted to take a future focus. Extensive data are presented, to provide information about what is working well, and where there is the need to improve the degree or how it is taught. We have made a number of suggestions for the review panel to consider in their deliberations. We believe that these suggestions represent a balance between retaining what is currently working well, and changing those things that can and should be changed to position the BSc for the future.

1.2 Terms of reference

The relevant UQ policy (PPL 3.30.06) requires that the major generalist degrees are reviewed every 7 years, with the terms of reference determined by Academic Board Standing Committee (ABSC) in consultation with the Senior Executive and Executive Deans of the relevant faculties. For this review, ABSC approved the following terms of reference on 26th June 2014:

1. structure, content and quality of the program, in relation to the needs of students and external stakeholders, and with reference to national and international standards (including the effectiveness of gateway and capstone courses);
2. quality of the program in relation to perceptions of peers in the Australian and international scholarly communities, prospective employers and professional bodies;
3. destinations and graduate outcomes for those who complete the program;
4. quality and preparedness of students entering the program;
5. place and form of Honours within the program;
6. effectiveness of leadership of discipline areas for the program;
7. effect of any change on course offerings in other programs (e.g. service teaching and dual degrees);
8. scope of dual degree offerings with the program; and
9. future development and delivery of the program.
1.3 Faculty suggestions for consideration by the review panel

The vision and values that underlie the UQ BSc provide the context within which we make the following suggestions for the review panel to consider when formulating their recommendations. A detailed discussion of each suggestion is included in the main document. The suggestions are concentrated in Chapters 5 to 7, with one suggestion in Chapter 4. Overall, we believe that there is very strong evidence that the BSc is functioning effectively. Therefore, many of the following suggestions are part of a process of continuing improvement rather than radical change.

1.3.1 BSc Student Learning Experience

1. That student outcomes in the BSc be further strengthened by:
   a. managing and monitoring student achievement of graduate learning outcomes. [Page 76]
   b. consulting with discipline experts to identify appropriate standards for each graduate learning outcome to be attained by all students, and establishing guidelines for acceptable levels of variation across disciplines. [Page 76]
   c. coordinating cross-discipline curriculum planning to enhance horizontal and vertical integration. [Page 76]
   d. increasing the emphasis on communication skills (both oral and written), ethical reasoning and quantitative skills [Page 76]
   e. more effectively communicating the link between achievement of graduate learning outcomes and employability. [Page 86]
   f. increasing the scope for work integrated learning within the curriculum. [Page 86]
   g. highlighting the value of extra-curricular activities to future employment. [Page 86]

2. That assessment in the BSc be further strengthened by:
   a. coordinating and supporting ongoing improvements in assessment and feedback at the course level. [Page 118]
   b. coordinating assessment across year levels to optimise student learning of, and reduce academic duplication in, assessing graduate learning outcomes. [Page 118]

3. That teaching in the BSc be further strengthened by:
   a. increasing interactive teaching and improving feedback to students. [Page 111]
   b. encouraging sharing of current examples of best practice in teaching. [Page 111]
   c. the increased use of blended learning, with learning analytics supporting the enhancement of personalised learning. [Page 105]

4. That academic governance of the BSc be further strengthened by establishment of a faculty level, cross-discipline Science Curriculum Group, with the responsibility to:
   a. ensure the delivery of a high quality learning experience for all students. [Page 76]
   b. provide ongoing advice on strategies and priorities regarding vision and focus for the curriculum. [Page 76]
   c. manage implementation of the review recommendations. [Page 76]

5. That institutional support for the BSc be further strengthened by:
a. development of a coordinated approach to aggregating and reporting assessment data from electronic course profiles. [Page 118]

b. introduction of a coordinated approach to improve consistency of assessment standards and grading outcomes. [Page 118]

c. increasing and promoting more widely the student support, career advising and guidance delivered by central UQ services and by the faculty. [Page 59]

d. engaging with graduates for an extended time period, to monitor career outcomes. [Page 89]

e. ensuring that construction and redevelopment of teaching spaces focus on enabling effective learning in both formal and informal learning spaces, prioritising the needs of large classes. [Page 121]

1.3.2 Program Structure

6. That the development of interdisciplinary thinking and contextualised skills in statistics, data analysis, quantitative reasoning, programming, ethics and the philosophy of science be further strengthened by:

a. increasing the number of compulsory courses from one to two. [Page 141]

b. expanding the use of relevant, authentic, contemporary examples within these courses. [Page 141]

c. better embedding development of these skills into the subsequent courses and learning activities within each major. [Page 141]

d. undertaking regular review of the form, content and delivery of the compulsory courses by the Science Curriculum Group. [Page 141]

e. developing a small number of interdisciplinary courses. [Page 141]

7. That specialisations within the BSc be further strengthened by:

a. including a compulsory Level 3 capstone course or a compulsory Level 2 cornerstone course in each major. [Page 145]

b. removing dual majors and introducing optional minors. [Page 143]

8. That academic quality within the BSc be further strengthened by:

a. enforcing course prerequisites across all UQ degree programs. [Page 125]

b. increasing the minimum entry rank for the BSc to ATAR 81 (OP 9) or higher. [Page 34]

9. That the relevance and quality of an honours qualification be further strengthened by:

a. introducing fields in science education and science communication. [Page 149]

b. removing honours fields with no or few graduates. [Page 149]

c. introducing optional industrial placements and projects. [Page 149]

10. That the Bachelor of Advanced Science (Honours) be further strengthened by:

a. introducing a major in biomedical science. [Page 152]

b. reducing the size of majors and introducing minors. [Page 152]

c. introducing a three year version of BAdvSc, with an optional honours year. [Page 152]
CHAPTER 2: INTRODUCTION

This chapter introduces the broader context, vision and values underpinning the UQ BSc. A short history of the BSc is presented, followed by a summary of the 2006 review recommendations and subsequent changes. Finally, we describe the consultative processes undertaken in the preparation of this submission.

2.1 Context of the BSc

“Science is the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence” that encompasses both a body of knowledge and a reliable process of discovery\(^1\). Science plays a vital role in our everyday life and in addressing complex challenges facing society\(^2\). From new drugs to smart phones to climate change issues, science is pivotal to how we live our lives and how we see the world.

Science, as a discipline, is inherently dynamic. Rapid advances in science and technology continue to transform how science is practised, and are expanding the scientific body of knowledge. Higher education institutions are dedicated to creating and disseminating new scientific knowledge. They must also ensure teaching, learning and curricula in Bachelor of Science degree programs are representative of modern scientific practices and prepare students for future success in careers that start in science.

The BSc attracts a high proportion of school-leavers. Most of the 2015 graduates were born in the mid to late 1990s. Enabling technologies have always been a part of their lives. Facts, figures, information and seemingly ‘expert’ advice are just a click away. What students should learn in the BSc is equally as important as how they will learn it. Personalising the learning environment to suit individual students will remain of paramount importance. The challenge of providing differentiated but equitable learning opportunities for all students, whilst maintaining academic standards and assuring graduate learning outcomes, is a developing challenge.

The BSc sits within a context of national science and research priorities that value science and the way it is taught in universities. The Australian Chief Scientist recently proposed a vision for learning science at university\(^3\). “…Where lecturers engaged [students] in an interesting way, teaching science as it practiced, with the intention not of creating more science lecturers, but of forming curious minds fit for all sorts of careers.” His vision also encompasses the benefits of a university science degree that is visible to employers, in which “employers could see the benefits of the skill sets developed as part of an education in the scientific method - whether or not they needed the knowledge intrinsic to the particular discipline studied by the student”.

Science graduates in the Australian workforce value their degrees\(^4\) and have identified many beneficial outcomes regardless of whether or not they have pursued a career in science. Such outcomes include:

- skills (e.g. research, learning and enquiry; problem solving; technical skills including observation, experimentation and quantitative skills; presentation).
- ways of thinking (e.g. analytical, logical, critical, systematic, structured, questioning, evaluative, independent, sceptical, objective, evidence-based, rational, open-minded, innovative, creative).

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CHAPTER 2: INTRODUCTION

- knowledge (e.g. scientific method; science as a process; discipline subject knowledge; foundational knowledge and vocabulary).

The role of science in our society is changing why students study a science degree. Being able to think like a scientist is increasingly valued outside of scientific fields. The aim of BSc degree programs in preparing students in 2015 for future success reaches beyond success in science or mathematics careers, as approximately 50% of science graduates in Australia work outside of science professions. The modern BSc degree program has to instil scientific ways of thinking through the development of transferable skills that graduates can apply and extend to a diverse range of potential future endeavours. Thus, the science learning outcomes for the BSc align with employers’ expectations of science graduates. The national Statement for Science Teaching and Learning Outcomes provides an overall vision for science degree programs in Australia. It is centred around five domains:

1. understanding science;
2. scientific knowledge;
3. inquiry and problem solving;
4. communication; and
5. personal and professional responsibility.

2.2 Vision and values of the BSc

Intended to guide holistic curriculum development, the national statements have been translated to BSc and major level graduate learning outcomes at UQ. Thus, each major at UQ has a vision for the skills, knowledge and capacities expected of our graduates. These specific outcomes at the major level align with the broader national science graduate learning outcomes.

The advantage of the UQ BSc extends beyond knowledge and skills. UQ science students have the benefit of studying at a research intensive university where they interact with world-leading, discipline experts and learn in world-class facilities. Students are invited into a network of academic and professional staff who are passionate about science and who are dedicated to fostering optimal student learning. They are linked into cutting-edge practices that are transforming thinking on a global scale.

The success achieved by BSc students is influenced by the extent to which they engage in the learning activities, their academic ability and motivation, the quality of the resources and teaching, and the design of the curriculum. The following core values underpin the UQ BSc and the curriculum.

1. The UQ BSc is a diverse, flexible degree program that instils knowledge, skills and attitudes suitable to a range of post-graduate opportunities, within and beyond, careers in science.
2. The UQ BSc is structured around coherent pathways which are balanced with optimal student choice to explore individual interests.
3. The UQ BSc is more than the sum of the units of a major. Shared breadth units instil essential knowledge and ways of thinking for all science students and use real world challenges to make connections across multiple disciplines.
4. The UQ BSc engages students in appropriate learning activities and assessment tasks scaffolded from first to third year to ensure students extend the development of their knowledge and skills across the degree program.

7 All available on the UQ BSc Review website, http://www.science.uq.edu.au/bsc-review
CHAPTER 2: INTRODUCTION

5. The UQ BSc is taught by academics who are:
   a. deeply involved in disciplinary research and/or research into the scholarship of teaching and learning, and who bring the excitement, innovation and currency of their research into the classroom.
   b. dedicated to on-going teaching, learning, assessment and curriculum development opportunities grounded in evidence-based, science-specific teaching practices.

Vertical and horizontal integration within and across year levels is essential if students are to develop the complex graduate learning outcomes articulated by majors and the national science learning outcomes statement. Student experiences are conceptualised broadly as a learning trajectory, recognising that students enter the BSc with prior educational and life experiences. The UQ BSc should build upon and extend students’ learning from first to third year to prepare them for their post-graduation aspirations. A learning trajectory approach to the UQ BSc implies that the program is designed in a deliberate manner that scaffolds the desired graduate learning outcomes from first to final year. Designing the BSc curriculum to ensure coherence across units and year levels culminating in students’ attainment of science graduate learning outcomes is an on-going focus for the UQ BSc.

Since the most recent BSc Review, national higher education policy has shifted to a ‘demand driven system’ that has uncapped government limits on student enrolment in programs. In the last year, higher education funding has been hotly contested (and protested) as the government sought to introduce fee deregulation. The proposal that universities be able to set their own fees has been voted down twice in federal parliament, leaving the issue of funding for higher education in a state of uncertainty. The resolution of higher education funding issues will have major implications for the entire sector, including for the UQ BSc. The future-orientated vision for the UQ BSc, framed around graduate learning outcomes and employability, will not change. However, the effect of funding debates will directly impact on how we engage and support students. For example, if students were to pay more for a BSc degree, they would probably expect higher levels of engagement, greater access to world-class academic staff, and more personalised feedback from, and interaction with, those staff. With a smaller degree program, this would become more feasible. If no fee deregulation occurs, we might expect student numbers in the BSc to remain high or even increase. This would add pressure on academics and professional staff to personalise the learning experience without the benefit of additional resources.

2.3 Brief history of the BSc

The University of Queensland was the first university in the state and was officially founded on April 16, 1910, with the gazettal of appointments to the first UQ Senate. Teaching started in 1911 in Old Government House in George Street, Brisbane. In the first year there were three faculties – Arts, Science and Engineering – and 83 students (60 men and 23 women). According to the 1911 annual report, 21 students (13 men and 8 women) were enrolled in Science and graduated with a BSc on completion of their degree.

Much has changed since those early days, both for the university as a whole and for the BSc program. University wide restructures such as the move from year-long courses to a two semester year and the standardisation of course sizes have had a significant impact on the structure of the BSc. Enrolments in the program have gone from 21 in 1911 to over 5,000 in the BSc and dual programs in 2015. This massive increase in student numbers, mostly within the past twenty years, has significant implications for both small and large class teaching. The need for a flexible program responding to both internal and external factors is reflected in the many changes to the BSc throughout its history. Here we focus on changes that have occurred in the last ten years.
2.4 The 2006 BSc review

The most recent substantial review of the BSc took place in 2006, with implementation work occurring in 2007 and changes progressively introduced from the start of 2008. A full list of recommendations arising from that review is given in Appendix 3. They particularly focused on:

- the structure of the BSc, particularly around the number, structure and content of majors
- course offerings, including compulsory and highly recommended courses
- governance and committee structures for the implementation phase of the review
- student experience and facilities

As a result of the 2006 review, the following changes were implemented:

1. The number of majors was reduced from 40 to 20 (16 majors and 4 dual majors).
2. The number of Level 1 biology courses was reduced from 6 to 3.
3. Two quantitative courses, *Analysis of Scientific Data* (STAT1201) and *Theory and Practice in Science* (SCIE1000) were introduced, with STAT1201 being compulsory and SCIE1000 being highly recommended.
4. All majors now included a “capstone” course or experience as an opportunity for students to integrate and synthesise knowledge and skills gained from their major.
5. An Undergraduate Research Experience program was introduced to give students the opportunity to interact with researchers and gain experience in laboratories from their first year at university.
6. Special emphasis was placed on improving the student experience.

7. Two major building projects were completed: the Science Learning Centre and the Chemistry Podium. These spaces were designed to assist in improving the student cohort experience.

2.5 Since the 2006 review

The Faculty is constantly striving to improve the delivery of quality programs to our students. The changes to the BSc arising from the last review were extensive, however there is no suggestion that the program has remained static in the intervening years. A number of significant university and faculty wide reorganisations in recent years have had an impact on the BSc.

1. The current UQ Faculty of Science was established in January 2009. Previously, the Faculty of Biological and Chemical Sciences managed the BSc with support from Engineering & Physical Sciences Faculty (EPSA) and Social & Behavioural Science (SBS). Following the restructure and the formation of the new faculty, administering the BSc became the responsibility of the Faculty of Science.

2. The second stage of the reorganisation of the Faculty of Science in 2011 resulted in the addition of two schools, the newly formed School of Agriculture and Food Science and the School of Veterinary Science, both of which are located at UQ’s Gatton campus. This had significant implications for the BSc; it now became possible to offer the generalist BSc program at Gatton, and this commenced in 2014.

3. A further university re-organisation in 2014 resulted in the formation of three new faculties including the Faculty of Medicine and Biomedical Sciences (M+BS). The School of Biomedical Science (SBMS), formerly located in the Faculty of Science, moved to the M+BS Faculty. SBMS makes a very heavy teaching contribution to the BSc; indeed, biomedical science is the most popular major in the BSc. The implications of this reorganisation for the BSc are explored elsewhere in this document.

There have also been a number of substantial changes introduced more directly within the BSc structure, content, resourcing and teaching.

1. Focus on quantitative skills

The introduction of SCIE1000 (a recommendation from the 2006 review) has resulted in an increased awareness and focus on quantitative skills, which has had positive flow on effects through the BSc curriculum. This catalysed, and in turn benefited from, a UQ-led national project on quantitative skills in science.

2. Introduction of new majors

In 2015, a new major, archaeological science, was added to the BSc. Two new majors, animal and veterinary bioscience and plant and soil science, both only available at the Gatton campus, were added in 2014. A new extended major in marine biology was also added in 2014. It should be noted that the addition of new majors is not a proliferation of existing discipline areas. The new majors are in disciplines which have not been offered previously as part of the BSc.

3. Introduction of new dual degree program

The Bachelor of Music/BSc was introduced from 2015.

4. Introduction of the BSc (Gatton)

To extend the availability of the generalist BSc degree, the faculty offered the BSc at its Gatton
5. **Introduction of a new Bachelor of Advanced Science (Honours) Program**

A new four year Bachelor of Advanced Science Honours program, BAdvSc (Hons), with academically elite entry requirements, was introduced in 2014. The program allows the University to better cater to high achieving science students. Many courses are shared with the BSc, although students in BAdvSc (Hons) are exposed to advanced content and activities at different stages of the program. This is discussed in detail in Chapter 3.

6. **Introduction of new courses**

A number of new courses have been introduced. These include, but are not limited to, STAT1301 (an advanced version of STAT1201), SCIE1100 (an advanced version of SCIE1000), and MATH2001 (a core second year maths course), all introduced in conjunction with the BAdvSc (Hons).

7. **Renovation and refurbishment of science spaces**

Major renovations of chemistry, biology, biomedical and computing teaching laboratories have been undertaken in recent years. These facilities incorporate state of the art equipment and are designed to provide outstanding spaces and resources to classes with very large student numbers.

8. **Transition assistance for first year students**

   **a. Introduction of science induction days**

   In order to assist new students with the transition to university from high school, the faculty introduced a series of Science Induction Days (related to Recommendation #6 from the 2006 review). What was previously a brief and mostly administrative “welcome” session has been refined in recent years, so that students entering the BSc and other science programs attend a full day of authentic academic activities prior to the commencement of classes. The number of students attending each year has risen, with over 1000 students participating in 2015.

   **b. Establishment of a science mentor program**

   In line with improving the student experience, the faculty established a science mentor program in 2013. Science mentors are second and third year students who play an active role in easing the transition into university for new students, through both face to face interactions and answering questions on the first year science facebook page.

   **c. Enrolment assistance**

   Leading into semester, advanced level students are available on a daily basis to assist students with timetabling and enrolment assistance.

   **d. Email communication strategy**

   Commencing several weeks before the start of semester, new students receive a weekly email from the faculty, providing them with useful information on what they need to be doing to prepare for university. The emails continue until week two of semester.

   **e. Study assistance in the Science Learning Centre**

   First year students receive free study assistance from advanced level students, who are employed by the faculty across a range of discipline areas. Assistance is ongoing throughout semester and supplements the assistance available from course coordinators, tutors and PASS leaders.

   **f. Academic advice**
The faculty has established a dedicated team of academic advisors across all science discipline areas to offer high quality academic advice to students. For students who are experiencing difficulties with their studies, the faculty provides a team of student support staff who are available to meet with students to offer more personalised advice.

9. Faculty Teaching and Learning Committee and Board of Studies

The Faculty Teaching and Learning Committee (TLC) was formally reconstituted in 2009 to oversee all matters related to T&L in the faculty. The Faculty Board of Studies (BOS) was also established in 2009 and is the governance committee overseeing current and future issues that relate to the development, content, structure and rules pertaining to all academic programs (including the BSc) offered within the Faculty of Science.

10. Establishment of a faculty strategic fund to support T&L activities

In 2010, the faculty established a Teaching and Learning (T&L) grants scheme to support teaching and learning activities within schools in the faculty. Approximately $500,000 per annum has been allocated to T&L initiatives since its inception. This includes supporting a full time educational designer to assist with online curriculum development.

11. Large-scale changes to assessment policies
   a. Identity verified assessment and “assessment hurdles” in courses

   In 2011, the faculty introduced the requirement for individualised, identity verified assessment in all courses, to enhance the reliability, integrity and standards of assessment. In addition, these assessment items include a performance “hurdle”, so that irrespective of how well a student may perform on other assessment items, they need to perform to specified levels of achievement on the individualised, identity verified assessment in order to receive certain grades, such as passing the course. This is becoming particularly important given the increasing prevalence of plagiarism, excessive group work and “ghost writing” businesses, in which students can pay to have their assessment items completed to guaranteed levels of performance and with a guarantee that the work will avoid plagiarism detection.

   b. Changes to Supplementary Assessment rules in the BSc

   In 2014, the faculty introduced a new supplementary assessment rule to give students a single additional chance to demonstrate that they have met the learning objectives of a course, and raise their grade from 3 (failure) to 4 (pass).

12. Introduction of BSc program graduate learning outcomes and major-specific graduate learning outcomes

   In 2013 the faculty undertook a comprehensive review of the BSc graduate learning outcomes (GLOs). In consultation with majors’ coordinators, new GLOs were developed for the BSc, as well as specific GLOs for each major in the BSc and for BSc (Hons). GLOs for the BSc and BSc (Hons) are listed in Appendix 4a and 4b.

13. Professional development for teaching staff
   a. Tutor training program

   In 2009, the university introduced a 5 hour training program for all new tutors at UQ. As part of the ongoing commitment to improving teaching and learning, the faculty runs this training program twice annually, with around 300 new tutors attending each year. The faculty commitment of $40,000 annually is matched by UQ central funding.

   b. Academic staff support program

   A new initiative, the Teaching@UQ Program, is being developed as a support program for
new teaching staff to the university. The project is funded through a $295,000 UQ Central Technology Enhanced Learning grant, with two of the five project leaders being academics from the Faculty of Science.

2.6 Faculty consultation process

Students are the intended beneficiaries of our reform efforts and their experiences are an essential piece of the puzzle in determining the quality and future direction of the UQ BSc. Students were provided with multiple opportunities to provide input during the review process.

In April 2013, incoming first year students enrolled in the BSc or BSc dual programs were surveyed on their attitudes on entering university, and their experiences of study thus far.

The Science Students Skills Inventory (SSSI) was developed at UQ in 2008 to gauge final year science students’ perceptions of their science-specific learning gains. The SSSI also probed students’ post-graduate intentions. Final year UQ BSc students have been invited to complete the SSSI in 2008, 2011 and 2014. Final year science students at Monash, as part of a benchmarking exercise with UQ, completed the SSSI in 2011. UQ BSc students in first and second year levels, including dual degree students, were invited to complete the SSSI in 2014 to inform this BSc Review process.

The Federal government coordinates collection of student data to explore the quality of higher education from the perspective of students. These suites of surveys, administered a few months following graduation, probe satisfaction, generic skills acquisition, support services on offer, and employment outcomes. Recently, first and third year students were also invited to answer national surveys.

Staff consultation, particularly with academic staff, has been central to the BSc Review preparation process, because the BSc curriculum is driven largely by what academic staff do. The consultation phase was viewed as an opportunity to engage academics as a collective group to determine the goals of the BSc, develop a shared vision for the future of the program, and generate “buy-in” to the review process to facilitate engagement during the implementation of the review recommendations.

A series of BSc Review Workshops was held over the past 18 months. The workshops (Figure 1) were open to all staff interested in the UQ BSc. As information and drafts of proposals became available, they were posted on a Faculty of Science webpage linked to the Science Teaching and Learning page.

In 2014, all major coordinators were invited to respond to the following three questions, in the context of their major:

• Have there been any changes to the content or structure of the major, or significant introductions of new courses, in the last 3 years? If so, please describe them briefly.

• How well is the major meeting the goals of graduating students with appropriate learning outcomes? Is the “horizontal/vertical integration” within the major appropriate? What are the strengths and any weaknesses of the major?

• What changes do you think should be introduced to the major, and when? Are there any factors that are inhibiting this, including the broader structure of the BSc?

A summary of responses to these questions is included in Appendix 2.

Discussions have been held with key stakeholders, including all Faculty of Science Heads of Schools, Directors of UQ Institutes, members of ITaLI and key professional administrative staff.

In 2015, all academic staff teaching into the BSc were invited to complete a survey to explore the future focus of the BSc curriculum. The survey was framed around GLOs, in order to gauge academic perceptions on how effectively the current BSc was developing such outcomes for students.
## Date and Topic

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Mar 2013</td>
<td>Key questions</td>
<td>Key questions to address as part of the review</td>
</tr>
<tr>
<td>7 June 2013</td>
<td>Discussion at Faculty Board</td>
<td>To discuss the general approach to the review and make visible a range of relevant data</td>
</tr>
<tr>
<td>14 Jun 2013</td>
<td>Open forum</td>
<td>Fine tuning our approach to the BSc review</td>
</tr>
<tr>
<td>28 Nov 2013</td>
<td>Assessment 1</td>
<td>To look at the principles of effective assessment</td>
</tr>
<tr>
<td>2 Dec 2013</td>
<td>Assessment 2</td>
<td>To look at authentic progressive assessment, assessment hurdles, mid semester exams</td>
</tr>
<tr>
<td>18 Feb 2014</td>
<td>First year BSc in a day</td>
<td>To share content and teaching approaches in large enrolment, first year BSc courses.</td>
</tr>
<tr>
<td>7 Apr 2014</td>
<td>The good and the bad</td>
<td>To identify academics’ perceptions of what worked in 2006 BSc Review. 2. To identify academics’ perceptions of needed work for 2015 BSc Review</td>
</tr>
<tr>
<td>13 June 2014</td>
<td>Transition and Diagnostic testing</td>
<td>To disseminate “Get Set” diagnostic testing model used developer in Engineering. To invite comments on applicability to BSc.</td>
</tr>
<tr>
<td>23 July 2014</td>
<td>Prerequisites</td>
<td>To discuss prerequisites (not enforced) and option of enforced prerequisites. Link prerequisites to bigger picture of vertical and horizontal integration.</td>
</tr>
<tr>
<td>22 Aug 2014</td>
<td>Diagnostic Testing and preparedness</td>
<td>To progress idea of a diagnostic test for incoming students to gauge student preparedness for science programs</td>
</tr>
<tr>
<td>8 Sept 2014</td>
<td>Compulsory courses</td>
<td>To facilitate a discussion on compulsory units in the BSc - existing units, highly recommended units and new units</td>
</tr>
<tr>
<td>30 Oct 2014</td>
<td>Majors and minors</td>
<td>To facilitate a discussion on majors and minors in the BSc - existing units, highly recommended units and new units</td>
</tr>
<tr>
<td>19 Nov 2014</td>
<td>Honours</td>
<td>To share content, approaches and future directions for Honours fields in the BSc</td>
</tr>
<tr>
<td>13 Feb 2015</td>
<td>Graduate learning outcomes 1</td>
<td>To present findings of student survey on GLOs and discuss possible suggestions.</td>
</tr>
<tr>
<td>13 Mar 2015</td>
<td>Graduate learning outcomes 2</td>
<td>Follow up meeting to present discipline specific GLOs with a view to consolidating suggestions.</td>
</tr>
<tr>
<td>20 Mar 2015</td>
<td>Draft Suggestions</td>
<td>Present all draft suggested recommendations for feedback. Further discussion on discipline specific GLOs.</td>
</tr>
<tr>
<td>10 Apr 2015</td>
<td>Specialised vs General degrees</td>
<td>Presentation on MABS undergraduate program. Discussion focus on the environment in which the BSc sits and the role of generalist versus specialist degrees.</td>
</tr>
<tr>
<td>1 May 2015</td>
<td>Reviewing the suggestions 1</td>
<td>To look at document and identify deficiencies and areas which might need strengthening and further discussion</td>
</tr>
<tr>
<td>14 May 2015</td>
<td>Reviewing the suggestions 2</td>
<td>To look at the suggestions, do they need condensing, re-organising, re-wording?</td>
</tr>
<tr>
<td>5 June 2015</td>
<td>Finalising the submission</td>
<td>To finalise the review submission</td>
</tr>
</tbody>
</table>

**Figure 1.** Consultation events held as part of the BSc review preparation process.
CHAPTER 3: OUR DEGREE

This chapter presents a range of data for the BSc and related degrees, including degree structure, specialisations, entry requirements, dual degrees and governance structures.

3.1 Bachelor of Science

The BSc is one of two large scale, generalist degrees offered at UQ, the other being the Bachelor of Arts. Entry requirements into the BSc are English, Maths B (intermediate level senior secondary mathematics, with introductory calculus), and either Chemistry or Physics.

The BSc is a 3 year full time equivalent program. To graduate, students are required to pass 24 courses in total, each worth 2 units of credit. Within these 48 units, students must complete:

- first year statistics (STAT1201).
- 32 units (16 courses) from the BSc course list, including at least 12 units (6 courses) of advanced Level 3 courses.
- a major (6 units at Level 2 and 8 units at Level 3) or extended major or dual major (each requiring 10 units at Level 2 and 12 units at Level 3).
- Up to 16 units (8 courses) of electives, of either science or non-science courses.

Each major ‘grows’ from a maximum of 6 units of Level 1 courses. The intention behind fixing the maximum number of Level 1 courses required for a major was to allow students sufficient breadth to choose other courses in which they may have an interest.

The option to take up to one third of the degree as electives from the BSc list or any other program gives students great flexibility and allows them to study an additional area of interest, for example a language, music or philosophy, as well as a major in their chosen science discipline. It also allows the BSc to operate effectively as a dual degree with a range of other degrees.

The full program rules for the BSc are listed in Appendix 5. The rules should be read along with the UQ General Award Rules (www.uq.edu.au/student/GeneralRules2014/2014GARs.pdf).

Policies on matters related to teaching and learning can be found in the Policies and Procedures Library (https://ppl.app.uq.edu.au/).

There are currently 26 majors offered in the BSc; see Figure 2.

| Animal & Veterinary Bioscience | Computer Science | Mathematics |
| Archaeological Science | Ecology | Microbiology |
| Biochemistry & Molec. Biology | Food Science | Physics |
| Bioinformatics | Food Science and Nutrition | Plant Science |
| Biomedical Science | Genetics | Psychology |
| Biophysics | Geographical Sciences | Plant and Soil Science |
| Chemical Sciences | Geological Sciences | Statistics |
| Chemistry | Marine Science | Zoology |
| Computational Science & duals | Marine Biology |

Figure 2. Majors offered in the BSc.
CHAPTER 3: OUR DEGREE

Students have the option of completing the BSc as part of a dual degree program of study. A dual degree offers students additional depth and breadth of knowledge with the benefit of a second qualification with less study time (typically 4-5 years) than the sum of the duration of two separate degrees. For example, the BSc and Bachelor of Arts (BA) are both 3 year programs, however a dual BSc/BA takes 4 years to complete. In effect, dual degree students receive cross credit for courses completed in the other degree program towards their BSc program, and must complete fewer than 48 units from the BSc course list; the typical requirement is 32 units from the BSc course list. Students forego the 16 units of electives available to students doing a straight BSc.

Currently there are 10 dual degree offerings coupled with science. These are Bachelors of: Arts, Business Management, Commerce, Economics, Education (Secondary), Engineering (Hons), Information Technology, Journalism, Laws (Hons) and Music (Hons). Enrolments in dual programs have steadily increased since 2008, when they were first listed by QTAC (Queensland Tertiary Studies Authority) as separate programs. Dual degree students now make up about 45% of the BSc cohort. The most popular dual degree options are Science coupled with Arts (BA) or Engineering (BE) as shown in Figure 3 (the dual medical degree and BSc, the MBBS/BSc, is no longer offered to commencing students).

Figure 3. Distribution of BSc and dual degree enrolments, semester 1, 2014 (n = 5356).

Figure 4 shows information on BSc programs from similar institutions around Australia and the two other major local institutions, Queensland University of Technology (QUT) and Griffith University (GU). It is worth noting that UQ entry cutoffs are significantly higher (that is, more elite) than those from the other major local institutions. (In Queensland, most students gain entry on the basis of their high school Overall Position (OP) score; Australian Tertiary Admission Rank (ATAR) equivalents are presented in Figure 4, for ease of benchmarking.) UQ BSc entry cutoffs are lower than most other Group of Eight (Go8), research intensive universities. This has potential ramifications in terms of the need to provide additional support to those students with lower levels of academic preparation. Unlike UQ, most Go8 universities have a system of compulsory prerequisites within their program to guarantee prior learning before proceeding to more advanced levels. This is discussed in detail in Chapter 7.
### ATAR Majors Minors Num. duals Entry Prerequisites Annual Fees $ Dom Int'l

<table>
<thead>
<tr>
<th>Institution</th>
<th>ATAR</th>
<th>Majors</th>
<th>Minors</th>
<th>Num. duals</th>
<th>Entry Prerequisites</th>
<th>Annual Fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>UQ</td>
<td>79</td>
<td>26</td>
<td>NA</td>
<td>11</td>
<td>English, Maths B, Chemistry or Physics</td>
<td>8461 31920</td>
</tr>
<tr>
<td>ANU</td>
<td>80</td>
<td>20</td>
<td>43</td>
<td>NA</td>
<td>-</td>
<td>NA 3168</td>
</tr>
<tr>
<td>Monash</td>
<td>85</td>
<td>26</td>
<td>NA</td>
<td>11</td>
<td>-</td>
<td>8768 34100</td>
</tr>
<tr>
<td>UAdel</td>
<td>66</td>
<td>16</td>
<td>NA</td>
<td>5</td>
<td>-</td>
<td>8650 30000</td>
</tr>
<tr>
<td>UMelb</td>
<td>85</td>
<td>37</td>
<td>NA</td>
<td>NA</td>
<td>English, Maths, Biology or Physics or Chemistry</td>
<td>8768 36544</td>
</tr>
<tr>
<td>UNSW</td>
<td>84</td>
<td>24</td>
<td>NA</td>
<td>8</td>
<td>-</td>
<td>8768 37440</td>
</tr>
<tr>
<td>USyd</td>
<td>83</td>
<td>30</td>
<td>NA</td>
<td>3</td>
<td>-</td>
<td>8768 39200</td>
</tr>
<tr>
<td>UWA</td>
<td>80</td>
<td>31</td>
<td>NA</td>
<td>NA</td>
<td>-</td>
<td>8061 33000</td>
</tr>
<tr>
<td>GU</td>
<td>64</td>
<td>13</td>
<td>NA</td>
<td>NA</td>
<td>English, Maths A or B</td>
<td>8768 36925</td>
</tr>
<tr>
<td>QUT</td>
<td>71</td>
<td>5</td>
<td>NA</td>
<td>4</td>
<td>-</td>
<td>8800 30600</td>
</tr>
</tbody>
</table>

**Figure 4.** BSc programs at a number of Australian universities.

**Figure 5** shows the required prerequisite subjects for entry into the BSc and BAdvSc (Hons) and comparable degrees at QUT and GU. In each case, students must have completed the identified subjects at high school (or equivalent bridging subjects) before they will be admitted to the program.

<table>
<thead>
<tr>
<th>Institution and degree</th>
<th>Compulsory prerequisite courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>UQ BSc</td>
<td>English, Maths B, plus one of Chemistry or Physics</td>
</tr>
<tr>
<td>UQ BAdvSc (Hons)</td>
<td>English, Maths B, plus two of Agricultural Science, Biology, Chemistry, Earth Science, Maths C, or Physics</td>
</tr>
<tr>
<td>QUT BSc</td>
<td>None</td>
</tr>
<tr>
<td>GU BSc</td>
<td>English, Maths A or B</td>
</tr>
</tbody>
</table>

**Figure 5.** Compulsory entry prerequisites.

### 3.2 Bachelor of Advanced Science (Honours)

Key benefits of generalist degrees such as the BSc are the flexibility and accessibility of the programs. The BSc provides great flexibility to students who wish to explore a range of science disciplines, or who would like to study a substantial component of non-science courses as part of their program. BSc students may elect to complete a major or extended major in a wide range of areas, complete multiple majors in different science disciplines, or study up to one third of their degree from courses outside the BSc course list. In addition, students may combine the BSc with another program, and gain the benefit of completing two degrees in less combined time than it would normally take. The BSc is also very accessible to students, with relatively low entry requirements compared to most specialised degrees.

The faculty highly values these many strengths of the BSc, but flexibility and accessibility do have some impacts on program structure, student outcomes and perceptions of the program. For example, because all graduating students need to have achieved the BSc graduate outcomes, these outcomes are effectively statements of minimum standards. In such a flexible degree, this minimum is lower than it would be in a more highly structured degree.
In particular, the faculty recognises the need to attract and cater to high achieving science students who have a keen interest in research and who may wish to focus almost exclusively on science courses, and achieve a greater depth and problem-solving and research sophistication within science. UQ Science has offered an informal program (Advanced Study Program in Science) for high achieving students for the past 14 years, but noticeably UQ was, until recently, the only Go8 university which did not offer a formal “Advanced” program for its top end science students. There is clearly a market driven demand for academically elite programs, with evidence that students with high entry scores are attracted to such programs.

Aligned with UQ’s strategic priority to “attract, support and retain high-achieving students” and in response to the perceived need for a program which would better cater to the needs of our high achieving, research focused students, a new four year program, the Bachelor of Advanced Science (Honours) (BAdvSc (Hons)) was introduced in 2014. The entry cutoff is considerably higher (OP 3; ATAR 95) than for the BSc (OP 10; ATAR 79), and also includes more compulsory secondary school subjects for entry. The BAdvSc (Hons) degree is a more specialised, structured program than the BSc, with reduced flexibility. It is designed to complement the existing science offerings at UQ, with students able to choose the program that caters to their own particular needs and goals, and also to move between the two programs if their circumstances change. Figure 6 compares key features of the structures of the BSc and the BAdvSc (Hons).

<table>
<thead>
<tr>
<th>Item</th>
<th>BSc</th>
<th>BAdvSc (Hons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry OP</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Entry prerequisites</td>
<td>Maths B, English, one of Chemistry or Physics</td>
<td>Maths B, English, two of Chemistry or Physics or Maths C or Biology or Agricultural Science or Earth Science</td>
</tr>
<tr>
<td>Duration</td>
<td>3 years + optional 1 year honours</td>
<td>4 years including honours</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Very flexible</td>
<td>Inflexible</td>
</tr>
<tr>
<td>Electives</td>
<td>Up to 8 courses (#16) non science</td>
<td>Up to 3 courses (#6) non science</td>
</tr>
<tr>
<td>Number of majors</td>
<td>26</td>
<td>6</td>
</tr>
<tr>
<td>Major</td>
<td>Complete 1 or 2, #14 or #22</td>
<td>Complete 1, #52</td>
</tr>
<tr>
<td>Compulsory course(s)</td>
<td>STAT1201</td>
<td>SCIE1100, STAT1301, SCIE2111</td>
</tr>
<tr>
<td>Research experiences</td>
<td>Optional; compulsory in honours</td>
<td>Compulsory from first year; large project in honours</td>
</tr>
<tr>
<td>GPA required</td>
<td>None</td>
<td>Maintain GPA of at least 5</td>
</tr>
</tbody>
</table>

Figure 6. Comparison of the BSc and the BAdvSc (Hons).

The BAdvSc (Hons) includes a small number of advanced versions of existing science courses, a focus on research, and a more restricted pathway ensuring students have more discipline specific training than required in the BSc. Both BSc and BAdvSc (Hons) students engage in multiple activities and courses together, with the advanced students taking on additional activities and assessment based on extensions of the core course content. Great care was taken during the development, introduction and ongoing promotion of the BAdvSc (Hons). It was never intended to, and nor has it, become a replacement for the BSc, or to make the BSc a “second-rate” choice for a science degree. There are advantages and disadvantages for students taking each program, as summarised below.

Advantages of the BAdvSc (Hons) include:

- The ability for UQ to assert higher-level graduate learning outcomes for all graduates (arising from
both the reduced flexibility compared to the BSc, and the academically more elite student cohort enabling more challenging academic experiences to be offered).

- An increased focus on effective development of research expertise, with students transitioning from a compulsory 2 unit introduction to research in Year 1, to at least 2 units of research development and preparation in Years 2 or 3, culminating in a compulsory substantial “honours-style” research project in the final year. In the current BSc, many students who leave after 3 years have no research experience at all; those who complete honours often have their first (and only) experience of research in their honours year.

- More comprehensive majors, with more certainty as to what students have studied.

- An increase in the “common experiences” in first year, with more compulsory courses.

- Participation in an academically more challenging program, with a range of academically enriching activities/course experiences offered within the new program. For example, an advanced version of SCIE1000 (coded SCIE1100) is a compulsory course in Semester 1 of year 1 and an advanced version of STAT1201 (coded STAT1301) is a compulsory course in semester 2 of year 1. In Semester 2 of year 1, students complete the compulsory course SCIE2111, Introduction to Research.

- A marketing advantage, as the term “Advanced” is likely to be of significant appeal to high-achieving students, addressing a gap in the previous range of UQ offerings.

- Enabling our top graduates to compete for employment on a “level playing field” with graduates from other institutions, including other Go8 universities.

**Advantages of the BSc include:**

- The option to combine the BSc with one of ten other programs and complete two programs in less time that it would normally take. There are a wide range of different combinations to choose from in the fields of Arts, Engineering, Business, Music or Law. The development of skills and knowledge in two widely different areas is an advantage in the employment market.

- The ability to complete a second major in science.

- A greater breadth of major choices and fields of study within the science disciplines.

- The option to study up to one third of the degree as non-science electives, such as a language or other area of interest.

BSc students are able to undertake most of the advanced courses offered to BAdvSc (Hons) students as part of the BSc, provided they meet course prerequisite requirements. If BSc students meet the academic requirements for entry, they may switch into the BAdvSc (Hons) at any time during their first two years. Equally, BAdvSc (Hons) students may elect to switch out of the BAdvSc (Hons) at any time during their degree program, and complete a BSc instead.

The prerequisites, program structure and rules, and the curriculum outcomes are all designed to support the notion that BAdvSc (Hons) is a challenging program, offering advanced experiences and content, with the expectation that students will maintain a high level of academic performance. The GLOs for BAdvSc (Hons) (Appendix 4c) are set at a ‘higher’ level than the comparable outcomes for the BSc (Appendix 4a). Students must complete advanced courses and research experiences in the degree, leading to higher level graduate outcomes. Secondly, because there is less flexibility in the degree, it can be guaranteed that students will complete broader and deeper studies in their discipline than in the BSc. The key feature of the BAdvSc (Hons) is the inclusion of advanced courses, experiences, skills and knowledge. Some of this is inherent in the program (e.g., compulsory SCIE1100, SCIE2111, STAT1301 and a Level 3 research preparation course), and the rest is incorporated into each major.
The majors offered in BAdvSc (Hons) are: biology; chemistry; geological science; geographical science; mathematics; physics. This is a limited selection in comparison with the BSc, and no additional major will be approved for inclusion in BAdvSc (Hons) unless it can demonstrate a significant component of advanced material.

3.3 BSc at Gatton

In 2014, the faculty commenced offering the BSc at the Gatton campus. Although for administrative reasons the degree appears as a distinct option in student entry guides, its rules and requirements are identical to the existing BSc at St Lucia, and are intended to remain so.

Two new areas of study were introduced into the BSc program, taught only at the Gatton campus (and these are the only areas of BSc study offered at Gatton). Either of the new areas can be taken as a major or an extended major. The animal and veterinary bioscience (AVB) major offers a high quality animal sciences program with likely employment opportunities in industries concerned with the health, welfare, nutrition, production and management of domesticated, wild or captive animals including the pharmaceutical, tourism, agricultural, environmental and recreation sectors. There are also opportunities in the human biomedical area especially in areas using animal models of human disease as well as the interface between human and animal disease. The major also acts as a recommended tertiary transfer pathway to the current Bachelor of Veterinary Science (BVSc) program at Gatton. The latter function is enhanced by two first year BVSc courses being co-taught to BSc students so that, should they gain entry to the BVSc program, they will already have completed one quarter of the first year course work.

The soil and plant biosciences (SPB) major was designed to complement existing applied science offerings in agricultural science, agronomy and horticulture at the Gatton campus and to increase the number of students studying agriculture-related topics to meet the demand from industry for graduates and to strengthen the University’s reputation as a leader in agriculture education.

The structure of the Gatton-based fields is the same as those offered at the St Lucia campus, where students undertake broad science courses in Year 1 and move into more specialised courses within their specific major or extended major in Years 2 and 3. Students studying the BSc at Gatton follow the same set of program rules as for the BSc at St Lucia and may undertake electives from other programs offered at either the Gatton or St Lucia campuses. There are sufficient courses offered at the Gatton campus for students to complete their entire program at that campus, if they wish. New, high quality courses with an appropriate focus are being developed specifically for the AVB major and existing courses from other programs are being reviewed for appropriateness for the BSc. Some courses have also been transferred from St Lucia (e.g. STAT1201 and CHEM1100). One potential issue with transferred courses is that, although they have the same course code as their St Lucia counterparts, they are taught by different staff from a different school which could lead to different outcomes for students on one campus versus the other. There are regular meetings between teaching teams on both campuses, and student outcomes are being monitored.

The student experience is also being monitored closely through informal interactions with the comparatively small cohort during delivery of courses as well as through formal course evaluations. In addition, two student forums have been organised, one in 2014 and one in 2015, where the students were able to meet senior staff. The second forum also enabled the first and second year students to interact and discuss topics such as the formation of a BSc Gatton student association.

In the first two years of operation, enrolments have numbered around 50 students each year, with the majority indicating that they wish to complete the AVB major. Of those who enrolled in 2014, the overall UQ retention rate was 91%, with most staying in Faculty of Science degree programs.
3.4 Governance

Good decision-making processes, and therefore good governance, share several characteristics. All have a positive effect on the quality of the outcomes, consultation policies and practices, and engender strong and effective working relationships. Characteristics of good governance include accountability, transparency, responsiveness, inclusiveness, effectiveness, and efficiency.

Academic and administrative governance of the BSc is built around the schools, major coordinators, Faculty of Science Board of Studies (BOS), UQ administrative structures, the Faculty TLC and a program coordinator for the BSc and the BAdvSc (Hons).

The first lines of governance are the schools and the major coordinators. Each major has a coordinator, who is an academic embedded in the appropriate school and discipline area. The program rules for the BSc and its majors remain an overarching framework, but within those rules the major coordinator (as a representative of the discipline area) has responsibility for ensuring that the courses offered within that major are appropriate. Course content, activities, assessment and grading outcomes are monitored within each school, and changes to the course list for a major are presented by the appropriate major coordinator.

The next level of governance is applied at the faculty, in the form of the Faculty of Science BOS, the BSc program coordinator (an Associate Dean Academic) and the Executive Dean. The Faculty BOS is responsible for overseeing the administrative rules and processes for all of the faculty’s programs, and in particular the BSc. The BOS includes members from each school in the faculty, and also members from other faculties. This committee is chaired by an Associate Dean Academic. Broad changes to the BSc rules are proposed by the program coordinator, and specific changes to majors or course lists are proposed by the appropriate major coordinator. All of these changes are considered and debated by the BOS, which then passes recommendations to the Executive Dean. Once proposals have passed through these steps, those that can be enacted at the faculty level are incorporated, and those which require consideration at a higher level are passed on.

The final level of governance takes place as part of the central UQ processes. Proposed changes pass through any or all of: approval from senior management; the Committee for Academic Programs and Policies; Programs Subcommittee; Academic Board; Legislative Committee and UQ Senate. There are numerous opportunities for widespread scrutiny and substantial changes to be considered.

In addition to administrative governance, there are also structures for academic and pedagogical governance. Each school has an active TLC and a Chief Examiner (or equivalent). Chairs of each TLC are members of the Faculty of Science TLC, which also includes representatives from schools outside the faculty but with a substantial interest in the BSc (especially the School of Biomedical Sciences and the School of Psychological Sciences). In addition to overseeing teaching and learning matters within the Faculty of Science, this committee distributes the $500,000 faculty strategic teaching and learning funding each year, and selects faculty teaching excellence award winners. The Faculty TLC website is an up to date repository for documents and information related to teaching and learning in the faculty, including minutes and agendas for TLC meetings, information on teaching awards and grants and other relevant matters.

These governance structures have ensured effective operation of the program and compliance with university rules, policies and procedures. They have also encouraged high quality teaching. However, there is scope for improved BSc curriculum planning, strengthened horizontal and vertical integration within the BSc curriculum and systematic implementation of review recommendations.
CHAPTER 4: OUR STUDENTS

This chapter presents a snapshot of the state of the BSc, including descriptive, trend, and benchmarking data on student cohorts in terms of entry, enrolment trends, progression, and graduation rates. Diversity, internationalisation, honours and post-graduate study are discussed, as well as data on student satisfaction with their courses. This chapter includes a suggestion to the review panel at the end of Section 4.1 [Page 34].

4.1 Entry

Students entering the BSc are a mix of domestic and international students. Most have just completed high school, but a substantial number are either returning to study after a break, or entering university for the first time as mature age students. Applications for entry into the BSc program by students completing year 12 of high school and by students at other universities must be lodged through QTAC. Applicants are assigned an OP (with OP 1 being highest and OP 25 lowest) and/or an ATAR rank (with 99.95 being highest and 1 lowest, based on their previously completed studies. Applicants who have met the minimum required score and who have completed compulsory prerequisites are offered a place in the degree. Over the past five years, the OP score required for entry and the median OP for the UQ single BSc has remained fairly steady; there was an improvement from OP 11 (ATAR 76) to OP 10 (ATAR 79) in 2015 (Figure 7).

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Figure 7. OP entry scores for selected UQ, QUT and GU degrees, 2011 – 2015.

UQ aims to attract high achieving students, and one way of monitoring this is to consider the proportion of entering students who have achieved high entry ranks. Figure 8 shows data for entry offers that were made to students for various UQ degree programs in 2015, identifying the proportions of offers that were made to students with an OP of a certain level or higher. Of the benchmarked degrees in Figure 7, the BSc and BSc dual programs very closely track the figures for UQ overall, which is perhaps surprising given that the BSc is a generalist degree. Certainly, students entering the BSc or BSc dual degrees have entry scores significantly higher than those for UQ’s other generalist degrees, Bachelor of Applied Science (BAppSc)
and BA. The proportion of offers in the OP 1 to 5 range in the BSc and dual programs is almost exactly the same as the UQ average (around 67%); when BAdvSc (Hons) is included, the proportion of offers in the OP 1 to 5 range increases slightly to around 70%. This compares favourably with 35% for the BA and dual programs and around 26% for the BAppSc.

Figure 8. OP distributions for entry offers to a range of UQ degrees, 2015.

In preparing this submission, we examined restricted data regarding the OP distribution of offers made for entry into science degree programs in 2015 at UQ, QUT and GU. Those data cannot be included in this document. However, as a general summary, the UQ combined BSc, BSc duals and BAdvSc (Hons) programs have attracted more than ten times as many OP 1 applicants in 2015 than did the BSc and dual programs at the other two major local universities combined. For applicants in the OP 1 to 5 range, the UQ programs attracted around five times as many applicants than the other local universities combined. These comparisons are important: in Australia, students typically enrol in a university near their home, rather than relocating to study. Students who come from a remote area with no local university often choose one located in the state capital city. Thus, it is particularly important that the UQ BSc compares very favourably with equivalent programs at the other Brisbane-based universities.

The preceding figures, and the OP entry data for other local universities, all show clearly that the BSc at UQ is very highly regarded by applicants to science degrees in South East Queensland, both in terms of numbers of offers that are made, and also when considering the entry ranks of applicants to whom offers are made. The UQ BSc also has a higher minimum entry rank than the other local degrees, and is more demanding in terms of compulsory prerequisite subjects. National benchmarking across the Go8 shows that UQ has the second lowest entry rank required for the BSc, although it does have stricter prerequisite subjects than most other Go8 universities. There appears to be scope to further increase the minimum entry rank in the future, particularly given the very strong positioning of the UQ BSc in the local market.

Suggestion

That academic quality within the BSc be further strengthened by increasing the minimum entry rank for the BSc to ATAR 81 (OP 9) or higher.
4.2 Student numbers

Figure 9 shows that the number of students entering the BSc and dual programs has increased significantly since 2010. The sharp rise in domestic BSc enrolments between 2012 and 2013 is most likely attributable to students intending to enrol in the graduate medicine program after completing the BSc. The MBBS/BSc dual program stopped taking enrolments in 2013, which has led to an increase in the single program BSc enrolments.

Figure 10 benchmarks UQ against the Go8 universities in terms of the number of students commencing natural and physical sciences degree programs across 2009 to 2012 (with the reduction in the number of undergraduate degrees and corresponding focus on generalist degrees at the University of Melbourne and the University of Western Australia particularly apparent in this graph). In that time, UQ had the 5th highest number of student commencements. Note that these fields of study do not directly match enrolments in the BSc or BSc dual programs (so the data in Figure 9 and Figure 10 are not directly comparable). However, the large increase in BSc enrolments from 2013 identified in Figure 9 would probably lead to an increase in 2013 for the data in Figure 10.

Figure 11 presents total enrolment and EFTSL numbers in the BSc and dual degrees, 2010 – 2014 (BMusic/BSc was introduced in 2015, so no enrolment data are available). It is noteworthy that enrolment numbers and EFTSL in the single BSc and in every one of the BSc dual degrees have increased from 2010 to 2014. Overall EFTSL have increased by around 50% during this time. Some of the increase in BSc dual enrolments has been in the MBBS/BSc. This program has stopped taking new enrolments, so EFTSL numbers will shortly start to decrease. The number of students continuing on to honours has increased by more than 50% in the given time period.
Table 1 shows the enrolments in various programs from 2010 to 2014. The table includes columns for the program, enrolments in EFTSL, and the number of students. The dual programs (BSc and duals) account for 40% of the BSc enrolments, while the BA and BE are very popular choices as duals with the BSc.

Figure 11. Enrolments and EFTSL for BSc and duals, 2010 – 2014.

Figure 12 compares 2014 EFTSL for three of UQ's largest programs: the BSc, BA and BE. The BSc is slightly larger than the BE in terms of total enrolments, but is smaller than the BA. Dual BSc programs account for 40% of BSc EFTSL. The BA and BE are very popular choices as duals with the BSc.

Figure 12. EFTSL comparison between the BSc, BA and BE, 2014.
Figure 13 and Figure 14 present a breakdown of domestic and international student load for 2010 – 2014. The numbers of domestic students studying a single BSc or a BSc dual program are similar, whereas international students are far more likely to take the BSc as a single degree. This may be a reflection of the time and cost of dual programs, as well as a limited awareness and value of dual program offerings in the international market place. There has been a steady increase in international student load in the past two years, in line with national trends.

![Figure 13. Domestic EFTSL in the BSc and dual programs, 2010 – 2014.](image)

Figure 13. Domestic EFTSL in the BSc and dual programs, 2010 – 2014.

![Figure 14. International EFTSL in the BSc and dual programs, 2010 – 2014.](image)

Figure 14. International EFTSL in the BSc and dual programs, 2010 – 2014.

Figure 15 presents data showing the percentage of commencing and continuing female students (and by implication the corresponding proportion of males) in the BSc or BSc dual degrees, 2010 – 2014. Overall, the proportion of females enrolled has remained relatively constant at around 46% during this period.

![Figure 15. Proportion of female students in the BSc, dual programs, and both, 2010 – 2014.](image)

Figure 15. Proportion of female students in the BSc, dual programs, and both, 2010 – 2014.
4.3 Equity

Figure 16 shows that the percentage of students in the BSc who are classified by Australian government guidelines as being low socio-economic status (SES) has remained fairly constant at around 14%, which is slightly lower than the UQ average of 15% (note that the comparatively small population enrolling in honours means that numbers vary more significantly within this group). UQ’s targets for low SES enrolments are 18.4% in 2015, rising to 22.7% by 2020. The proportion of students in the BSc or dual programs from rural and/or isolated areas is also slightly below the UQ average of 17%; see Figure 17. The number of students identifying as Aboriginal and Torres Strait Islander (ATSI) doubled between 2010 and 2014 and continues to increase, although numbers are still low; see Figure 18.

The proportion of students in the BSc at Gatton in 2014 who were either low SES or from a rural/isolated background was 29.8%, which is much higher than for students enrolled in the BSc at the St Lucia campus. This is perhaps unsurprising given the location of the Gatton campus in a rural area, and the nature of the degree offerings, which are likely to have greater appeal to students from a rural background.
4.4 International considerations

Each year over 300,000 international students choose to study in Australia. As well as providing financial funding benefits for the host institution, there are other advantages in attracting international students to study at UQ. These students have a significant impact on the broader economy of their host country, both in terms of consumer spending and employment. Those who enrol in, and graduate from, degree programs such as the BSc, bring with them a rich cultural mix and a unique perspective of the world, which enhances the intellectual and cultural environment of domestic students and staff who interact with them. Additionally, those international students who graduate and return home and whose university experience has been a positive one, become engaged alumni who serve as our greatest advocates in international spheres, generating awareness and goodwill and building the international reputation of the university.

Income received from international students has become central to funding a broad range of activities. With the recent discussions of deregulation of the Higher Education sector in Australia and the uncertain fiscal climate, a greater emphasis has been placed on extending and deepening priority international partnerships, as a means to diversify and consolidate income sources for the university. Thus, there are clearly compelling reasons to continue with a policy designed to attract international students into UQ programs.

There are four key reasons why the UQ BSc is particularly attractive to international students. First, international students’ choice of university is strongly driven by international university and disciplinary rankings. UQ has a very high institutional ranking on all major global ranking scales, and the BSc is seen as a flagship undergraduate program at UQ. Many of UQ’s science disciplines rank very highly among the world’s top universities. Second, the broad range of specialised disciplines available in the BSc provides international students with an opportunity to undertake study in a science or mathematics area of their choice. The program is a popular pathway into professional programs such as medicine and postgraduate coursework options. For those students who complete the BSc (Hons), the BSc serves as an entry point to a Research Higher Degree (PhD or MPhil). Third, the flexible structure of the BSc allows students to complete their preferred major while undertaking a number of elective options from other science disciplines or from non-science areas. Finally, much of the faculty’s recent international student recruitment has relied on credit transfer and advanced standing arrangements into the BSc for students from countries such as Singapore, Malaysia and Hong Kong where students are seeking to complete an undergraduate qualification after completion of a tertiary diploma. This recruitment has been based on both formal and informal credit transfer or advanced standing arrangements which capitalise on the “non-university” status of institutions in these countries.

Around one in five students in Australian universities is an international student (Grattan report, 2014). In the BSc, international students account for around 11% of enrolments. The number of international students enrolling and completing degrees in the UQ BSc or BSc (Hons) has not changed significantly in the past five years. Figure 19 shows international student awards conferred in 2010-2014, as a percentage of total awards. The percentage decrease in international students completing honours is due primarily to an increase in the number of domestic honours students, rather than a drop in international enrolments. Actual enrolment figures are shown in Figure 9.

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Figure 16. Aboriginal and Torres Strait Islander Enrolments, 2010 – 2014.

Figure 18. Aboriginal and Torres Strait Islander Enrolments, 2010 – 2014.
Building strong formal relationships with international partners for recruitment purposes is essential to “future-proof” our international student recruitment. The BSc is an integral component of the faculty's consolidated program to establish partnerships with international tertiary institutions, both university and non-university, with the purpose of recruiting coursework students through formal articulation pathway agreements. These agreements facilitate progression of students from a partner institution to UQ via an established program of study at the partner institution. As part of the formal agreement, students must complete the agreed component at the partner institution prior to entering the specified UQ program.

The flexibility of the current BSc means that it is an ideal vehicle to form the cornerstone of the faculty's international cohort recruitment strategy. The current BSc rules, combined with the University's credit rules, allow for development of articulation arrangements for students from international tertiary institutions which offer advanced standing from a minimum of one year (16 units) to a maximum of two years (32 units). Students who enter the BSc with 32 units (four semesters') credit must complete a further 16 units of credit (two semesters) to be conferred a UQ degree.

Articulation arrangements with international institutions may involve the BSc in a 2+1 or 2+2 type arrangement (2 years at originating institution followed by 1 or 2 years at UQ), or may involve the BSc plus a pathway to a postgraduate coursework program such as the Master of Biotechnology or Master of Financial Mathematics in a 2+ 1+1.5 or 2+1+2 type arrangement.

Figure 20 shows the number of international students who enrolled in the BSc with 16-32 units of credit between 2010 and 2014. While the numbers are relatively small, they do show an increase each year, as more agreements with international tertiary institutions are developed and links between countries are strengthened. Currently, the highest proportion of students who enter through advanced standing/credit arrangements are coming from polytechnic and non-university tertiary institutions in Singapore and Malaysia, however there is an increasing emphasis on recruitment from China and Indonesia. These students are an important part of the faculty’s international engagement and recruitment strategy.
The establishment of articulation and partner agreements between the Faculty of Science and international institutions is heavily reliant on the BSc as a pathway program. The faculty has a rigorous procedure for assessing the curriculum of partner institutions to ensure the quality of students entering the BSc, and subsequently assuring the quality of our graduates. Any potential changes to the credit arrangements for entry into the BSc would need careful consideration, as there could be serious ramifications for the international market.

A recent NSW Independent Commission Against Corruption report-highlighted the risks universities face in becoming dependent on international student fees, in the face of increasing global competition for international students and the need to maintain academic standards. Managing these competing forces is a difficult balancing act for universities who are seeking to enter new international markets and build student numbers, while at the same time ensuring the capabilities of students to meet academic demands. This creates significant tensions between the generation of revenue and the compliance with academic standards.

The establishment of strong international partnerships and articulation agreements based on the BSc allows the University to reconcile these tensions by ensuring both academic rigour through careful curriculum matching and a future funding stream through the intake of defined cohorts of students. The BSc is the integral component in these partnerships.

4.5 Retention

Student retention is defined as the proportion of commencing students who are enrolled at UQ on the enrolment census date in Semester 1 of a particular year, and also enrolled at UQ on the census date one year later. This may mean that retained students are still in the program in which they started (for example, the BSc) or they may have switched to another program at UQ. Figure 21 shows retention rates for a range of programs at UQ including the BSc, BSc dual programs and for comparison, Arts and dual programs, and the faculty and institution as a whole. The BSc has maintained a consistent level of around 83% retention for the period 2010-2013. This is around 10% higher than UQ's other generalist program, the BA, and slightly higher than the Faculty of Science retention rate. It is slightly lower than the UQ average retention rate across all programs.
CHAPTER 4: OUR STUDENTS

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<td>131</td>
</tr>
<tr>
<td>BInfTech/ BSc</td>
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<td>86</td>
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<td>B Arts</td>
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<td>76</td>
<td>75</td>
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</tr>
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<td>83</td>
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<tr>
<td>B Arts/BLaw</td>
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<td>95</td>
<td>153</td>
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<td>81</td>
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<td>56</td>
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</tr>
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<td>84</td>
<td>83</td>
<td>84</td>
<td>7868</td>
</tr>
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</table>

Figure 21. Student retention rates for a range of UQ degree programs, 2010 – 2013.

The factors which contribute to student retention, and the reasons for students leaving the university before completion of their degree, are many and varied. Academic preparedness, student engagement with their program and the wider university, the role of teaching and learning practices, financial and personal issues, and general preparedness for university life, may all play a role in a student’s decision to stop studying. Indeed, it would be a mistake to regard all such decisions to stop studying as a problem. If a student realises that study is not appropriate for them, or that UQ is not the most appropriate institution at which they should study, then withdrawing can be an ideal outcome. There are many reasons for enrolling in a BSc, not all of which revolve around the student completing that particular degree, or even continuing to study at UQ. We recognise that the BSc is used by a number of students to “increase their entry rank”, in order to “upgrade” their degree. It is perfectly appropriate, even desirable, if a period of study in the BSc can assist such students to achieve their goals. Thus, aiming for a very high retention rate should not necessarily be the primary goal, particularly in a generalist degree such as the BSc.

This is not to say that retention rates are unimportant. It is important to monitor student retention and success, to attempt to understand the reasons that students withdraw, and to minimise the numbers who withdraw due to problems that could be addressed by providing more support or enhancing the first year curriculum. Since the last BSc Review, substantial efforts have been made to innovate in the first year courses and provide co-curricular opportunities to foster students’ sense of belonging.

One useful question to consider is how levels of student retention relate to students’ academic performance. Figure 22 shows retention rates for students who achieved an overall passing grade point average (GPA) in their first year, versus retention rates for students whose overall GPA was under the passing level of...
4. Data are averaged over the period 2010 – 2012, with figures presented for all UQ students, students enrolled in Faculty of Science degree programs, and students enrolled in the BSc. On average, around 90% of students with an overall passing GPA in first year stay on at university. On the other hand, students with an overall GPA under the passing level are much more likely to leave. Institutionally, approximately 60% of such students return to study the following year. The data in Figure 22 are very similar across the three cohorts; BSc students with an overall passing GPA are around 1% more likely to be retained than the overall UQ average, and BSc students with an overall failing GPA are around 1% more likely to leave the university than the overall UQ average.

![Figure 22](image1.png)

**Figure 22.** Retention rate by Pass/Fail, averaged over the period 2010 – 2012.

Figure 23 shows retention rates for students who achieved an overall passing GPA in their first year over the period 2010 to 2013. Data are presented for all UQ students, students enrolled in Faculty of Science degree programs, and students enrolled in the BSc. Data are also presented for retention rates for UQ as a whole. Retention rates for students with an overall passing GPA in science programs, and the BSc in particular, have increased during this time period, and are now 2.5% higher than the UQ retention rate for students with an overall passing grade.

![Figure 23](image2.png)

**Figure 23.** Retention rate of students with passing GPA, 2010 – 2013.
CHAPTER 4: OUR STUDENTS

Figure 24 shows the proportion of students who left the university and who achieved an overall GPA below the passing level in their first year, during the period 2010 to 2013. Data are presented for all UQ students, students enrolled in Faculty of Science degree programs, and students enrolled in the BSc. For BSc students who have left UQ after one year, around 51% had an overall GPA below the passing level. This is considerably higher than the UQ average of around 37%.

Retirement data for the BSc paint an interesting picture. Generalist degrees appeal to a wide range of students, for many different reasons. Some students will enter the BSc (or the BA) because they failed to gain entry to their preferred degree, or because they wish to ascertain whether they are suited to undertake tertiary study. Thus, it could be expected that the large, generalist degrees would have a lower retention rate than occurs in other degrees, particularly those in professional areas. The retention rate for the BSc has consistently hovered around 83%, which is only slightly below the UQ average of 84%. In comparison, the BA is much lower, at around 75%.

Pleasingly, first year BSc students who have an overall passing GPA are more likely to be retained than are such students across UQ as a whole, and the BSc retention rate of these students has increased since 2010 whereas the UQ wide rate has decreased. Of those students who left UQ after one year, the proportion of BSc students with an overall GPA below the passing level is substantially higher than the UQ proportion. If achieving a GPA above the passing level is a measure of success, then the BSc is retaining a higher proportion of successful students than UQ more broadly, and of the BSc students who lapse, a higher proportion are unsuccessful than the UQ average.

When considering reasons why students leave UQ, it is worth noting that a higher proportion of students enrolled in the first year of the BSc have a GPA below the passing rate than the UQ average for comparable students – 26.1% compared to institutional average of 19.6%. This is discussed further in the following section.

4.6 Academic performance

Figure 25 shows the proportion of first year students who obtained a GPA above the passing level, according to their entering OP score. These proportions are lower in the BSc than in UQ overall or the faculty more generally. This is discussed after Figure 28.
CHAPTER 4: OUR STUDENTS

Figure 25. First year students with GPA above passing level, by OP, 2010 – 2012.

A recent report on First year (Baik, Naylor and Arkoudis, 2015)\(^9\) notes that students with low ATAR (that is, numerically high OP) scores were less prepared for university, less able to cope with university study and report lower levels of academic engagement than other students. The data presented in this document suggest that students entering the BSc with lower scores are more likely to fail. This has implications for how we support students, particularly those students in the lower OP bands. The fluctuations in the graph at OP 10 and higher are the result of very few students in these OP bands. However it is interesting to note that in 2012, there were 12 students who entered the BSc with OP 12 (ie the cutoff) and all successfully passed their first year. A weaker OP may increase the chance of a student performing poorly, but this does not mean that all students with weaker OPs will be unsuccessful.

Figure 26, Figure 27 and Figure 28 show the 2014 grade distributions for all undergraduate students, students enrolled in courses taught by the Faculty of Science, students enrolled in the BSc, and students enrolled in the BSc or duals or BAdvSc (Hons), split across Level 1, 2 and 3 courses. Note that grades range from 1 (lowest) to 7 (highest), with 4 being the lowest passing grade.

Figure 26. Grade distributions in Level 1 courses, 2014.

At all year levels, student grading outcomes in courses taught by the Faculty of Science are usually lower than the UQ average. Faculty of Science courses have generally higher failure rates (particularly grades of 3), and lower performance on the passing grades than the UQ average. This is particularly noteworthy at Level 1, where the failure rate is around 50% higher than the UQ average. In most cases, students enrolled in the BSc or duals or BAdvSc (Hons) receive a larger proportion of high grades than both the UQ average and the average for courses taught by the Faculty of Science.

Assessment and its crucial role in both enabling and evaluating student learning is discussed in detail in Chapter 5, but it is worth noting here that the Faculty of Science has put a large amount of thought and effort into assessment over recent years. In particular, we introduced compulsory Identity Verified Assessment (IVA) with performance hurdles in all courses a few years ago. IVA includes all types of assessment items in which it can be certified that the individual student completed that work themselves. This includes oral presentations, individual practical and field work, and invigilated exams. The hurdle aspect of IVA requires that students who do not perform to certain identified levels on those assessment items have grades limited (for example, if students do not score at least 40% on a final exam then the highest grade they can receive is a failing grade of 3). Furthermore, we implemented more rigorous assessment standard moderation, which reduced the possibility of individual variations in expectations and grading outcomes.

4.7 Course enrolments and satisfaction

Of the 325 courses offered to students in the BSc, enrolments vary from 2 students to a maximum of 2,500 students in any one course (Figure 29). Approximately 40 courses have enrolments above 400, and around 110 courses have enrolments above 100.
Figure 29 shows the courses on the BSc list with the largest total enrolments. The total number of students taking each course is identified, as well as the number of these students who are enrolled in the BSc or BSc duals. The table also shows whether or not the course is owned by the Faculty of Science. The data show that in many cases, BSc students form a relatively small component of the total number of students taking courses on the BSc list with large enrolments. This means that many of these courses need to satisfy a wide range of student aspirations and needs, and cannot be focused solely on BSc students.

![Our students in the outdoor classroom](image-url)
CHAPTER 4: OUR STUDENTS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Faculty of Science owned</th>
<th>Course Title</th>
<th>Total student numbers</th>
<th>BSc+duals student numbers</th>
</tr>
</thead>
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<tr>
<td>PSYC1030</td>
<td></td>
<td>Intro. to Psychology: Developmental, Social &amp; Clinical Psych.</td>
<td>2532</td>
<td>506</td>
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<td>CHEM1100</td>
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<td>Chemistry 1</td>
<td>2019</td>
<td>928</td>
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<td>STAT1201</td>
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<td>Analysis of Scientific Data</td>
<td>1796</td>
<td>1121</td>
</tr>
<tr>
<td>BIOL1040</td>
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<td>Cells to Organisms</td>
<td>1758</td>
<td>711</td>
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<tr>
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<td>Genes, Cells &amp; Evolution</td>
<td>1650</td>
<td>929</td>
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<td>273</td>
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<td>Theory &amp; Practice in Science</td>
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<td>Neuroscience for Psychologists</td>
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<td>Cell Structure &amp; Function</td>
<td>671</td>
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<td>CHEM1200</td>
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<td>Chemistry 2</td>
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<tr>
<td>INF1200</td>
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<td>Introduction to Information Systems</td>
<td>502</td>
<td>99</td>
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</table>

Figure 30. Courses on the BSc list with the largest enrolments, 2014.

The Student Evaluation of Course and Teacher (SECaT) questionnaire evaluates the student experience of a particular course and teaching in one instrument. Each time a course is offered, students enrolled in that course are invited to evaluate their course and their teacher. Figure 31 and Figure 32 show student responses to the question, “Overall, how would you rate this course?”. Responses were measured on a five-point Likert scale with % agree responses measured as “Strongly Agree” or “Agree”. The courses listed are all large first year courses offered to BSc students. In general, most courses received above average satisfaction ratings with most showing an improvement from year 2010 to 2014. STAT1201 scores relatively lowly in student evaluations, which is perhaps to be expected as it is the only compulsory course in the BSc. This is discussed in more detail in Chapter 7.
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Figure 31. Student evaluations of semester one, first year courses, 2010 – 2014.

Figure 32. Student evaluations of semester two, first year courses, 2010 – 2014.
4.8 Awards and completions

Figure 33 shows a 70% increase in total awards between 2010 and 2014, with a 30% increase in total awards in 2014 compared with 2013. This increase is largely a result of the increase in popularity of the dual degree programs, and this trend is likely to continue in the near future as the increase in dual degree program enrolments work their way through the system.

![Figure 33](image_url)

Figure 33. BSc and dual degrees awarded, 2010 – 2014.

Figure 34 splits the number of degrees awarded by gender. In the period 2010 to 2014, 2920 females and 2930 males graduated with the identified degrees.

<table>
<thead>
<tr>
<th>Program</th>
<th>2010</th>
<th>2011</th>
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<td>F</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
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<tr>
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<td>254</td>
<td>246</td>
<td>271</td>
<td>270</td>
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<td>BSc duals</td>
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<td>131</td>
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<td>154</td>
</tr>
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<td>Sub Total</td>
<td>384</td>
<td>397</td>
<td>377</td>
<td>443</td>
<td>424</td>
</tr>
<tr>
<td>BSc (Hons)</td>
<td>128</td>
<td>87</td>
<td>116</td>
<td>104</td>
<td>67</td>
</tr>
<tr>
<td>Total</td>
<td>512</td>
<td>484</td>
<td>493</td>
<td>547</td>
<td>491</td>
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</table>

![Figure 34](image_url)

Figure 34. BSc, BSc duals and BSc (Hons) awarded by gender, 2010 – 2014.

Figure 35 benchmarks UQ against the Go8 universities in terms of the number of students completing natural and physical sciences degree programs across 2007 to 2012 (with the generalist degree structure introduced in Melbourne particularly apparent in this graph). In that time, UQ had the 4th highest number of student commencements. Note that these fields of study do not directly match enrolments in the BSc or BSc dual programs (so the data in Figure 33 and Figure 35 are not directly comparable). However, the large increase in BSc completions from 2013 identified in Figure 33 would probably lead to an increase in 2013 for the data in Figure 35.
Figure 35. Student completions in natural and physical sciences at the Go8, 2007 – 2012.

Figure 36 and Figure 37 show the numbers of each major that were awarded to graduating students from 2010 to 2014 (note that students can choose to graduate with multiple majors). For the period 2010-2014, almost 40% of students graduated with a biomedical science major; the second most popular major was mathematics (8%). Seven majors each attracted less than 1% of the total number of majors awarded: bioinformatics, biophysics, chemical sciences, computational science dual majors, computer science, and statistics. Some majors did not exist prior to the most recent BSc review, so there has been less time for students to graduate with those majors.

Figure 36. Majors awarded in the BSc and BSc dual programs, 2010 – 2014 (n=3345).
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<table>
<thead>
<tr>
<th>Majors</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>Total</th>
<th>% Total</th>
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</thead>
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<td>Biochemistry &amp; Mol Biol</td>
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<td>16</td>
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</tr>
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<td>4</td>
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<td>39.4</td>
</tr>
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<td>4</td>
<td>1</td>
<td>11</td>
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</tr>
<tr>
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<td>3</td>
<td>2</td>
<td>9</td>
<td>11</td>
<td>29</td>
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</tr>
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<td>23</td>
<td>25</td>
<td>15</td>
<td>19</td>
<td>28</td>
<td>110</td>
<td>3.2</td>
</tr>
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<td>Comp Sci and Geological Sci</td>
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<td>1</td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>1</td>
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<td>36</td>
<td>137</td>
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<td>4</td>
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<td>682</td>
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<td>3345</td>
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</tr>
</tbody>
</table>

**Figure 37.** Numbers of majors awarded in the BSc and BSc dual programs, 2010 – 2014 (n=3345).
CHAPTER 4: OUR STUDENTS

4.9 Honours

UQ has been awarding classes of honours in four bands: class I, class IIA, class IIB and class III. Figure 38 shows the number of BSc honours graduates with each honours class for the period 2010 – 2014, and Figure 39 shows these data broken down by domestic and international students.

![Figure 38. Classes of honours awarded in the UQ BSc, 2010 – 2014.](image)

<table>
<thead>
<tr>
<th>Honours</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class I</td>
<td>119</td>
<td>125</td>
<td>94</td>
<td>125</td>
<td>158</td>
</tr>
<tr>
<td>Class IIA</td>
<td>44</td>
<td>41</td>
<td>39</td>
<td>52</td>
<td>54</td>
</tr>
<tr>
<td>Class IIB</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Total domestic</td>
<td>164</td>
<td>168</td>
<td>136</td>
<td>181</td>
<td>217</td>
</tr>
<tr>
<td>International</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class I</td>
<td>28</td>
<td>37</td>
<td>19</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>Class IIA</td>
<td>19</td>
<td>15</td>
<td>13</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Class IIB</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Class III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total international</td>
<td>50</td>
<td>52</td>
<td>33</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Total honours graduates</td>
<td>214</td>
<td>220</td>
<td>169</td>
<td>216</td>
<td>257</td>
</tr>
</tbody>
</table>

![Figure 39. Classes of honours by domestic and international students, 2010 – 2014.](image)

Figure 40 shows the fields available within honours, and also shows the number of students graduating with each field in the period 2010 – 2014. The ten most popular fields account for 72% of all graduates, and the ten least popular account for 0.6% of graduates (although one field, archaeological science, is new).

![Figure 40. Classes of honours by field, 2010 – 2014.](image)
### CHAPTER 4: OUR STUDENTS

<table>
<thead>
<tr>
<th>Field</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>Total</th>
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<td>19</td>
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</tr>
<tr>
<td>Biotechnology</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
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<td>5</td>
</tr>
<tr>
<td>Botany</td>
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<td>1</td>
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<td>14</td>
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<td></td>
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<td>Developmental Biology</td>
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<td>Drug Design&amp;Development</td>
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<td></td>
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<td>Entomology</td>
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<td>1</td>
<td>1</td>
<td>1</td>
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<td>4</td>
<td>7</td>
<td>1</td>
<td>15</td>
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</tr>
<tr>
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<td>3</td>
<td>3</td>
<td></td>
<td></td>
<td>6</td>
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<tr>
<td>Food Science and Nutrition</td>
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<td></td>
<td></td>
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<td>Genetics</td>
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<td>1</td>
<td>6</td>
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<td>1</td>
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<td>8</td>
<td>23</td>
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<td>8</td>
<td>8</td>
<td>19</td>
<td>9</td>
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<td>12</td>
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<td></td>
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<td>8</td>
<td>9</td>
<td>25</td>
<td>8</td>
<td>65</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>212</td>
<td>217</td>
<td>172</td>
<td>215</td>
<td>256</td>
<td>1072</td>
</tr>
</tbody>
</table>

*Figure 40. Graduates in each field of honours, 2010 – 2014.*
In a recent large survey of current undergraduate students enrolled in the BSc or BSc dual degrees (n=977), students were asked to identify their current plans on completion of their undergraduate study. **Figure 41** summarises the responses. Around 59% of students intended to undertake further study, with 32% planning on studying honours and 27% planning on other study (in many cases, a medical degree). Overall, 15% of students planned to study honours then a PhD. Thus, honours is an important intended destination for BSc graduates, but it is not the only destination. Similarly, PhD study is important (with 15% of students planning on studying one), but it is interesting that only around half of the students who are intending to study honours are intending to proceed to a PhD. Traditionally, many honours degree programs have focused predominantly on the goal of research preparation. Responses to the student survey indicate clearly that the BSc honours program must cater to the diverse range of goals of the student body, needing to prepare graduates both for further study and also for direct entry into the workforce.

**Figure 41.** Students’ intentions after graduation from the BSc.
4.10 Postgraduate study

Figure 42 lists the numbers of UQ graduates who completed a BSc or BSc (Hons) and progressed to research higher degree or postgraduate coursework awards at UQ, by field of study, between 2010 and 2013. Microbiology, zoology, biochemistry, chemistry, biomedical science and mathematics are the most popular fields of study.

<table>
<thead>
<tr>
<th>Field of Study</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>Total</th>
</tr>
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<td>Anatomy</td>
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<td></td>
<td></td>
<td>2</td>
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<tr>
<td>Biochemistry</td>
<td>10</td>
<td>9</td>
<td>1</td>
<td>5</td>
<td>25</td>
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<td>4</td>
<td>22</td>
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<tr>
<td>Biophysics</td>
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<td>1</td>
<td>1</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Biotechnology</td>
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<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Botany</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Chemistry</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Computer Science</td>
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<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Developmental Biology</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Ecology</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Entomology</td>
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<td>Environmental science</td>
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<tr>
<td>Evolutionary Biology</td>
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<td>4</td>
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<td></td>
<td>6</td>
</tr>
<tr>
<td>Exploration Geophysics</td>
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</tr>
<tr>
<td>Genetics</td>
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<td></td>
<td>6</td>
</tr>
<tr>
<td>Geographical Sciences</td>
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</tr>
<tr>
<td>Geology</td>
<td></td>
<td></td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Marine Biology</td>
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<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Mathematics</td>
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<td>8</td>
<td>5</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Microbiology</td>
<td>8</td>
<td>15</td>
<td>8</td>
<td>4</td>
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<tr>
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<td>8</td>
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<td>3</td>
<td>15</td>
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<td>Parasitology</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Pharmacology</td>
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<td>2</td>
<td>7</td>
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<tr>
<td>Plant Science</td>
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<td>2</td>
</tr>
<tr>
<td>Psychology</td>
<td>4</td>
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</tr>
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<td>Zoology</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>27</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73</strong></td>
<td><strong>78</strong></td>
<td><strong>57</strong></td>
<td><strong>58</strong></td>
<td><strong>276</strong></td>
</tr>
</tbody>
</table>

Figure 42. UQ graduates awarded postgraduate degrees at UQ, by field of study, 2010 – 2013.
4.11 Summary

Data in this chapter demonstrate that the BSc is a highly regarded, effective program, preferentially selected by students who wish to study science in Queensland. The median ATAR entry score of 89 shows that many high achieving students are attracted into the program. The success of the new BAdvSc (Hons) in attracting science students does not appear to have had a detrimental effect on the profile of the BSc, suggesting an important role for both programs in catering to different student needs. The increase in student enrolments and graduations over the past 5 years, as well as the numbers of students proceeding to study honours or medicine, suggests a program which is highly valued by students. The opportunity to combine the BSc with one of ten dual programs is very popular and accounts for a large component of the increase in enrolments in recent years. The flexibility of the degree is very appealing to both domestic and international students. Overall, the data point to a program enjoying strong success.
CHAPTER 5: GRADUATE LEARNING OUTCOMES AND EMPLOYABILITY

This chapter considers graduate level learning outcomes and graduate employability. Data from national and local surveys are presented, with detailed benchmarking against other institutions. This chapter includes suggestions to the review panel at the end of Section 5.1 [Page 59], Section 5.2 [Page 76] and Section 5.3 [Page 86].

5.1 National quality indicators: benchmarking in science

The Australian Government initiative, called “Upholding Quality – Quality Indicators for Learning and Teaching (QILT)”, expands and improves upon past national student surveys by centralising the administration and ensuring alignment between three national surveys on teaching and learning in higher education. These surveys are the Australian Graduate Survey (AGS), the University Experience Survey (UES) and the Employer Satisfaction Survey (ESS). These survey instruments provide general and broad data on the quality of teaching and learning, allowing benchmarking with peer institutions. Data are drawn from the major fields of education of natural and physical sciences, mathematics, and biological sciences, as degree program level data are not available. Extensive data from these surveys are presented in Appendix 1; we urge the review committee to examine these data.

Feedback on the quality of UQ’s science programs and science student experience has shown an improvement in 18 of the 20 categories over the relevant time periods. Thus, most of the benchmarked categories do not identify any cause for concern, either in comparison with other institutions or over time. When the data are further broken down into the UQ single BSc and the UQ BSc dual degrees, feedback from students in the single BSc is very positive, and has increased in every category over the period 2010 to 2014. In terms of student satisfaction, the UQ BSc provides a vibrant and steadily improving educational experience.

Of the 20 categories, only two showed a decrease. Student satisfaction with the learner resources showed a slight decrease (Figure 151), and does not appear to indicate a particular problem. However, feedback in the category “Percentage of third-year science students satisfied with the level of student support” (UES) (Figure 152) indicates a need for improvement, with UQ scoring lower compared to other institutions and also showing a significant decrease from 2012 to 2013. The multiple items from the survey questions that combine to form this category include students’ interactions with administrative staff and systems, careers advisers and counsellors. A number of the items are at least partially within the control of the Faculty of Science, but most fall partially or completely within broader UQ support.

Suggestion

That institutional support for the BSc be further strengthened by increasing and promoting more widely the student support, career advising and guidance delivered by central UQ services and by the faculty.

---

5.2 Graduate learning outcomes in the BSc

Students are the intended beneficiaries of curriculum reform. Thus, data from students are a vital piece of the puzzle when assessing the effectiveness and quality of the UQ BSc. The Science Students Skills Inventory (SSSI) is a student survey tool created at UQ in 2008 to explore student perceptions of how an entire science degree program contributes to the development of knowledge and skills that underpin expected graduate learning outcomes (GLOs). These learning outcomes are aligned with the UQ BSc major-level GLOs, which in turn align with the Australian Statement of Science Threshold Learning Outcomes.

The SSSI gauges students' perceptions of their learning gains for each GLO across several indicators: importance of developing skills within the program; improvement of skills while enrolled in the program; inclusion and assessment in the program; students' beliefs of their likely future use of those skills; and students' confidence in their skills. The SSSI has been published, administered at three Australian research-intensive universities (Melbourne, Monash, and UQ), and used in published research. It was modified to gauge academics' perceptions of the learning gains students' make as a result of the BSc. Appendix 6 shows the full list of SSSI questions.

The SSSI allows for analysis of, and reflection on, the broader GLOs that frame the UQ BSc, enabling whole of degree program planning centred on outcomes expected by the scientific community and employers. Assessment experts view the use of purpose built and discipline specific evaluative instruments as part of a cycle of curriculum review as 'good practice'. This is because such tools, for example the SSSI, are more likely to engage academics in collective curriculum planning, which is an essential step in changing teaching and learning practices in higher education. Evidence driven curriculum review underpins the UQ BSc Review. Generic surveys, including the Student Experience Survey or AGS discussed above, are administered by the government for quality assurance purposes, are aggregated by broad disciplinary groups (not degree programs), and indicate little differentiation amongst science programs. The national surveys represent an overall, non-discipline specific ‘climate’ of quality in higher education, which shows UQ sciences are equivalent to other similar universities. The SSSI offers insight into the quality of the UQ BSc specifically and has sparked robust debates amongst UQ academic staff leading to several suggestions below.

All GLOs reported on below are essential learning outcomes identified for the BSc and all of its majors, and are linked to agreed, national, discipline-specific conceptualisations of statements of learning outcomes (for example, in chemistry, mathematics, biomedical sciences and other areas of science). The results of the SSSI have been considered with an appreciation for the instrument's limitations (for example, it explores broader outcomes in a quantitative manner, and qualitative variation or conceptual understandings of outcomes are not explored). Data for each GLO are presented from the following three data sources, each guided by the given question(s).

Data source #1 - 2014 cohort:

All BSc and BSc dual degree students across the undergraduate year levels enrolled in semester 2, 2014 were invited to complete the SSSI online, and 27% (n = 1065) of students responded. The SSSI modified for academics was completed by 81 academics. For the comparison of disciplines the students’ majors were classified into the discipline groups shown in Figure 43.

This analysis answers the questions:

1. What are students’ perceptions of their GLOs?
2. What are academics’ perceptions of students’ GLOs?
3. How do students’ perceptions differ by discipline?

4. How do students’ perceptions differ by year level?

<table>
<thead>
<tr>
<th>Disciplines</th>
<th>Majors Comprising Disciplines</th>
<th>Total n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomedical sciences (BioSc)</td>
<td>Biomedical Science</td>
<td>307</td>
</tr>
<tr>
<td>Life sciences (LS)</td>
<td>Ecology, Food Science, Genetics, Marine Biology, Marine Science, Microbiology, Plant Science, Zoology, Animal and Vet Bioscience</td>
<td>211</td>
</tr>
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<td>Mathematics, statistics &amp; computer science (MS_CS)</td>
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</tr>
<tr>
<td>Chemical and physical sciences (CPS)</td>
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</tr>
<tr>
<td>Psychological sciences (PS)</td>
<td>Psychology</td>
<td>50</td>
</tr>
</tbody>
</table>

**Figure 43.** Discipline area of student respondents to the 2014 SSSI survey.

**Data source #2: Trend analysis:**

All single degree, final year BSc students were invited to complete the SSSI online in 2008 (n=107), 2011 (n=154) and 2014 (n=144). This analysis answers the question:

5. How did final year UQ science students’ perceptions change from 2008 to 2011 to 2014?

**Data source #3: Benchmarking**

All single degree, final year BSc and Bachelor of Biomedical Sciences Honours (BBiomedSc (Hons)) students enrolled in UQ and Monash University were invited to complete the SSSI online in 2011, with 242 UQ respondents and 158 Monash respondents. BBiomedSc (Hons) students were included as they generally take the same classes as BSc students but with more structured requirements. This analysis answers the question:

6. How do the perceptions of science students vary between UQ and Monash University?

**Results**

The results are presented for each GLO in turn; a series of one-way ANOVAs (analysis of variance) were conducted to assess differences. A statistical significance threshold of \( p < .05 \) was applied.

Graphs show student (and academic staff, in some cases) perceptions of GLOs across 6 indicators. The first five indicators (important, included, assessed, improved, and future use) were scored on a 4 point Likert scale, with 1 the lowest value and 4 the highest. The final indicator (confidence) was scored on a 7 point Likert scale, with 1 lowest and 7 highest, to match the UQ course grading scale. Confidence was not rated by academics. Graphs represent the percentage of respondents who ‘agreed’ indicated by responding with either 3 or 4 on a 4-point scale, or with 5, 6 or 7 on a 7-point scale. For each GLO, the first graph compares academic and student perceptions, and subsequent graphs present data:

(i) split by discipline area of enrolled students;
(ii) split by year level of enrolled students;
(iii) showing the trend across multiple years; and
(iv) benchmarked between UQ and Monash.

1. **Scientific content knowledge**

The broad purposes of a bachelor degree in science are to prepare graduates for careers in science or to enter the general workforce as scientifically literate members of society. This implies knowledge of scientific content, although skills and broader outcomes are also expected. As such, developing a depth and breadth of scientific content knowledge particularly links to the agreed national statement on Scientific Knowledge which recommends that all science graduates exhibit a well-developed knowledge in one or more discipline areas.

![Figure 44](image1.png)

**Figure 44.** Students’ and academics’ views on scientific content knowledge.

![Figure 45](image2.png)

**Figure 45.** Students’ views on scientific content knowledge, by discipline.

![Figure 46](image3.png)

**Figure 46.** Students’ views on scientific content knowledge, by year level.
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The data show that students' perceptions of scientific content knowledge as a GLO are very high across all indicators (Figure 44), across all disciplines (Figure 45), across all year levels (Figure 46), over time (Figure 47) and in both universities (Figure 48), with no statistically significant differences in perceptions across year levels or universities. These results suggest that, from the perspective of students, the BSc is appropriately developing scientific content knowledge. The perceptions of academics (Figure 44) are closely aligned with those of the students.

2. Scientific writing skills

Developing scientific writing skills is central to the ability of students to communicate scientific knowledge and research outcomes, and to contribute to the integral process of debate within the workforce, scientific community and society more broadly. Written examinations and assignments, often in the form of literature reviews and laboratory reports, remain common assessment methods in the BSc. Writing skills underpin the agreed national recommendation that all science graduates be able to communicate science effectively using a range of modes, to a range of audiences, and for a variety of purposes.
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Figure 49. Students’ and academics’ views on scientific writing skills.

Figure 50. Students’ views on scientific writing skills, by discipline.

Figure 51. Students’ views on scientific writing skills, by year level.

Figure 52. Students’ views on scientific writing skills, over time.
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Figure 53. Students' views on scientific writing skills, UQ and Monash.

**Scientific writing skills** also rated quite highly across most indicators, although students perceived they could have improved more and did not rate “future use” as highly as other indicators (Figure 49). Students and academics had comparable perceptions for importance and improvement, however academics had much lower perceptions than students for inclusion and assessment.

**Figure 50** shows that students’ perceptions of scientific writing were generally quite similar across disciplines, with the exception of mathematics, statistics, and computer sciences. While students in that grouping perceive writing skills to be important (although less so than other disciplines), and their perceptions of future use are comparable to those of students in other disciplines, the degree to which writing is included, assessed, or has improved, and their confidence in their written skills is drastically lower than for students in the other science disciplines.

First year students rated writing skills statistically significantly lower than other year levels in terms of importance, assessment, inclusion and improvement (Figure 51). Students’ perceptions that they show some improvement from first year to later years is perhaps unsurprising, because it is more difficult to include and assess writing skills in the very large classes that are typical of first year courses. Scaffolding of writing skills across year levels warrants further consideration, particularly given that confidence does not change across year levels, perceptions of improvement remain unchanged from second to third year, and the perception of future use drops slightly from year 2 to year 3. While confidence levels reported by the 2014 cohort remain unchanged across year levels, these students report a statistically significant lower confidence in their writing skills compared to students in 2008 and 2011 (Figure 52). This is a step in the wrong direction for the BSc. Benchmarking results with Monash (Figure 53) indicate very similar students’ perceptions of this GLO.

3. **Oral scientific communication skills**

Developing oral scientific communication skills is central to the ability of students to communicate scientific information, and also to operate effectively as members of a workforce and of society more broadly. Science graduates need to be able to convey information in a clear, accurate, and understandable manner. This skill underpins the agreed national recommendation that all science graduates be able to communicate science effectively to a range of audiences, using a range of modes, and for a variety of purposes.
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Figure 54. Students’ and academics’ views on oral scientific communication skills.

Figure 55. Students’ views on oral scientific communication skills, by discipline.

Figure 56. Students’ views on oral scientific communication skills, by year level.

Figure 57. Students’ views on scientific communication skills, over time.
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Figure 58. Students’ views on oral scientific communication skills, UQ and Monash.

As with all other indicators, students perceived oral scientific communication skills to be important, and rated this GLO more highly in terms of future use than scientific writing skills. Perceptions of other indicators, particularly the levels of inclusion, assessment, and improvement, were low. For example, only around half of the respondents believed that their oral communication skills had improved as a result of their studies (Figure 54). Academic and student perceptions were fairly comparable across all indicators with the biggest difference being that academics perceived higher levels of student improvement than did students (Figure 54). Figure 55 indicates little variation across disciplines for importance and future use, while perceptions of all other indicators varied across disciplines. While disciplines show similar trends across inclusion, assessment, improvement, and confidence, biomedical and life sciences rate these indicators higher than psychological, and chemical and physical sciences. Mathematics, statistics and computer sciences have comparatively lower perceptions of oral communication skills.

Third year students rated communication skills more highly than their first and second year counterparts (Figure 56) on almost all indicators. As with written scientific communication skills, resource limitations often make it difficult to develop oral scientific communication skills in the large classes that are typical of first year courses. These skills can be developed in higher year courses, and student feedback suggests that this is happening at third year. However there is little apparent development from first year to second year, which would appear to offer significant scope for improvement. The trend data from 2008-2014 (Figure 57) indicate substantial gains since the last BSc review but relatively small improvement from 2011 to 2014. Monash students reported that oral scientific communication skills were more included, and that students showed greater improvement in this GLO during their degree program when compared to UQ students (Figure 58).

4. Quantitative skills

Developing quantitative skills is central to modern science, and underpins the ability of students to understand the quantitative nature of science and evidence, and to carry out the scientific method. This skill underpins the agreed national statement on science learning outcomes, particularly the outcomes for Understanding Science, Inquiry and Problem Solving, and Communication. These outcomes recommend that science graduates be able to demonstrate a coherent understanding of science, critically analyse and solve scientific problems, and present quantitative data in a variety of ways, including charts, graphs and symbols, which show clearly the trends or conclusions from their analysis as well as the accuracy of the underlying data. Developing quantitative skills was a major focus of BSc curriculum reform efforts following the last BSc Review.
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Figure 59. Students’ and academics’ views on quantitative skills.

Figure 60. Students’ views on quantitative skills, by discipline.

Figure 61. Students’ views on quantitative skills, by year level.

Figure 62. Students’ views on quantitative skills, over time.
Considerable efforts have been made since the last BSc review to build quantitative skills into the BSc. It is therefore encouraging that the data show significant increases in students’ perceptions of quantitative skills since 2008 (Figure 62). All year cohorts regarded quantitative skills as important. There was a significant improvement in terms of student confidence, as well as inclusion and improvement in quantitative skills, in the views of students in 2014 as compared to earlier cohorts.

The 2014 cohort of students believes that quantitative skills are important, and that the levels of assessment, inclusion, and improvement of quantitative skills throughout the degree are all quite high (above 75% agreement; Figure 59). Unfortunately this does not translate into perceptions of confidence and the use of quantitative skills in the future. Academic and student perceptions are comparable for importance, improvement, and future use however academics had lower perceptions of inclusion and assessment of quantitative skills than students (Figure 59). Student perceptions are relatively consistent across all year levels (Figure 61). However, in terms of future use, there was a decline in students’ perceptions from first year to third year. This suggests a potential misalignment across year levels.

Figure 60 shows variation across disciplines in a consistent trend: students in mathematics, statistics and computer sciences have the highest perceptions; psychological, and chemical and physical sciences are consistently in the middle range (with the exception of future use which is low for psychological sciences); biomedical and life sciences maintain comparatively lower perceptions. Results presented in Figure 63 indicate a high similarity between UQ and Monash students.

5. Teamwork skills

Developing teamwork skills is central to the ability of students to function within the collaborative scientific community, and in the workforce and society more broadly. These skills underpin the agreed national statement for Personal and Professional Responsibility which recommends that all science graduates be able to work effectively, responsibly, and safely in a team context.
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Figure 65. Students' views on teamwork skills, by discipline.

Figure 66. Students' views on teamwork skills, by year level.

Figure 67. Students' views on teamwork skills, over time.

Figure 68. Students' views on teamwork skills, UQ and Monash.
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Teamwork skills are generally regarded by students as being important and the 2014 cohort is no exception. They believe it is important, they believe that it will be useful in the future, and they largely feel confident about teamwork. However they see room for improvement in the areas of inclusion and assessment, and in how these skills can be improved throughout their program. Only around 60% of respondents believed that teamwork skills were assessed, or that they had improved those skills as a result of the BSc; these perceptions did however increase from first to third year (Figure 66). There was a statistically significant difference in students’ perceptions of teamwork skills being assessed, having improved and being confident, which increased from first to third year. Student and academic perceptions were different across all indicators. Students saw teamwork skills as more important, more included, and more assessed than did academics. In contrast, academics’ perceptions of student improvement were substantially higher than those of students (Figure 64).

Figure 65 indicates that students’ perceptions of teamwork skills vary widely across disciplines for all indicators. The variation across disciplines shows similar trends for all indicators except importance: biomedical and life sciences perceive teamwork to be very important; psychological, and chemical and physical sciences are consistently in the middle range; while mathematics, statistics and computer sciences maintain drastically lower perceptions of the importance of teamwork. Across cohorts from 2008 to 2014, students in 2014 felt that teamwork skills did show improvement throughout the program and are included more often, as compared to students in 2008 (Figure 67). UQ and Monash students held very similar views on teamwork skills across all indicators (Figure 68).

6. Ethical thinking

Developing ethical thinking is central to the ability of students to consider problems from an ethical standpoint, to carry out ethical scientific research, and to think and act with appropriate professionalism in the workplace. These skills underpin the agreed national science statements, particularly the outcome for Personal and Professional Responsibility which recommends all science graduates should be held accountable for their own scientific work by practising ethical conduct.

Figure 69. Students’ and academics’ views on ethical thinking.

Figure 70. Students’ views on ethical thinking, by discipline.
Ethical thinking has only been part of the SSSI from 2011, so no trend analysis has been conducted.

While students believe that ethical thinking is an important skill, they rated this skill at a very low level for inclusion and assessment, and they do not feel confident in the mastery of this skill (Figure 69). Fewer than 50% of students perceive that they are improving throughout their degree, yet almost 75% think it will be important to their future. This held true across all year levels (Figure 71). In particular students in third year felt even more uncertain than students in first year about the use of ethical thinking in the future, which suggests that ethical thinking is not being developed and extended across year levels. Academic and student perceptions differ in that students have higher perceptions than academics for all indicators. Academic perceptions of inclusion and assessment for ethical thinking are particularly low, indicating that academic staff are aware that there are very limited opportunities for students to learn and practice ethical thinking in the BSc. 

Figure 70 indicates a substantial misalignment in students’ perceptions of ethical thinking across disciplines. While students from all disciplines believe them to be important and likely to be used somewhat in the future, there is variation across disciplines, with mathematics, statistics and computer sciences students, and chemical and physical sciences students, consistently in the lower range of perceptions. It is worth noting that UQ students had lower perceptions of the importance, inclusion and improvement of ethical thinking skills throughout their program than did students from Monash (Figure 72).

7. Critical thinking

Developing critical thinking is central to the ability of students to participate in the process of science by critically approaching and analysing scientific problems, and evaluating difficult and unfamiliar problems they will encounter in the workplace. These skills underpin the agreed national statement for Inquiry and
Problem Solving which recommends that all science graduates be able to analyse and solve scientific problems by critically evaluating information from a range of sources.

Critical thinking has only been part of the SSSI from 2014, so trend analysis and benchmarking across universities have not been conducted.

The data on critical thinking skills indicate that students’ perceptions are high (above 75% agreement) across the range of indicators (Figure 73). In contrast, academics’ perceptions are low for inclusion and assessment in the BSc, but high for other indicators (Figure 73). Figure 74 indicates that students’ perceptions of critical thinking do not vary widely across disciplines. There was no statistically significant difference across year levels for any indicator (Figure 75).
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Discussion of GLOs

The SSSI provides insight into students’ perceptions of their learning gains in relation to the development of science-specific GLOs in the UQ BSc degree program. The 2006 BSc Review focused on degree program structure, which was appropriate given the lack of oversight and vision for the BSc in the decade prior to that review. There was a strong emphasis on one broader learning outcome: quantitative skills. This led to the development of an introductory mathematics-science interdisciplinary course (SCIE1000) and the requirement that all BSc students complete a first level statistics unit (STAT1201). In addition, the Faculty of Science funded teaching and learning grants under the priority area of building quantitative skills, and UQ led a large national grant to support development of quantitative skills across science degree programs. As the trend data from 2008, 2011 and 2014 demonstrate, these efforts have enhanced students’ perceptions of their quantitative skills. These data show that change can take years to impact on students, even with sustained efforts and resources dedicated to this goal. This is an important lesson to inform the current BSc Review – that curriculum development to achieve graduate level learning outcomes is a long-term commitment. Nonetheless, curriculum development to build students’ learning outcomes has to remain a focus of the UQ BSc.

Wide variation of student perceptions of learning outcomes across disciplines is concerning and indicates a lack of consistency and coherence in the BSc program structure. GLOs are intended to be integrated across the whole BSc degree, regardless of scientific content area, major, or discipline. This suggests the need for a mechanism at the faculty level to ensure vertical and horizontal integration to achieve the desired GLOs across disciplines, year levels, and the degree program as a coherent whole.

Hence we suggest the formation of a faculty level, cross-discipline Science Curriculum Group with broad responsibility for overseeing and supporting a coordinated approach to student learning in science. This group offers a vehicle through which other changes can be realised in a sustainable manner whilst being responsive to emerging issues. Evidence (including institutional and national teaching awards and grants, innovative projects, and teaching and learning publications from science academics) indicates a culture of teaching and learning excellence in the UQ Faculty of Science. The proposed Science Curriculum Group could provide strategic advice to the Associate Dean Academic and the Faculty of Science TLC. Existing groups in university science departments internationally could provide guidance as this group is formed (e.g. University of British Columbia; University of Maryland; University of Copenhagen).

A number of schools in the faculty employ teaching-focused academics, who have excelled on many levels including scholarly teaching, evidence-based publishing on science teaching and learning, leadership on national teaching grants, and curriculum leadership within majors. There are also numerous teaching and research staff who demonstrate high levels of teaching excellent and leadership. Formation of the Science Curriculum Group provides an opportunity to bring together expertise from the schools to focus on broader, shared BSc curricular issues.

When discussing student feedback on their perceptions of the GLOs, variations between disciplines provoked extensive discussion. Points that were raised include:

- Should all of the GLOs be attained (to some level) by all graduating BSc students, irrespective of discipline area? All academic staff who participated in the formal discussions agreed that the answer to this question is yes.

- Are all of the GLOs of equal importance, with equal time, effort and coverage devoted to each one? There was broad agreement that the answer to this question is no: for example, many participants felt that there should be more focus on critical thinking and content knowledge than there should be on some other GLOs.

- Is it reasonable to have disciplinary variation in the extent to which a given GLO is covered? Again, there was broad agreement that the answer to this question is yes, whilst recognising that every graduate needs to attain every GLO to some level.
Thus, when steps are taken to address apparent gaps in students’ attainment of some of the GLOs, it will be important to first decide what level of variation is appropriate as to the level at which each GLO is included and attained.

Through the direction of, and support from, the Science Curriculum Group, interdisciplinary teams should be formed around projects that aim to address the preceding suggestions, by defining the problems, identifying solutions, implementing approaches to enhance skill development, evaluating effectiveness, and reporting outcomes. Similar to the approach taken to develop students’ quantitative skills after the previous BSc review, the strategies to drive curricular developments will be varied and should be considered as a longer-term commitment. Unlike quantitative skills, where the problems in the BSc had been well understood and international exemplars to enhance quantitative skills in science were known at the time of review, the issues with ethical thinking and communication skills, in particular, are less well understood. Thus, before committing to an explicit approach, time should be allowed to understand the problem at UQ and determine approaches that are informed by relevant expertise. It would not be appropriate to adopt a simplistic approach to implementing the previous suggestions. For example, consider the GLO on teamwork skills. Developing and assessing such skills is not the same as conducting or assessing group work: simply requiring students to work with others does not necessarily improve their ability to do so effectively. In order to show a gain in these areas, there should be an increased focus on how to improve teamwork abilities, rather than simply adding requirements to complete group projects. For example, there could be activities around negotiating roles in groups, how to work together to achieve a shared goal, and effective communication.

Assessment arose as an issue in several BSc review workshops with the SSSI data sparking further debate on the role of assessment and feedback in students’ development of GLOs. A programmatic view of assessment should be central to the activities of the Science Curriculum Group for several reasons. First, academics in science recognise that ‘assessment drives learning’. Second, debates on these data highlighted the implicit nature by which such outcomes are taught and assessed, although ‘explicit teaching’ was viewed as only part of the solution. This raised the final point, whereby academics continually came back to how outcomes are assessed and how patterns of assessment across units and year levels were enabling, or inhibiting, students’ perceptions.

Innovative approaches to identify assessment patterns in degree programs, and explore how they influence student learning, should be examined and then adopted for use in the UQ BSc. For example, projects such as "Transforming the Experience of Students through Assessment (TESTA)" project12 funded by the UK Higher Education Academy are likely to be useful. Assessment is considered in detail elsewhere in this document.

The following suggestions offer a direction to guide implementation activities following the 2015 BSc Review without articulating an explicit strategy for what must change in the BSc curriculum with regards to developing GLOs. The first suggestion can be viewed as the vehicle, or structure, that allows for the other suggestions to be addressed in ways that are determined through collective approaches to curriculum development. This approach aligns with the general consensus amongst academics teaching into the BSc that on-going coordination and collaboration are needed to enhance coherence across schools, disciplines, and year levels.

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12 [http://www.testa.ac.uk/](http://www.testa.ac.uk/)


**Suggestions**

That academic governance of the BSc be further strengthened by establishment of a faculty level, cross-discipline Science Curriculum Group, with the responsibility to:

- ensure the delivery of a high quality learning experience for all students.
- provide ongoing advice on strategies and priorities regarding vision and focus for the curriculum.
- manage implementation of the review recommendations.

That student outcomes in the BSc be further strengthened by:

- managing and monitoring student achievement of graduate learning outcomes.
- consulting with discipline experts to identify appropriate standards for each graduate learning outcome to be attained by all students, and establishing guidelines for acceptable levels of variation across disciplines.
- coordinating cross-discipline curriculum planning to enhance horizontal and vertical integration.
- increasing the emphasis on communication skills (both oral and written), ethical reasoning and quantitative skills.

## 5.3 Employability

“STEM [science, technology, engineering, and mathematics] graduates from Australian universities will be best prepared to contribute to innovative growth if they are equipped with skills that enable them to be effective in a range of professions, as well as in research.”  - Australian Chief Scientist (2012)\(^\text{13}\)

Data show that only 20% of science graduates progress to be employed as technical scientists (Graduate Careers Australia, 2011\(^\text{14}\); University of Sydney, 2008\(^\text{15}\)) with approximately 40% of graduates working in science related fields (Harris, 2012\(^\text{16}\)). Many science graduates pursue careers outside scientific research. They may work as journalists, teachers, lawyers, policy analysts, financial advisors or farmers. A central question for the UQ BSc is: how are we equipping University of Queensland (UQ) BSc graduates with the transferrable skills and attributes they need for employment in a range of sectors?

To answer this question, we draw on available data from science graduates to understand where they work and whether they felt prepared for the workplace as a result of their university education. These data are sparse as UQ does not systematically track graduates. National data are available that can be aggregated by institution and broad discipline groups via the AGS and the (ESS). The ESS is a new initiative, piloted with 2013 graduates in several disciplines, including science, although UQ was not involved in 2013. In the second ESS pilot of 2014 graduates, UQ was involved but this yielded no valid data as only 15 employer surveys were completed for UQ and none was from science. Despite the lack of direct UQ data from the ESS, the survey reveals some noteworthy trends that are reported below.


\(^{15}\) University of Sydney (2008). Graduate Destination Report 2008. Careers Centre, Faculty of Science, University of Sydney.

\(^{16}\) ACDS, A Background in Science, What science means for Australian society, Kerri-lee Harris, Uni Melb 2012.
We draw on three sources of data to explore graduate employment plans and outcomes: the SSSI (administered to final year science students); the AGS (administered 3 months after graduation) and the ESS (administered to graduates and their direct supervisors, a few months after the AGS).

1. Science Students Skills Inventory (SSSI)

This survey was issued to final year BSc students in 2008, 2011, and 2014. In 2014, the SSSI was administered to BSc students, including dual degree students, across all year levels. The data presented in this section are student responses to the question:

Which one of the following best describes your plans following graduation:

- Work (science related area/non-science related area)
- Postgraduate studies (Honours then seek employment/honours then medical school/honours then PhD/honours then PhD then medical school/medical school/graduate diploma or masters in education/another undergraduate degree)
- No plans yet
- Other

Science students’ plans following graduation

Results presented in Figure 76 indicate that the majority of surveyed undergraduate science students planned to continue on to postgraduate study. The next highest proportion of students planned to seek work, and a smaller proportion did not have specified plans. This trend was typical across 2008, 2011, and 2014. For students indicating “postgraduate study”, what they hoped to study varied. Of the 71% of final year BSc students in 2014 who reported planning to undertake postgraduate study, 23% reported a plan to complete honours and then seek employment, with 17% planning to complete honours as entry into PhD, and 15% aspiring to medical school.

![Figure 76. Graduate plans of final year UQ BSc undergraduates (2008, 2011, and 2014).](image)

The views of final year students are typical of students in first and second year but atypical of fourth year students where the majority of students planned to seek employment (Figure 77). This could be explained by the fact that fourth year students will be enrolled in dual degrees and hence may have a more specific career goal in a field outside of (or in combination with) science. Other year level trends found that there was a notable decline in students planning to carry on to postgraduate medical degrees from first to fourth years with a drastic drop between second and third years. Secondly, students were most likely to indicate studying honours as an option as they progressed from second to third year.
Graduate plans reported by students in 2014 were explored by discipline groups, with BSc majors categorised as BioSc (biomedical science; n=307), LS (ecology, food science, genetics, marine biology, marine science, microbiology, plant science, zoology, animal and vet bioscience; n=211), MS_CS (mathematics, statistics, computer science; n=85), CPS (biochemistry, molecular biology, bioinformatics, biophysics, chemical sciences, chemistry, geographical sciences, geological sciences, physics; n=242) and PS (psychology; n=50). The likely destination for students varied depending on the discipline they were studying (Figure 78). Clearly, a significant number of students in most discipline areas have direct plans to enter the workforce immediately on graduation, so it is not sufficient for the BSc to only, or even predominantly, prepare students to enter research or academic careers.

2. Australian Graduate Survey (AGS)

Figure 79 shows the proportion of respondents in full time study, or who are available for full time employment and are in full time employment for three of UQ’s largest programs: the BSc, BA and BE. The data show that the BSc has a high proportion of graduates in full time study, and that 50 - 60% of graduates who are available to work are employed within 3 months of graduation. Figure 80 presents data for the proportion of respondents who are available for full time employment and are in full time employment, for BSc single degree graduates and BSc dual degree graduates. The employment rate for graduates who have completed a BSc dual degree is considerably higher than for graduates with a single degree (although the sample sizes for BSc duals are relatively small).
CHAPTER 5: GRADUATE LEARNING OUTCOMES AND EMPLOYABILITY

Figure 79. Graduates’ study and work status, 2010-2014.

<table>
<thead>
<tr>
<th></th>
<th>BSc single</th>
<th></th>
<th>BSc duals</th>
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<td></td>
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<td>145</td>
<td>62.2</td>
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</table>

Figure 80. Employment status for BSc single and BSc dual degrees, 2010 – 2014.

Figure 81 shows the proportion of UQ respondents who are either enrolled in full time study or are in full time employment, for graduates with a BSc, BA or BE. Outcomes for BSc graduates compare favourably with graduates from the other listed degrees.

Figure 81. UQ respondents in full time study or employment, 2010-2014.
Figure 82 shows the level of further study qualification among UQ BSc graduates who were undertaking further full time study, for 2013. Approximately half of those surveyed who indicated that they were studying were enrolled in BSc (Hons), with n=235.

![Figure 82. Intended qualification of UQ BSc graduates continuing with further study, 2013.](image)

Figure 83 shows how important UQ BSc graduates perceive their degree to be in their primary job. Around 50% of surveyed graduates say that their qualification is not important. It should be remembered that graduates are surveyed 3-4 months after completing their degree; it would be of more interest to survey students who had been in the workforce for a longer period of time. It may also be the case that some graduates are not placing a direct value on the transferable skills (such as communication, teamwork, quantitative skills, creativity and problem solving) that they developed during their studies. Even allowing for these factors, it would be hoped that future graduates from the BSc would have a higher perception of the relevance and importance of their degree for their employment.

<table>
<thead>
<tr>
<th>Year</th>
<th>Formal requirement</th>
<th>Important/ somewhat important</th>
<th>Not important</th>
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<tr>
<td></td>
<td>Count</td>
<td>%</td>
<td>Count</td>
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<tr>
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<td>20.5%</td>
<td>96</td>
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<td>23.1%</td>
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<tr>
<td>2014</td>
<td>56</td>
<td>36.8%</td>
<td>37</td>
</tr>
</tbody>
</table>

![Figure 83. Perceived importance of qualification in main job, 2010-2014.](image)

Figure 84 shows the median salaries of those UQ BSc and BSc dual graduates 2010-2014 in full time employment at the time of surveying. Again, it is worth noting that these are graduates who have only recently completed their degree. Numbers for dual degree graduates are low, but suggest some financial benefit of having completed a dual degree.
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</tr>
<tr>
<td>2010</td>
<td>$37,993</td>
<td>140</td>
<td>$46,523</td>
<td>31</td>
</tr>
<tr>
<td>2011</td>
<td>$42,092</td>
<td>133</td>
<td>$47,977</td>
<td>39</td>
</tr>
<tr>
<td>2012</td>
<td>$44,319</td>
<td>133</td>
<td>$53,350</td>
<td>32</td>
</tr>
<tr>
<td>2013</td>
<td>$41,415</td>
<td>106</td>
<td>$56,962</td>
<td>27</td>
</tr>
<tr>
<td>2014</td>
<td>$47,523</td>
<td>76</td>
<td>$56,172</td>
<td>31</td>
</tr>
</tbody>
</table>

Figure 84. Median salary of UQ graduates in full time employment, 2010 – 2014.

Results presented in Figure 85 to Figure 87 benchmark UQ against the Go8 and local universities (GU and QUT) for science graduates in the fields of Natural and Physical Sciences, Mathematics and Biological Sciences. Specific data include the percentages of science graduates employed full time (Figure 85), the perceptions of science graduates of the importance of their qualification in their main job (Figure 86), and the median salaries of science graduates in full time employment (Figure 87).

Figure 85. Graduates in science fields employed full time, 2010-2013. (n= 31 – 177 across universities for full-time employment rate and median salary).

Figure 86. Perceived importance of qualification in main job, science graduates, 2013.
Figure 87. Median salary of science graduates in full-time employment, 2010 – 2013.

The number of graduates responding to the question (*where do you work?*) was upwards of 270 in each year. These responses listed the graduates’ individual employers, which were then categorised into the broad employment sectors/groups shown in Figure 88. Examples of the types of jobs typical of responses are also given. The largest proportion of graduates indicated employment in the higher education sector. It is worthwhile noting that no single employer or sector was listed by a large number of graduates, with the exception of higher education.

Figure 88. UQ science graduates employed across different sectors, 2012 – 2014.

**Examples of jobs in each sector:**

- Science (outside academia): scientific testing, analysis and scientific technical services
- Minerals Industry: coal mining, oil and gas extraction
- Higher education: unspecified
- Education (other): preschool and school education, technical and vocational training
- Government: local and state government administration
- Health: medicine and pathology services
- Sales/Retail: motor retailing, department stores, supermarket, grocery stores
• Hospitality: bars, accommodation, restaurants
• Other: transport services, finance, insurance

3. Employer Satisfaction Survey (ESS)

The ESS carried out by the University of Sydney\(^\text{17}\) asked employed graduates from 2013, and their employers in the workplace, to rate various aspects of the graduate students’ employability and how well their degree prepared them for the workplace. The survey comprised a total of 2,749 graduate interviews and 539 supervisor interviews across four non-identified universities and five broad fields: Natural & Physical Sciences; Engineering; Education; Management & Commerce; Society & Culture. It is not known whether UQ was one of the selected universities, and none of the data in this section should be read as directly representing UQ. However, given the similarity of student responses across multiple institutions for other surveys quoted elsewhere in this document, it seems reasonable that the views reported in the ESS are broadly representative of the views of UQ graduates.

Figure 89 and Figure 90 present data relating to the following questions.

• Graduates were asked: Overall, how well did your qualification prepare you for your current job?

• Supervisors were asked: On the basis of your experience with [the graduate], how confident would you be recommending another graduate [with the same qualification from the same university] for a similar position in your organisation?

Results in Figure 89 indicate that employers consistently rated the graduates’ preparedness for the workplace as higher than the graduates themselves perceived. Figure 90 presents data grouped by educational field of qualification. Those graduates from science and engineering disciplines were the most likely to underestimate their skills relative to their employers’ perceptions of their skills.

Figure 89. Views of graduates and supervisors on work preparedness, 2013.

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CHAPTER 5: GRADUATE LEARNING OUTCOMES AND EMPLOYABILITY

Figure 90 presents views of graduates and supervisors on work preparedness, by field, 2013.

Figure 91 presents average scores (out of 100) given to graduates by supervisors for general employability skills required in the graduate workplace. These skills were: ability to cope with work pressure and stress, capacity to be flexible and adaptable, and ability to meet deadlines. Results indicate that graduates from Natural & Physical Sciences degree programs ranked above all other sectors for these employability skills.

Discussion

It is important to recognise three factors highlighted in this report. Firstly, the majority of UQ BSc students have clear plans for what they intend to do after graduation. Naturally, these plans may change. Figure 77 suggests that between 2008 and 2014 there has been a noticeable decline in the proportion of students whose plans involve postgraduate study. Secondly, the BSc must prepare some graduates for entering the workforce and others for undertaking further study in the form of higher degrees or subsequent graduate entry study, such as medicine. Many of the skills required for each of these pathways are the same, such as teamwork, communication, critical thinking and creativity. However, there are also some variations, so the degree cannot focus solely on work preparation, or on preparation for subsequent study. Thirdly, many BSc graduates who enter the workforce will not work in science, and their degree will not be directly important for their job (depending, of course, on interpretation of the word “directly”).
CHAPTER 5: GRADUATE LEARNING OUTCOMES AND EMPLOYABILITY

These three factors have clear implications for the approach we take to integrating GLOs into the degree program. It is not sufficient to prepare students for a career in science research, and as such the BSc must value and develop broader skills. In the SSSI responses to open ended questions, both students and academic staff identified certain GLOs (such as communication skills and teamwork) as being important aspects of the degree program, but areas in need of improvement. Both academic staff and students linked these types of outcomes to employability. Graduate Careers Australia (GCA)\(^\text{18}\) cites the most significant factors for employers as being interpersonal and communication skills, attitude and work ethic, and motivation. Thus, the role of science GLOs as employability skills is an important connection to make.

"the core problem solving and analysis skills that I acquired by studying science are highly valued in all industries"

UQ science graduate, 2011

“One area where the IT side of my degree was well complemented by my BSc was in the skills and practice I gained in communication, persuasion and analytical skills”.

UQ science graduate, 2010

A survey by GCA (2014)\(^\text{18}\) found that 32 per cent of university graduates who wanted a full-time job had not found one four months after completing a degree in 2014, topping the previous record set in 1992. In times of economic uncertainty and rising unemployment, highlighting the links between GLOs and employability is even more critical. Of course, the GLOs are aligned with national statements on science learning outcomes, and these in turn align directly with skills and knowledge desired by employers. This should be made more explicit to students.

Employability of UQ graduates is a strategic priority of the university. The future focus of the UQ BSc very much aligns with this priority. We want UQ science graduates to be able to articulate the outcomes gained from their degree and relate them to skills and capabilities desired by employers (interestingly, Figure \text{90} and Figure \text{91} suggest that employers often recognise and value those skills more than the science graduates themselves). Developing the BSc curriculum around GLOs, and reviewing assessment patterns, are key steps towards realising our goals for student employability. However, there also needs to be more scope for students to engage in work integrated learning (WIL) and “on the job” experiences within the curriculum, where appropriate.

Students can also gain employability skills outside the formal curriculum. For example, participation in extra-curricular activities such as sport, debating, clubs and societies provide environments to hone skills in leadership, teamwork and communication, while central services offer expert guidance on careers, writing CVs, and performing well in job interviews. Moving forward, the Faculty of Science should link more effectively into these central services and extra-curricular activities for the benefit of science students. There are also numerous other opportunities available to students, such as leadership programs, voluntary participation as student mentors, attending and giving presentations at undergraduate research conferences, and even undertaking study abroad. These activities should be better highlighted to students.

Ideally, the question about how well the UQ BSc develops employability skills would be answered from UQ BSc graduates who have been in the workforce for some years. These data are not available and it is

\(^\text{18}\) Graduate Careers Australia (2014) Beyond Graduation 2013: the report of the beyond graduation survey.
not economically feasible or pragmatically sensible for each organisational unit with oversight for a degree program to track graduates and collect such data.

**Suggestions**

That student outcomes in the BSc be further strengthened by:

- more effectively communicating the link between achievement of graduate learning outcomes and employability.
- increasing the scope for work integrated learning within the curriculum.
- highlighting the value of extra-curricular activities to future employment.
- highlighting the value of extra-curricular activities to future employment.

That institutional support for the BSc be further strengthened by:

- engaging with graduates for an extended time period, to monitor career outcomes.
CHAPTER 6: LEARNING, TEACHING AND THE STUDENT EXPERIENCE

This chapter provides insight into the student experience in the BSc curriculum, including information on teaching excellence, high impact learning activities, the role of technology in learning, teaching approaches, assessment and infrastructure. This chapter includes suggestions to the review panel at the end of Section 6.5 [Page 105], Section 6.6 [Page 111], Section 6.7 [Page 118] and Section 6.8 [Page 121].

6.1 The student experience

Because individual effort and involvement are the critical determinants of university impact, institutions should focus on the ways they can shape their academic, interpersonal, and extracurricular offerings to encourage student engagement. (Pascarella & Terenzini, 2005, p602).

The student experience encompasses academic and intellectual development, social and emotional life, and cultural, sporting and artistic interests. Students typically are seeking a degree (preferably with prestige and subsequent employment), as well as the intellectual and personal growth and development that comes from learning in a supportive and facilitative environment. Broadly, the ‘student experience’ is used to refer to all experiences of an individual student, within the context of their time at university. This encompasses in-class experiences, broader interactions with university staff and other students and a broad range of extra-curricular activities.

Engagement, and the concept of a good student experience, means different things to different people. It is not possible to guarantee that any particular student will have an experience that they regard as being “good”. For example, students are necessarily assessed on their academic abilities and achievements. Not all students are guaranteed to succeed, and students who fail courses are unlikely to be satisfied with their student experience. Some students will engage in numerous extra-curricular activities, others will turn up for their lectures alone, and an increasing number of students conduct most of their study off campus, online. None of these approaches is inherently superior or inferior. In essence, the quality of the student experience can only be judged by the individual student. Students can and should tailor their experience to their own particular goals and preferences.

Nonetheless, as an institution, UQ can strive to improve the range of options available to students, and the quality of the elements which are under our control. This includes academic elements such as assessment, curriculum and teaching, service elements such as facilities and student support services, and social elements such as clubs and societies. By focusing on the areas we can control, we seek to engage with our students and improve their overall student experience.

It is our view that the student experience should be informed by the following guiding principles:

- There should be an emphasis on supporting student engagement and learning, in particular how we develop and offer learning experiences, both in and out of the classroom, that achieve the desired GLOs, and meet the personal goals of the students.
- There should be recognition that there are close links between academic activities and other services and interactions, but that these facets of university life are not identical or interchangeable.
- The institution has a responsibility to maintain academic standards and promote learning that is relevant to students’ subsequent life stages.
CHAPTER 6: LEARNING, TEACHING AND THE STUDENT EXPERIENCE

• Ultimately, it is the choice and responsibility of individual students to decide the extent to which they participate in the various aspects of the student experience, both academic and other.

Quite rightly, the student experience needs to feature prominently in all of our institutional activities. However, we must recognise that students are autonomous adults with the freedom to exercise choices. An institutional goal could be to provide students with a wide range of options for engagement, learning and accessible support, and then to encourage students to make informed choices that are likely to be in their best interests.

The rest of this chapter discusses aspects of the student experience, first considering how students are finding the transition to tertiary study, and then focusing on those aspects of the student experience that relate directly to student learning within the curriculum and how that learning is facilitated.

6.2 Transition to university

Considered holistically, the student experience commences before students attend their first classes. Student surveys typically focus on gauging the student experience after at least a year of study, or even on graduation. This runs the risk of missing important information about one of the key phases of a student’s life, the transition into tertiary study.

In April 2013, incoming first year students enrolled in the BSc or BSc dual programs were asked a number of questions regarding their attitudes on entering university, and about their experiences so far. In total, 307 responses were received, a response rate of about 30%. As shown in Figure 92, more than 75% of respondents moved directly from school to university. Most domestic students came from Queensland, where the starting age for school is below other states in Australia. This means that the majority of first year BSc students enter the degree at 17 years of age. Around 31% did not select the BSc or dual program as their first preference. Of these, popular first preferences were the MBBS medicine degree (9%), Engineering (5.5%), Veterinary Science (3%) and programs at other universities (3.9%). The number of students for whom the BSc is not their first choice has implications for attrition from the program as it highlights that many students enter the BSc with the intention of not completing it; instead they hope to “upgrade” to another program.

As shown in Figure 93, and as expected for a large generalist degree, students enrol in the BSc and duals for a range of reasons. The most common reason was to enter a graduate program at UQ, with medicine as the most cited graduate program. A sizeable proportion of students (43%) indicated that they had interest in undertaking research after graduating.
CHAPTER 6: LEARNING, TEACHING AND THE STUDENT EXPERIENCE

Figure 93. Responses to the question: “Why are you enrolled in the BSc?”.

As shown in Figure 94, around 80% of students indicated that they were finding the transition to university “not too bad”, “easy” or “very easy”. There is clearly scope to offer more assistance to the 20% of students who have encountered difficulties in making their transition to tertiary study.

Figure 94. Responses to the question: “How are you finding the transition to UQ?”

Figure 95 shows data exploring potential challenges that students may have encountered in their individual transition into university. Students identify workload, motivation and lecturer’s requirements as areas where they are challenged, however most students reported feeling comfortable with the level of skills (both course discipline skills and generic) which they bring to their study. Adapting to new learning styles and feelings of isolation also seem problematic for a large number of students, as does identifying the courses in which to enrol. Naturally, this graph should be read in conjunction with Figure 94, which indicates that most students are not finding the transition very difficult.
6.3 Excellence in teaching and learning

One indicator of the success of learning and teaching in the BSc is the number and range of teaching awards received by academic staff teaching into the program.

- At a national level, recognition is given through the Australian Awards for University Teaching (AAUT), awarded by the Office of Learning and Teaching (OLT), the Australian Government body which promotes and supports learning and teaching in higher education institutions.
- At an institutional level, recognition is given by internal UQ awards. National and institutional awards both fall into three highly competitive award categories.
  - **Awards for Programs that Enhance Learning** (APEL) recognise outstanding programs in higher education which contribute to the quality of student learning and the student experience. Approximately 12 APEL (each worth $25,000) are awarded at the national level annually.
  - **Awards for Teaching Excellence** (ATE) celebrate a group of the nation’s most outstanding university teachers in their fields. Approximately 16 ATE (each worth $25,000) are awarded at the national level annually.
  - **Citations for Outstanding Contributions to Student Learning** (COCSL) recognise and reward the diverse contributions made by individuals and teams to the quality of student learning. Approximately 150 COCSL (each worth $10,000) are awarded at the national level annually.
- At the faculty level, science gives four awards (each worth $5,000) each year for teaching excellence within its programs.

At both the national and institutional level, the UQ Faculty of Science submits and receives more awards (of all types) than any other UQ Faculty. **Figure 96** and **Figure 97** present comparative data for successful applications for both UQ and AAUT awards. (Note that there were faculty reorganisations in 2014, with Arts and SBS becoming HaSS, and Health Sciences splitting into HaBS and M+BS. The HaSS data include awards to Arts and SBS).
A total of 39 national awards have been received by UQ since 2008 and 31\% (12) of these awards went to academics in UQ’s Faculty of Science; see Figure 98.

<table>
<thead>
<tr>
<th>Year</th>
<th>Award</th>
<th>Recipient</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>APEL</td>
<td>John Taylor</td>
</tr>
<tr>
<td>2014</td>
<td>ATE</td>
<td>Susan Rowland</td>
</tr>
<tr>
<td>2013</td>
<td>ATE</td>
<td>Gwendolyn Lawrie</td>
</tr>
<tr>
<td>2009</td>
<td>ATE</td>
<td>Victor Galea</td>
</tr>
<tr>
<td>2012</td>
<td>COCSL</td>
<td>Michael Drinkwater</td>
</tr>
<tr>
<td>2011</td>
<td>COCSL</td>
<td>Matthew Davis</td>
</tr>
<tr>
<td>2010</td>
<td>COCSL</td>
<td>Lawrence Gahan</td>
</tr>
<tr>
<td>2010</td>
<td>COCSL</td>
<td>Terry Tunny</td>
</tr>
<tr>
<td>2010</td>
<td>COCSL</td>
<td>Michael Jennings</td>
</tr>
<tr>
<td>2010</td>
<td>COCSL</td>
<td>Joseph Grotowski</td>
</tr>
<tr>
<td>2009</td>
<td>COCSL</td>
<td>Stephen Anderson</td>
</tr>
<tr>
<td>2009</td>
<td>COCSL</td>
<td>Victor Galea</td>
</tr>
</tbody>
</table>

Figure 98. AAUT/OLT awards received by Faculty of Science staff since 2008.
CHAPTER 6: LEARNING, TEACHING AND THE STUDENT EXPERIENCE

At the national level, project grant funding (administered by the OLT) is provided for the discovery, development and implementation of innovations in learning and in higher education. A total of 27 grants were received by UQ since 2008, 63% (17) of which went to projects in the sciences. National grants involving UQ Science academics that impact on UQ BSc students are listed in Figure 99.

<table>
<thead>
<tr>
<th>Person (s)</th>
<th>Year: Title</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>GU, QUT, USC, JCU, Adams (UQ)</td>
<td>2014: Queensland STEM network</td>
<td>2.9M</td>
</tr>
<tr>
<td>Schultz, Lawrie (UQ)</td>
<td>2014: Supporting a new generation: development and transfer of PCK in tertiary chemistry</td>
<td>50K</td>
</tr>
<tr>
<td>Gupta (UQ), Adams (UQ)</td>
<td>2014: Enhancing engagement of agricultural students in learning mathematics through innovative teaching and learning strategies</td>
<td>50K</td>
</tr>
<tr>
<td>Baglin, Bowe, MacGillivray, Bulmer (UQ)</td>
<td>2014: Virtualising Science: Using an Online World to Immerse Junior Secondary School Students in Real Applications of Maths and Science Curriculum</td>
<td>97K</td>
</tr>
<tr>
<td>Jennings (UQ), King, Bridgeman, Johnson</td>
<td>2014: Not just Another Diagnostic Test! Extending Get Set resources into new contexts</td>
<td>30K</td>
</tr>
<tr>
<td>Roach, George, Cox, King, McLaren, Verdel (UQ)</td>
<td>2013: Immersive visualisation for field-based sciences</td>
<td>225K</td>
</tr>
<tr>
<td>Cribb (UQ), White, Munroe (UQ), Shapter, Muhling, Frost (UQ), Whittington</td>
<td>2013: MyScope: a national approach to education in advanced microscopic characterisation through integrated learning tools</td>
<td>219K</td>
</tr>
<tr>
<td>Goos (UQ), Grotowski (UQ), Belward, Balatti, Anderson, Osborn, Sandison, Beswick, Beames (UQ)</td>
<td>2013: Inspiring mathematics and science in teacher education</td>
<td>2.2M</td>
</tr>
<tr>
<td>Dawes, Diezmann, Francis, Loughlin, Whitehouse, Adams (UQ), Nugent</td>
<td>2013: Step up! Transforming maths and science pre-service secondary teacher education in Qld</td>
<td>3.2M</td>
</tr>
<tr>
<td>Suphioglu, Belward, Chuck, Chunduri (UQ), Coady, Trapani, Hodgson, Luka (UQ), Markham, Poladian, Thompson, Watters, Simbag</td>
<td>2013: Development and implementation of MathBench for Australian universities to improve quantitative skills of science and mathematics students</td>
<td>298K</td>
</tr>
<tr>
<td>Matthews (UQ), Adams (UQ), Hodgson, Johnson, Thorn (UQ), Varsavsky</td>
<td>2013: Extending QS in Science: trialling and disseminating resource to link and build QS across life sciences majors</td>
<td>30K</td>
</tr>
<tr>
<td>Rowland (UQ), Lawrie (UQ), Zimbardi (UQ), Wang (UQ), Myatt</td>
<td>2012: Developing and resourcing academics to help students conduct and communicate URE</td>
<td>298K</td>
</tr>
<tr>
<td>Lawrie (UQ), Schultz, Wright (UQ), Tasker, O’Brien, Bedford</td>
<td>2012: Enhancing the secondary-tertiary transition in chemistry through formative assessment and self-regulated learning environments</td>
<td>200K</td>
</tr>
<tr>
<td>Farah (UQ), Mills (UQ), Aland (UQ), Lakhan (UQ), Maybury (UQ)</td>
<td>2010: The Virtual Slidebox - a new learning paradigm for exploring the microscopic world</td>
<td>133K</td>
</tr>
<tr>
<td>Savage (UQ), McGrath (UQ), McIntyre (UQ), Wegener (UQ)</td>
<td>2010: Teaching physics using virtual reality</td>
<td>219K</td>
</tr>
<tr>
<td>Elliott, Boin, Irving (UQ), Johnson (UQ), Galea (UQ)</td>
<td>2010: Teaching scientific inquiry skills: a handbook for bioscience educators in Australian universities</td>
<td></td>
</tr>
<tr>
<td>Matthews (UQ), Adams (UQ), Belward, Coady, Rylands, Pelaez, Thompson</td>
<td>2010: Quantitative skills in science: curriculum models for the future</td>
<td>220K</td>
</tr>
</tbody>
</table>

Figure 99. OLT grants with UQ science involvement, 2010 – 2014.
6.4 High impact learning activities

Drawing on extensive data on student engagement, educational research has identified the following ten high impact activities that contribute to student motivation and success, measured by, for example, high grades, high levels of engagement and graduates with employability skills (Kuh, 2008).

1. First year seminars and experiences
2. Common intellectual experiences
3. Learning communities
4. Writing intensive courses
5. Collaborative assignments and projects
6. Diversity/global learning
7. “Science as science is done”; undergraduate research experiences
8. Service learning, community-based learning
9. Internships (work-integrated learning)
10. Capstone courses and projects

The following section highlights some effective examples of high impact learning activities available to BSc students.

Undergraduate Research Experiences

It is widely accepted that an interactive, enquiry-based approach to learning can provide a meaningful experience for students. Within science, undergraduate research experiences (UREs) enhance the link between teaching and discipline based research and can provide a true sense of what it means to “think like, act like and be a scientist”. Engaging students in research and enquiry provides them with the opportunity to be producers of knowledge (not just consumers) and to develop many of the skills identified as essential GLOs.

As a research intensive university, with a strong reputation for scientific research, UQ is well placed to offer research placements at the undergraduate level. Students have the opportunity to participate in research either as part of the formal curriculum (through third level research based courses), and/or through a program of summer and winter scholarships.

Figure 100 shows the number of students enrolling in third level research based courses in the period 2010 – 2014. Mainstreaming undergraduate research and enquiry by integrating it into the curriculum allows a significant number of students to participate in a genuine research experience. Typically, the learning experiences in such courses include a literature review, a project report and a performance appraisal (if the project is laboratory based).

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Around 2010, the university adopted an institutional approach to engaging more students in undergraduate research experiences, through a program of summer and winter research scholarships. The numbers of science students awarded such scholarships are shown in Figure 101. In this scheme, students may be awarded a scholarship valued at $300 per week, for 6 – 12 weeks of full time research. A list of suggested projects and supervisors is supplied to assist students, however projects may be organised with any available lecturer or researcher from UQ or any institute/centre associated with UQ. Scholarships are competitive and awarded based on a student's academic record.

The number of students carrying out research projects has risen significantly in the past five years, however entry into research courses and summer and winter research placements is highly competitive and of necessity limited to more academically capable students. It is not possible to accommodate all students with an interest in pursuing research projects. Consequently, disciplines have devised a range
of strategies that incorporate research activities into coursework and student laboratory sessions. Recent research by Zimbardi and Myatt (2012)\(^2\), analysed the range of undergraduate research opportunities available to students at UQ, and concluded that research based experiences are being extensively used and are available to most students as part of the curriculum. In science, an example of such an activity is the ALURE project (Authentic Large Scale Undergraduate Research Experience). Running in at least 10 different courses available to BSc students, ALURE replaces the more traditional undergraduate practical experience. A hallmark of ALURE is that students generate new data and communicate their findings to an interested audience.

**Common intellectual experiences**

The 2006 BSc Review resulted in a more structured model for the BSc that included a required first year statistics course (STAT1201/1301), a new first year, first semester course recommended for all BSc students (SCIE1000/SCIE1100), and a final year capstone course for students within their major. Furthermore, students were required to select a major for graduation, first year was streamlined in terms of numbers of courses on offer, and designated “pathways” across year levels for each major were articulated. An overall aim was to create more shared experiences amongst BSc students whilst also retaining the flexibility that attracts many students to a BSc.

Many new first year courses were designed as a result of the 2006 BSc review. Experienced academics with a track record of teaching excellence were selected to develop and implement these new courses. Interactive learning activities that leveraged students working together in groups were the hallmark of a number of new courses. Enquiry-based practical modules were developed in experimental first year courses to engage students in group activities.

The newly created first semester, first year course, SCIE1000, was designed to achieve several purposes. The obvious goal was to build quantitative skills by applying mathematics and computer programming across a range of scientific areas in real-world contexts. Equally as important, SCIE1000 was designed to ease the transition of new BSc students by engaging students from across the range of discipline areas in meaningful, academically relevant critical thinking activities facilitated in an active learning environment. The course was developed, designed and implemented by professors recognised with teaching awards. They have adopted a genuine team teaching approach whereby they teach together in each lecture, in part to demonstrate the cross disciplinary links between science and mathematics.

**Learning communities and informal learning spaces**

*Peer Assisted Study Sessions (PASS)* are sessions for BSc students which form part of the class contact time for specific first year courses. They provide small group informal study sessions led by second or third year students (PASS leaders), and are similar to tutorial classes. The intention is for new students to have supportive, non-graded sessions in which they can learn how to study, make new friends, and receive guidance from more experienced peers. Becoming a PASS leader has numerous benefits for upper year science students, including paid employment on-campus, leadership training, development of communication and interpersonal skills, and the opportunity for learning science concepts in more depth. Academic course coordinators engage in the planning of PASS by linking the structure of the sessions to their courses. This has enriched the learning activities in PASS sessions and increased student engagement in their courses.

The 2006 BSc Review identified a lack of space for science students to gather and interact whilst on campus outside formal class time. The role of informal social learning spaces at campus-based institutions such as

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\(^2\) http://dx.doi.org/10.1080/03075079.2011.651448
UQ has been recognised as important in building students’ sense of belonging. A number of such spaces have been developed in the ‘science precinct’. Their use is not limited to science students, however it is predominantly science students who use these spaces. The Science Learning Centre situated close to the Faculty of Science office, is a student learning space which also acts as a social hub for students. Science mentors (second and third year students) monitor the space and offer informal assistance in specific, high enrolment first year courses. The Chemistry Podium is another area which is a hub of activity for student-student and academic-student interactions. The Biological Sciences library was converted from a traditional “rows of books” and “silent” place into an open plan, interactive study space. UQ led research shows a positive correlation between students who use these spaces and engagement (Matthews, Andrews, & Adams, 2010).

UQ Abroad

UQ Abroad is The University of Queensland’s student exchange program, which allows students to study overseas for up to one year on exchange while gaining credit towards their UQ degree. UQ has agreements with 175+ universities in 40 countries around the world. The opportunity to ‘broaden horizons’ and experience studying at a different university in another country has significant benefits for students. In 2013, there were 37 BSc (and dual) students on exchange; in 2014 the number increased to 92. These numbers are still relatively small compared with the number of students enrolled in a BSc.

Internships

Efforts to engage university students in work-based learning, typically called work-integrated learning (WIL), are gathering momentum. In the sciences, the Australian Chief Scientist’s vision for science education includes “widespread adoption of WIL” with “incentives for education institutions to include work placements for credit in most degrees and training programmes” (Chubb, 2014, p 24). There are significant challenges in a science degree program to achieving this goal. Nonetheless, pockets of academics in the BSc have been liaising with industry to secure WIL placements for students. For example, in chemistry, academics have developed relationships with Kelly Scientific and have been offering placements for selected students for over five years. The number of similar links, and the number of discipline areas in which such opportunities are offered, will increase in coming years.

Collaborative and active learning

Active learning is a mode of instruction that clearly focuses the responsibility of learning on the learners. The premise is that in order to learn, students must read, write, discuss or be engaged in solving problems. Many UQ science courses have been redesigned to incorporate active learning in the classroom. For example, first year physics has incorporated a ‘flipped classroom’ style, with students using ‘clickers’ in class to support collaborative problem solving. Several physics courses from first to final year have been redesigned to better encourage active learning. Collaborative learning in the form of group assignments and projects is common in many BSc courses.

There are numerous other examples of high impact teaching practices in the BSc, some of which are documented on the Faculty of Science teaching website, as case studies of innovative teaching and learning, and others which are featured in the following section, Technology in Science Teaching and Learning.
Other opportunities

University wide, there are opportunities for students to represent the university at events, summer schools and conferences, to participate in national and international leadership forums, to mentor students, to volunteer in a range of science and non-science areas, and to engage actively with clubs and societies. Within the faculty, students may become science ambassadors, science mentors, PASS leaders, tutors, or peer assistants. Students may attend research seminars outside their classroom lectures. These are all examples of informal learning activities which combine to support a high quality student experience.

6.5 Technology in science teaching and learning.

The University of Queensland has directed significant attention to technology enhanced learning (TEL), including:

- UQ participation in the EdX consortium, which has resulted in eight Massive Open Online Courses (MOOCs) created since 2013.
- The University’s strategic plan, which outlines a vision for becoming national leaders in online learning.
- A requirement for all UQ courses to have an online presence in the designated eLearning Management System, Blackboard.
- From 2014, allocation of significant centralised funds to an institutional TEL scheme.

Consistent with the broader UQ TEL goals, the vision for the BSc has been to provide students with authentic, active learning opportunities and assessment tasks, in a way that is efficient and manageable for academic staff. These approaches to learning have both driven, and been driven by, innovations in the use of technology. A particular focus has been on shifting passive lectures to active learning experiences with technologies being key enablers of such changes.

However, we have been careful to remember that innovation and the increased use of technology are not goals for their own sakes. Sometimes in education, innovation can take on a life of its own, with “early technology adopters” being described as “champions”, and those who are slower to adopt new approaches viewed as “dragging the chain”. We have adopted the approach that excellence in teaching and learning is the goal, and that technology and innovation can provide mechanisms to achieve excellence, provided they are applied in a reflective, informed manner.

Thus, rather than adopting a “one size fits all” approach, the Faculty of Science supports academic staff to take an imaginative, scholarly approach to innovation and the continued development and uptake of TEL as appropriate to different discipline areas, courses and student needs. We have adopted “active learning” and “flipped classroom” approaches in many large-enrolment BSc courses. There are numerous examples of technology enhanced online learning activities and assessment tasks in our courses, including eConferences, video assignments, new content created from collaborative wiki tools, online resources and activities, use of digital media, high-technology lecture content and online assessment.

In order to encourage and support ongoing teaching excellence, the faculty provides $500 K each year for projects in Teaching and Learning, and a substantial component of that money funds TEL developments. Since 2012, UQ and the faculty have funded employment of an e-Learning designer working full time on science TEL projects; since late 2013 this position has been fully funded by the faculty's strategic T&L money. In addition, schools and the faculty have funded a diverse range of TEL developments led by individual academics; see Figure 102 for the TEL projects that are relevant to BSc students since 2012. In addition to projects supported by internal UQ funding, many of the projects supported by the national OLT listed in Figure 99 include a substantial TEL component.
Students working in a UQ science laboratory, ca1958 (left) and in a modern UQ laboratory (right).

<table>
<thead>
<tr>
<th>2015: Leader, School, funding</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldizen, Biol Sciences, $12 K</td>
<td>Incorporating higher technology (camera traps) quantitative data analysis into student field work</td>
</tr>
<tr>
<td>Johnston, Biol Sciences, $20 K</td>
<td>Development of eLearning material to enhance first year biology student experience through small group teaching</td>
</tr>
<tr>
<td>Ward, Biol Sciences, $10 K</td>
<td>Ocean acidification system for enhancing student research experience</td>
</tr>
<tr>
<td>Welsh, Earth Sciences, $40 K</td>
<td>Integrating process &amp; structure measurements - Active applications of gigapixel images for teaching earth/ecosystem sciences</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2014</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Riginos, Biol Sciences, $6 K</td>
<td>Blended learning in first year biology with future options for open course structure</td>
</tr>
<tr>
<td>Welsh, Earth Sciences, $7 K</td>
<td>Developing “virtual field sites” to enhance real world field teaching in Geosciences</td>
</tr>
<tr>
<td>Mortlock, Ag. &amp; Food Sc, $12 K</td>
<td>New Resources for the Visualisation of Biometry</td>
</tr>
<tr>
<td>Fraser, Chemistry &amp; Molecular Biosciences, $18 K</td>
<td>From Brewer to Brewmaster: Deepening Third Year Microbiology Integration with Chemistry and Bioinformatics</td>
</tr>
<tr>
<td>Robertson-Dean, Math &amp; Phys, $10K</td>
<td>Foundations in computer programming using Matlab in MATH1051 and MATH1052</td>
</tr>
<tr>
<td>Sharpe, Chem &amp; Mol Biosc, $60 K</td>
<td>Hands-on NMR for Chemistry Teaching Labs, Lectures and Workshops</td>
</tr>
<tr>
<td>Wang, Chem &amp; Mol Biosc, $12 K</td>
<td>Authentic large-scale assessment of practical lab competencies in Microbiology</td>
</tr>
<tr>
<td>Beatson, Chem &amp; Mol Biosc, $8 K</td>
<td>Dedicated High Performance Computing Resources for Bioinformatics Students</td>
</tr>
<tr>
<td>Pullar, GPEM, $18 K</td>
<td>Online Geospatial Course with Facilitated Learning</td>
</tr>
</tbody>
</table>
Figure 102. TEL projects supported by faculty and schools, 2012 – 2014.

In 2014, the University commenced a centrally funded Technology Enhanced Learning Grants scheme, and this scheme will continue to fund new projects into the future. The Faculty of Science has received more funding through this scheme than any other faculty. Figure 103 shows TEL grants supported by UQ central in 2014; the first four are led by members of the Faculty of Science, and two of the five named Chief Investigators on the last are based full or part time in the faculty.
A simplistic approach to future TEL developments, perhaps highlighted by the introduction of MOOCs, is to replace classes by online resources. In the more nuanced approach we take in the BSc teaching, TEL is integrated with in-class activities in a way that enhances the teaching and learning experience. This is consistent with the views of thought leaders in the NMC Horizon Report: 2015 Higher Education. Certain activities are better undertaken outside the classroom: reading slides or pages of a textbook does not represent good use of in-class time. However, this is not an argument that class contact times should be removed, or even reduced. In fact, UQ’s strategic priorities aspire to “develop and promote active learning pedagogies that encourage interactions between students and teachers, and among students”. The challenge for academic staff and students is to find the appropriate balance between direct contact in classes and TEL, in order to achieve excellence in teaching and learning predicated on positive, intellectually stimulating activities. Students in the UQ BSc appear to recognise this: incoming BSc students in 2013 were asked for their views on whether their courses should be offered as in-class only, or as online only. Figure 104 summarises their responses; students clearly prefer a blend of in-class and TEL.

In addition, there is evidence that student attendance at face-to-face classes is correlated with better academic performance. (Note that correlation by no means implies causation.) Figure 105 presents information on class attendance and final percentage marks for students who completed the introductory physics course PHYS1171 taught in Semester 2, 2012. The line of best fit shows that, on average, students’ marks and number of lectures attended are positively correlated, with an increase of around 0.85% for each lecture attended. Figure 106 presents similar information for STAT1201 in Semester 2, 2014. Rather than plotting marks against number of lectures attended, marks are plotted against number of clicker questions answered during lectures. Thus, these data measure performance versus active engagement in
lecture activities, rather than passive attendance. Once again, there is a strong positive correlation between engagement and performance as measured by marks.

![Graph](image1)

Figure 105. Final marks versus lecture attendance in PHYS1171, 2012.

![Graph](image2)

Figure 106. Exam marks versus number of clicker questions answered in STAT1201, 2014.

There are numerous examples of blended learning in BSc courses, including the following.

- The content and learning experiences of a MOOC have been incorporated in the 3rd year course, BIOL3023 (Tropical Marine Ecosystems). The MOOC (“Tropical Coastal Ecosystems”) was first offered in 2014 by EdX and run by UQ. During the first six weeks of BIOL3023, the students received online content through the MOOC, supplemented by weekly tutorials; this flipped classroom approach enabled in-class teaching time to be used for more in-depth discussion. These first six weeks were followed by two weeks of project work, either in the field at Heron Island or using online materials again prepared for the MOOC, and the final weeks included more detailed face-to-face lectures expanding on the previous material.
• Two entomology courses have been designed around flexible delivery with an aim to allow students at UQ to learn online but also for students from anywhere in Australia to take the courses. The resource materials are delivered as eBooks. They include recorded voice-over-Powerpoint lectures and videos. Assessment tasks are designed to be completed at home or online. Surveys have shown that students appreciate the flexibility in study time and the portability and accessibility of the resource materials.

• The website “MyScope” is an open-access set of modules, funded as “A National Approach to Education in Advanced Microscopic Characterisation through Integrated Learning Tools” through the OLT. It was developed across 6 tertiary institutions led by UQ (B. Cribb), and supported by a national body (Australian Microscopy & Microanalysis Research Facility). Its use has extended internationally and stands at an average of around 13000 sessions and 9000 users per month. The site has been structured to allow tailoring by academics, specific to their needs in class, and to enable use as a personal learning tool. Further development is being explored through funded industry linkages. The resource has also provided the opportunity to explore student attitudes to online environments and effectiveness for achieving enhanced educational outcomes.

• CHEM1200 is a gateway into second level courses for many study programs. To improve student access to learning activities and improve curricular progressions, the course is being reformulated to embed TEL activities. Their design is based on three pedagogical strategies: (i) the delivery of interactive, self-contained, online learning modules which will complement or substitute for existing lecture activities; (ii) the weaving of these modules into a new, hybrid, blended learning Summer semester offering of CHEM1200; and (iii) the introduction of virtual peer-assisted study sessions (iPASS) for all first-year CHEM courses so that students can opt into online tutorial help instead of the current on-campus delivery.

• BIOL1020 – Genes, Cells & Evolution – is a core first year biology course for majors in the biological and biomedical sciences. The centrepiece of BIOL1020’s online learning is a weekly one hour learning sequence hosted on edX; these weekly activities include videos, images, text, and java script simulations interspersed with formative questions (multiple choice, number input, drag and drop). Each weekly segment was designed by contributing lecturers to address core and/or conceptually difficult topics and to complement on-campus learning activities. In addition, students read from an online textbook with built in interactive questions and self-test modes and optionally participate in a lively discussion board (~20+ student questions and responses per day) that is moderated daily by contributing lecturers. In a typical week a BIOL1020 student would also attend a three hour laboratory practical, a one hour tutorial, and two lectures on campus.

• In STAT1201, “The Island” is a revolutionary approach to engaging students with authentic experiences in study design, data collection and management, statistical reasoning and communication skills. It consists of an online virtual population of 16,000 unique individuals who can be recruited for the purpose of conducting a wide range of scientific and statistical studies including surveys, observational studies, case-control studies and experiments. The existing Island was developed by Michael Bulmer (SMP) and launched in 2009. It has been used by over 12,000 students in a range of courses at UQ, Royal Melbourne Institute of Technology, Curtin University and the University of the Sunshine Coast, as well as at various institutions overseas such as the University of Minnesota, University of California Los Angeles, University of Nebraska-Lincoln, University of Louisiana, University of Florida and the US Air Force Academy. Students have so far set a total of 1.6 million experimental tasks for the Islanders to carry out.

The blended learning approach within the BSc will revolve around enabling personalised learning through the use of learning analytics. **Personalised learning** gives individual students access to information to guide their decision-making, develop their mastery of knowledge and skills, and build their confidence. **Learning analytics** is the use of intelligent data, learner-produced data and analysis models to discover information and social connections, and to predict and advise on learning.

**Personalised learning** informed by student and academic data provides an opportunity to address several
known challenges in the BSc, including:

- Very large class sizes inhibiting optimal student-academic interactions
- First year BSc program attrition rates
- Student dissatisfaction with provision of, and academic disillusionment in providing, feedback for learning
- Students with little sense of how they are performing in relation to class mates and how they are likely to perform in end of semester assessments
- Proliferation of online content and learning resources with insufficient guidance to students on how to tailor their use of such materials to engender deep learning.

Personalised learning can and should commence at the time students enter university, and continue throughout their studies. Diagnostic testing is a common approach to gauge the skills and knowledge of incoming students as a means to guide academic planning within units of study. In the BSc, a project is currently developing and exploring an innovative software tool, Get Set, which has been piloted in Semester 1 2015 and is intended to continue in future years. The purpose is to assist students by identifying any gaps in the knowledge and skills expected in first year BSc courses, and then help students to rectify any identified problems. The project has involved first year BSc course coordinators identifying core prerequisite knowledge and skills, along with relevant key resources. This information has been distilled into questions which ‘test’ new students (in 2015, the questions focus on core quantitative skills). All new BSc students are encouraged strongly to use the online system, which gives immediate feedback on their performance along with personalised resources to guide their revisions.

The University is hoping to use information from its participation in the EdX consortium to enhance the broader experience for students enrolled in mainstream courses. Coordinators of courses in the BSc are eager to participate in this transfer of approaches from MOOCs to courses taught with a blend of in-class contact and online resources. Any model for providing individualised educational interventions will be built around approaches that gather data that informs the type of individual feedback and support required, and then gives each student guidance by delivering individualised feedback in a way that clearly guides their learning and decision making.

Such approaches typically draw on student data (including demographic, surveys, learning in the course) compared to predictive models based on large scale student databases. By collecting information from students who perform “better or worse than expected”, it is possible to catalogue strategies, resources and advice that become part of personalised feedback to guide other students. By drawing together data from academic staff and students, personalised feedback allows each student to check their “learning trajectory”, to assess their current performance relevant to predictive models and then identify strategies and resources to do “better than expected” in their studies. This model for personalised learning informed by analytics is achievable in the sciences (for example, see Better than Expected: Using learning analytics to promote student success in gateway science\(^{23}\), although scalability and effectiveness of such systems are viewed as more difficult challenges facing higher education (NMC Horizon Report: 2015 Higher Education\(^{24}\)).

**Suggestion**

That teaching in the BSc be further strengthened by the increased use of blended learning, with learning analytics supporting the enhancement of personalised learning.

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\(^{23}\) [http://www.changemag.org/Archives/Back%20Issues/2014/January-February%202014/better_abstract.html](http://www.changemag.org/Archives/Back%20Issues/2014/January-February%202014/better_abstract.html)

6.6 Teaching approaches

Teaching is inextricably linked to how learning happens, and has to be a future focus for the BSc if we are serious about enhancing students’ learning. The review process is more than what we teach, or how it is “delivered” through a degree program structure, and even more than our goals as per the GLOs. How we teach is of fundamental importance. It is the teaching and assessment practices of academics that have the strongest impact on student learning.

Gauging teaching quality is a complicated task, and what quality teaching looks like varies by discipline. There are many teaching activities and approaches that have been shown to aid student learning. These include: contextualising subject matter, incorporating practical and fieldwork into learning activities, encouraging students to ask questions and reflect on their learning, incorporating high quality assessment, structuring classes so that students write rather than passively listen, pedagogical training for teaching staff, having appropriate academic expectations of students and ensuring that the teaching team has a high level of content knowledge. This list is by no means exhaustive.

Last year, scientists and educators at the Carl Wieman Science Education Initiative published the Teaching Practices Inventory, which measures a selection of evidence-based teaching practices in university science and mathematics that have been demonstrated via research to positively impact on students’ learning (Wieman & Gilbert, 2014). The Teaching Practices Inventory lists teaching and assessment approaches across eight categories.

I. Course information provided (including learning goals or outcomes)
II. Supporting materials provided
III. In-class features and activities
IV. Assignments
V. Feedback and testing
VI. Other (diagnostics, pre–post testing, new methods with measures, etc.)
VII. Training and guidance of tutors (“TAs”)
VIII. Collaboration or sharing in teaching

Using this instrument and supported by a Faculty of Science central Teaching and Learning Unit Fellowship scheme, we measured the extent to which these evidence based teaching practices are used in the UQ BSc. The intention was to contribute hard-to-get baseline data on the practices being used across all science based courses that comprise the BSc. More than knowing the results, the goal is to identify implications and focus future professional learning resources accordingly.

Methods

The Teaching Practices Inventory (Wieman & Gilbert 2014) is a brief questionnaire that asks the main lecturer for each course to report on evidence-based teaching methods being used in that course. It is based on a selection of high impact teaching methods from the research literature. Survey details are available on request. Figure 107 shows how the methods from two categories are linked to the literature.

The *Teaching Practices Inventory* provides an overall score (0 = lowest; 67 = highest), but more importantly, scores for each of eight different approach categories. Note: *Abbreviated descriptions of the list of inventory items that receive points on the rubric sorted according to general factors that support learning and teacher effectiveness, along with references on their impact* (Wieman & Gilbert 2014).

<table>
<thead>
<tr>
<th>Factor</th>
<th>Teaching Practice that supports</th>
<th>References on benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice</td>
<td>II. Practice problems or previous years’ exams + feedback for all items below</td>
<td>Chapter 5 in Ambrose et al. (2010); Promising Practice No. 6: Designing In-class Activities to Actively Engage Students in Froyd (2008); Freeman et al. (2014); Ericsson (2006)</td>
</tr>
<tr>
<td></td>
<td>III. Number of small-group discussions or problem solving</td>
<td>1Crouch et al. (2004); Sokoloff and Thornton (1997, 2004)</td>
</tr>
<tr>
<td></td>
<td>III. Demonstrations in which students first predict behavior</td>
<td>2Walberg et al. (1985); Cooper et al. (2006). The reviews by Walberg et al. (1985) and Cooper et al. (2006) are of the extensive K–12 research literature on the beneficial effects of graded homework. Numerous research articles report the educational benefits in undergraduate math and science. Two examples are Cheng et al. (2004) and Richards-Babb et al. (2011). 3Kuh (2008)</td>
</tr>
<tr>
<td></td>
<td>III. Student presentations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III. Fraction of class time [not] lecturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III. Number of PRS questions posed followed by student–student discussion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. Problem sets/homework assigned and contributing to course grade (+ knowledge organization + motivation)</td>
<td>Black and Wiliam (1998); Hattie and Timperley (2007); Promising Practice No. 5: Providing Students Feedback through Systematic Formative Assessment in Froyd (2008); Chapter 5 in Ambrose et al. (2010); Gibbs and Simpson (2005)</td>
</tr>
<tr>
<td></td>
<td>IV. Paper or project (involving some degree of student control)</td>
<td>1Atkinson et al. (2000)</td>
</tr>
<tr>
<td>V. Fraction of exam mark from questions that require reasoning explanation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback</td>
<td>II. Student wikis or discussion board with significant contribution from instructor/TA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II. Solutions to homework assignments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III. Number of times pause to ask for questions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. Assignments with feedback and opportunity to redo work (+ metacognition)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. Students see marked assignments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. Students see assignment answer key and/or marking rubric</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. Students see marked midterm exams</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. Students see midterm answer keys</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V. Number of midterm exams</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V. Breakdown of course mark</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 107. Literature supporting selected teaching practices.*
CHAPTER 6: LEARNING, TEACHING AND THE STUDENT EXPERIENCE

UBC and UQ samples

Wieman and Gilbert (2014) published results of their survey for five departments in the Faculty of Science at the University of British Columbia (UBC) in Canada. This is a good comparison institution for UQ as it is also a large, publicly funded, research-intensive university. Their sample also contains large introductory courses with 250-1000 students.

At UQ, we surveyed coordinators of 136 courses contributing to the BSc in Semester 1, 2015, with a response rate of 95% (n=129). Wieman and Gilbert did note a possible bias in their data if the staff that responded may not be representative of their whole department. Some of the UBC departments had completion rates as low as 50%. Such bias in the UQ data is likely to be small given our high (93%) overall completion rate, with all departments more than 70% complete; see Figure 110. We have tried to minimise the effect of bias in the UBC sample by limiting any comparisons to their three departments with completion rates greater than 70% (n=93 courses).

The use of evidence-based practices in the UQ BSc

We compare the total scores for the UQ courses to the Wieman & Gilbert sample in Figure 108. The graph shows the percentage of UQ (n = 127) and UBC (n=93) courses falling into the score ranges displayed on the x-axis. Note that the maximum score is 67.

The mean UQ score (30.1±0.7) is lower than that of UBC (32.4±0.7) but the difference is not statistically significant. UQ has fewer courses that score very highly, however 42% of UQ courses score greater than the UBC mean, so it is not just a case of a few ‘champions’ adopting these techniques at UQ.

Categories in which UQ differs from UBC

We used the eight subcategories of the Wieman & Gilbert survey to identify which aspects of UQ teaching differed from the practice at UBC. The UQ results for each category are detailed in Appendix 7.

UQ was noticeably stronger than the comparison sample in Category I. Course information. (UQ=5.0 out of 6, UBC=4.0, different at p<0.001). This focuses on items such as “list of topic-specific competencies” and “list of topics to be covered”. We believe our strong scoring in this area is due to the mandatory course profile documents that must contain this information.
UQ was weaker in Category III: In-class features and activities (UQ=5.4 out of 15, UBC=6.8, different at \( p<0.003 \)). This focuses on items such as:

- Small group discussions
- Pre-reading with tests before lectures
- Less than 60% of class spent in didactic lecturing
- Questions followed by student-student discussions.

These specific interventions are being used by a small number of UQ science courses (20-30%) and would have a strong impact if more generally adopted. This conclusion is strengthened by a recent survey of 5000 UQ students (Tregloan et al., 2015)\(^{26}\). They found that, on average, the science students (N=716) wish to increase interactive class time by 10 per cent (from the current level they report as 50%).

UQ was also weaker in Category V: Feedback and testing, (UQ=5.1 out of 13, UBC=7.2, different at \( p<0.005 \)) which focuses on:

- Formal feedback from students to staff during semester
- Assignments with feedback on drafts
- Students see marked work (various options)
- Having mid-term exam(s)
- Requiring explanations in exams

Some of the feedback activities are only being used in 15% to 30% of UQ science courses. Feedback is known to score lowly in student evaluations at UQ and other Australian universities, so these data point to specific areas for improvement.

**Differences within the BSc**

When comparing UQ results to the published sample we noted that some UQ courses appear to have larger enrolments than those in the sample, so we asked whether UQ’s poorer scores on feedback might be related to class size. We subdivided the UQ data by enrolment to see if this affected the results. Contrary to expectation, the overall score for the large classes (enrolment>200) was significantly higher than for small courses (32.2 compared to 29.0; \( p=0.021 \)).

We then split the sample by year level. Levels 2 and 3 were not significantly different so we combined them and compared the combination with courses offered at Level 1. The 30 Level 1 courses scored significantly higher than the 97 upper-year courses (33.0 compared to 29.2; \( p=0.014 \)). These distributions of the total scores are compared in Figure 109. The results for the specific category of feedback also showed a significantly higher score for the Level 1 classes (5.9 compared to 4.9; \( p=0.015 \)). These results suggest that lower UQ scores for assessment (compared to UBC) are not a result of our large class sizes. Indeed, our larger classes report better feedback scores according to the Teaching Practice Inventory. This may be related to strong efforts to improve the “first year experience” in UQ science in recent years.

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We had a very strong response to the survey with an overall completion rate of 95%. There was relatively minor variation in the completion rates or scores between the eight schools that make substantial contributions to teaching in the BSc, as shown in Figure 110.

<table>
<thead>
<tr>
<th>School</th>
<th>Courses</th>
<th>Done</th>
<th>Completion Rate</th>
<th>Mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture Food Sciences</td>
<td>18</td>
<td>15</td>
<td>83%</td>
<td>32</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>12</td>
<td>12</td>
<td>100%</td>
<td>34</td>
</tr>
<tr>
<td>Biomedical Sciences</td>
<td>11</td>
<td>10</td>
<td>91%</td>
<td>34</td>
</tr>
<tr>
<td>Chemistry &amp; Molec Biosciences</td>
<td>18</td>
<td>18</td>
<td>100%</td>
<td>27</td>
</tr>
<tr>
<td>Earth Sciences</td>
<td>10</td>
<td>9</td>
<td>90%</td>
<td>30</td>
</tr>
<tr>
<td>Geography, Planning &amp; Envin Mgt</td>
<td>13</td>
<td>12</td>
<td>92%</td>
<td>28</td>
</tr>
<tr>
<td>Mathematics &amp; Physics</td>
<td>29</td>
<td>28</td>
<td>97%</td>
<td>30</td>
</tr>
<tr>
<td>Psychology</td>
<td>17</td>
<td>17</td>
<td>100%</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>136</td>
<td>129</td>
<td>95%</td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Figure 110. TPI survey results by school. *Includes five additional schools with very small (1-4) numbers of courses.

The evidence based teaching practices measured by the Teaching Practices Inventory are used in a wide range of UQ courses, but we have fewer courses with high levels of these evidence-based approaches than the UBC sample. UQ BSc courses provide better course information but do not score as highly as UBC in the areas of in-class activity and feedback. Within UQ, our first year courses score higher than the later year courses.

Naturally, our response to these comparisons should not simply be to try and emulate the UBC scores: not only will there be statistical variations between institutions, but also the UBC context will be different. However, in the two specific areas in which UQ has a lower score, we have independent data from our students showing that they also desire improvements. The high impact teaching practices in these two
categories are only used in 20-30% of UQ BSc courses, so we should aim to improve these on a faculty-wide basis. The Science Curriculum Group should lead a professional development strategy focused on in-class activities and feedback (including assessment) across the BSc teaching staff. This would be implemented in partnership with ITaLI. The survey discussed here should be repeated in two years’ time as evidence of the effectiveness of the professional development strategy and to inform ongoing professional development efforts.

**Suggestions**

That teaching in the BSc be further strengthened by:

- increasing interactive teaching and improving feedback to students.
- encouraging sharing of current examples of best practice in teaching.

### 6.7 Assessment

Asserting that our students graduate from the BSc with defined GLOs (at both the major and program level), raises the question of how confident we are in stating that individual students have attained the identified Learning Outcomes. The key to answering this question lies in the selection, design and operation of appropriate and rigorous assessment. In addition to its importance in asserting achievement of GLOs, assessment is a key driver of student learning.

Good assessment in the context of large enrolment university courses is notoriously difficult to do well. Striving to improve assessment practices is one of the most important activities undertaken by course teaching teams and administering schools. The challenges of designing and implementing excellent assessment are compounded by the changing educational environment in which we must operate. Differences in student academic backgrounds and learning styles, and fulfilling UQ and national teaching priorities, all have an impact on assessment practices. In particular, moves towards sector-wide defensible academic standards are likely to impact significantly on our activities.

UQ BSc assessment adheres to the principles that underpin current UQ assessment policies:

- a) assessment adds to student learning
- b) assessment will be criterion referenced
- c) students should receive regular, reliable, helpful feedback throughout semester.

In addition, the faculty has adopted the following principles:

- d) assessment must reliably identify an individual’s level of achievement against appropriate standards
- e) the quantity of assessment should be the minimum required to be effective.

The university mandates that at least 30% of assessment must be progressive, that is, it should take the form of mid semester exams, quizzes, laboratory reports, assignments, tutorial marks, field work and so on. The vast majority of science courses also involve a comprehensive final examination, worth up to 70% although often weighted lower than this, particularly in first year.

The ongoing focus on assessment in the Faculty of Science includes considering the volume and types of
assessment at the course level, and also how this builds across year levels and courses, giving a coordinated and appropriate approach to delivering the desired outcomes.

**Integrity of assessment**

The complexity associated with good assessment practices is compounded further by issues such as plagiarism, “ghost writing” companies, excessive collaboration and group work. While preparing this faculty submission, the NSW Independent Commission Against Corruption (ICAC) issued a report *Learning the hard way: managing corruption risks associated with international students at universities in NSW*. It is very likely that similar issues are occurring in universities in Queensland. On Page 4, the report states:

“It is hardly surprising that problems are emerging. There is pressure for some international students to pass courses that are beyond their academic capabilities, pressure on staff within universities in NSW to find ways to pass students in order to preserve budgets, and pressure created by an increasingly competitive market that makes recruitment targets difficult to meet.

There is a widespread public perception that academic standards are lowered to accommodate a cohort of students who struggle to pass. Controversy around cheating features largely in the media and other sources. False entry qualifications, cheating on English-language proficiency tests, cheating in university exams and paying others to sit exams are reportedly common.”

There is no single, easy solution to the issues identified in the ICAC report. However, the faculty regards the validity and integrity of assessment as being of fundamental importance to our activities. Staff are encouraged to identify and pursue cases of suspected plagiarism, assignments are routinely subjected to plagiarism checks, and student identity cards are checked in examinations. In addition, in 2011 the faculty introduced the requirement for individualised, identity verified assessment (IVA) in all courses, with “hurdles” that require each student to perform at specified levels in order to receive particular grades. The minimum requirement across the faculty is that students must obtain at least 40% of the marks on identity verified assessment tasks.

IVA can take the form of exams (in which identity cards are checked), oral presentations, practical work and field work. These standards are intended to address a range of issues, including concerns over plagiarism, difficulties with identifying individual contributions to submitted work, students passing courses while failing to demonstrate that they have met key learning outcomes and students scoring well on intra semester assessment then scoring badly on final exams, but still passing the course. With the performance hurdles, irrespective of how well a student may perform on other assessment items, they need to perform to specified levels of achievement on the individualised IVA to pass the course. In many cases, courses have adopted standards and assessment approaches that are significantly more rigorous and higher quality than the minimum standards outlined above.

**Assessment at the course level**

Another risk with assessment arises from the well-known principle that assessment drives learning, which may lead to an erroneous assumption that more assessment will drive more learning. Teaching staff want students to learn and achieve good academic outcomes, so assessment can be used to help students focus their effort and time on important learning activities. Particularly as students transition into university in their first year, there is the need to provide opportunities and incentives for students to engage in behaviour which assists their learning. In many cases, this results in assessment marks being allocated to a wide range of activities and items, as a way to engage students’ educational attention. Such assessment tasks may be worth only a small percentage of the overall grade, but can combine to produce an over-crowded
CHAPTER 6: LEARNING, TEACHING AND THE STUDENT EXPERIENCE

assessment regime.

Of course, assessment items may be high quality and deliver excellent outcomes. However, research highlights numerous risks associated with an uncoordinated, over-assessed curriculum.

For academics teaching in such environments:

- giving feedback becomes difficult because of the quantity of assessment
- managing administration of assessment becomes time consuming
- marking, and managing others to mark consistently, becomes burdensome
- students increasingly focus on “what is worth marks” with seemingly little interest in learning or thinking
- linking or coordinating the “level and fit” of assessment with broader degree program goals becomes unmanageable

For students learning in such environments:

- feedback may appear, or indeed become, inadequate and impersonal
- the time required to complete all assessment requirements thoroughly leads to a strategic focus on ‘getting a grade/getting it done’ and moving to the next assessment piece
- having the time to think and apply learning from one course to another, or to the broader world, is limited
- understanding how all the different assessment requirements “connect” to broader learning goals is unlikely
- performance on progressive assessment tasks can lead to complacency if the assessment tasks are not representative of what they will encounter in the final exam.

In recent years there has been evidence from both student feedback and from academics that some of the issues identified above are occurring within the faculty, including for students enrolled in the BSc. We have sought to address some of these assessment issues, and have held a number of workshops for course coordinators and teaching staff. Our future aim at the course level is to work towards the following:

- reducing the total amount and number of summative assessment items, so that activities are the minimum required to achieve the learning outcomes of the course.
- reducing the use of summative assessment to motivate student behavior, in particular the allocation of marks for student attendance
- providing more genuine and useful feedback to students on their performance through semester, through the use of formative assessment
- increasing the number of “hurdle requirements” to ensure that students meet all identified learning outcomes of a course, not just a subset of them
- reducing the use of group assessment in courses, and increase the amount of individualized, supervised assessment. (Note that group work and group assessment are not identical. It is possible to have group work without group assessment.)
Feedback on assessment

No discussion of assessment is complete without mentioning feedback. The nature and quality of feedback given to students is of paramount importance in developing effective student learning. The 2014 survey of BSc students that explored GLOs also invited comment on the “best” and “please improve” aspects of the BSc. Assessment and feedback were common themes mentioned in the “please improve” section. For example the following student comment relates to feedback:

“The learning cycle (learn, test, feedback) is definitely missing the feedback aspect. …The emphasis seems to be solely on examination performance but not improving performance in those examinations. How can you improve when you don’t have access to your shortcomings?”

Royce Sadler, an international assessment expert, asserts that high quality feedback is not simply about students learning best from what they have been told, but requires that students learn to recognize quality and features that contribute to or detract from a given piece of work. Only after they have acquired a sufficient basis of appropriate tacit knowledge can they understand the content and implications of a marker's feedback. At that point, feedback can be effective, as learners become more discerning, more intuitive, more analytical, and generally more able to create high quality work.

As with assessment, developing good mechanisms for quality feedback which is relevant and which aids student learning and helps students to identify the GLOs they are working towards is a complex and ongoing long term activity which relies heavily on the expertise and goodwill of academic staff.

Assessment at the program level

Improvements in individual course assessment practices do not directly examine assessment from a whole of program perspective to determine whether the vision for student attainment of GLOs is being met through coordinated assessment practices. This is essential in order to achieve the vertical and horizontal integration necessary to ensure that students are graduating with the desired outcomes. A focus at the course level also does not identify whether there is repetition and overlap between types of assessment in different courses. (For example, oral scientific communication skills need to be covered and assessed in some courses, but do not need to be assessed in all courses.)

Figure 111 shows the assessment profiles for 1st year BSc courses in 2013; there have been some changes since, but the broad structures are unchanged. There are many different types of assessment, with different weightings. All of these courses include a final exam, typically contributing around 50% to final grades. For the most common choice of four courses taken by students in their first semester of BSc enrolment, there were more than 50 summative assessment items in 2013. Many of these had a low mark value, but it is still an enormous load. This poses the obvious question: what is a suitable quantity of assessment for a student across a given semester?

Research evidence suggests that too much assessment is counter-productive to deep student learning, although the question of how much is too much remains unanswered. Once again, we would assert that assessment should be the minimum amount required to be effective, and we will continue to work with course coordinators to identify what the minimum is for all of the courses we teach.

When students were surveyed on their views about the level of assessment of various GLOs (SSSI, 2014, n=893), their responses indicated substantial variation in the volume of assessment, depending on which GLO was being assessed, and in which discipline. In an open ended question about what areas of the BSc needed improvement, over 25% of students identified an aspect of assessment, including feedback.

exams, amount, group assessment tasks, purpose, timing and rules.

**Typical comments (best aspects)**

The concept of multiple assessments throughout the course is good encouragement of active learning. (Yr1, BioMed)

Clear idea of assessment requirements for courses (Yr3, BioMed)

**Typical comments (aspects to be improved)**

A higher degree of assessment should be based on critical thinking and analysing results to come to scientific conclusions rather than memorisation of facts. (Yr3, Biochem & Molecular Biol)

Perhaps also less emphasis in general on final exams, and spreading the percentage value of the course out more evenly (with the system as it is now, it's entirely possible to cruise for the semester, cram in the final week and still get a 6-7). (Yr3, MarineSc)

There is too much assessment. I would prefer to do one mid-semester and a final or one assignment and a final. Weekly quizzes and practical exams are just too much when I have 1000 other things to fit in. (Yr5, Genetics)

More consistency with what is expected for prac reports, formal scientific writing etc. between different courses. (Yr1, Unsure)
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<table>
<thead>
<tr>
<th>Course</th>
<th>Mid sem Exam</th>
<th>Project</th>
<th>Tutorial Exercises</th>
<th>Essay</th>
<th>Review Article</th>
<th>Research Participation</th>
<th>Final Exam</th>
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<td>5%</td>
<td>6x1%</td>
<td>50%</td>
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<td>50%</td>
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<td></td>
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<td>50%</td>
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<td>10%</td>
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<td>10%</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td>GEOM1000</td>
<td>In class quizzes (2x7.5%) = 15%</td>
<td>20%</td>
<td>15%</td>
<td>10%</td>
<td>45%</td>
<td></td>
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</table>

**Figure 111.** Assessment profile of first year BSc courses, 2013. (“P/F” means Pass/Fail item, “GM” means use of a “grading matrix” rather than a % mark.)
Very few students linked assessment to learning or the attainment of broader skills and GLOs, such as critical thinking and communication. Making these connections more explicit to students is an important objective in increasing student awareness of the skills and knowledge they are gaining as part of their degree. Given the significance placed on asserting GLOs and the role of assessment in such assertions, it would seem essential that we have an assessment framework in place for the BSc. Some key questions we need to answer include:

1) Are all discipline areas expected to assess each GLO equally?

2) Are all courses expected to assess all GLOs? If not, how do we decide which assessment task is suitable for a particular GLO, and where and how assessment tasks should be delivered?

3) Related to 2), should there be a limit to certain types of assessment such as posters, videos, presentations and group work, across the degree?

At present, there is no assessment framework and (at best) limited coordination for patterns of assessment across the BSc. Rationalising the number and variety of tasks so that we have clear guidelines for the type of tasks required to assess a particular GLO and how often any one task should be repeated for the majority of students across their program and across disciplines, would be an important step in being able to assert attainment of GLOs. Thus, understanding patterns of assessment must be a future focus for the UQ BSc. Recent research from David Boud and colleagues indicates that assessment should be appropriately coordinated across degree programs if the aim is to graduate students with some sense of their own learning outcomes. He asserts the following:

1. Type of assessment matters. Students were more aware of learning when they completed similar types of assessment in different units of study across their degree program.

2. Coherence of assessment criteria matters. Students were more aware of learning when they had consistent marking guidelines (commonly called criteria and standards) across courses for similar types of assessment.

For example, students will understand what a quality written scientific report looks like if they are assessed on writing scientific reports across several courses. This learning will occur more quickly when common standards for scientific report writing are used across courses.

**Assessment at the institutional level**

In line with current international practice, UQ uses criterion referenced assessment, in which grades are awarded to students that reflect the level of performance they have achieved relative to pre-defined criteria, rather than determining the grade relative to the performance of others, or to a pre-determined distribution of grades. However, this in turn poses an obvious question: how are the assessment criteria determined, and what consistency is there in “academic standards” between courses or between discipline areas? Ideally, there would be rigorous procedures of assessment and grading moderation and comparison, within the institution and also in cross institutional benchmarking. In practice, this does not appear to be happening with any consistency. Some professional programs can partially address this through professional accreditation processes, although this is not the case for generalist degrees such as the BSc. Even where professional accreditation is possible, it is unclear how effectively accreditation can address assessment rigour and grading outcomes.

There is current discussion within UQ about comparative assessment standards and outcomes.

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A university wide analysis of grading outcomes shows strong variations between discipline areas. For example, some discipline areas have a consistently higher percentage of students receiving grades of 7 (high distinction) and 6 (distinction) than other areas. In one area, more than 80% of grades awarded are 7 or 6, whereas in another area only 17% of grades are 7 or 6. In many cases, it is not the discipline areas with very high academic entry standards in which students are achieving high grades.

When students are competing for scholarships, awards, and employment, all of which may span discipline areas and all of which rely in part on comparing students’ GPAs, there may be inequality in a system which suggests that there is a tendency in some discipline areas for students to be awarded higher grades, on average, than students in other discipline areas. The university needs to take steps to investigate, and if necessary address, possible variations between academic standards and grading outcomes across the institution. Importantly, any changes should not represent a move away from criterion referenced assessment, but should instead focus on ensuring that the chosen criteria represent more consistent levels of academic expectation.

Conclusions

In summary it is recognised that there is no “silver bullet” for resolving challenges and problems with assessment. Improving assessment (and feedback) is an ongoing long-term activity, relying heavily on the expertise, professionalism and good-will of teaching staff. However, we believe that the BSc would be enhanced through better coordination and alignment of assessment practices across the science degree program. Thus, a programmatic view of assessment should be central to the activities of the Science Curriculum Group. Innovative approaches to identify assessment patterns in degree programs, and to explore how they influence student learning, should be reviewed, with the goal of adopting “best practice” for use in the UQ BSc. For example, projects such as “Transforming the Experience of Students through Assessment (TESTA)” project funded by the United Kingdom Higher Education Academy are likely to be useful. In addition, the future focus on patterns of assessment in the BSc must be informed by local data. The current institutional approach for electronic course profiles does not readily allow BSc specific data to be extracted and used to inform ongoing activities around enhancing assessment coordination.

Suggestions

That assessment in the BSc be further strengthened by:

- coordinating and supporting ongoing improvements in assessment and feedback at the course level.
- coordinating assessment across year levels to optimise student learning of, and reduce academic duplication in, assessing graduate learning outcomes.

That institutional support for the BSc be further strengthened by:

- development of a coordinated approach to aggregating and reporting assessment data from electronic course profiles.
- introduction of a coordinated approach to improve consistency of assessment standards and grading outcomes.

6.8 Infrastructure

As the number of students enrolling in faculty programs increases, the pressure placed on existing space and infrastructure also increases. Faculty-occupied buildings at St Lucia and Gatton comprise some of the highest profile but oldest buildings on the two campuses. Many faculty controlled rooms are “informal”
learning areas, which includes designated rooms such as learning centres and also incidental spaces. Formal spaces are mostly centrally controlled rooms, but also include a substantial number of faculty controlled tutorial and laboratory rooms.

Since its establishment in 2009, the faculty has devoted considerable effort to upgrading aging learning and discovery infrastructure. University approval and funding processes have only permitted relatively small and incremental improvements to existing facilities. As an example, upgrade of the Chemistry Building at St Lucia commenced in the early 2000s, with the final stage only completed in 2014. The average age of science buildings is 44 years, with the newest completed in 1993. Most buildings have subsequently undergone partial refurbishment with faculty priorities determined according to the criteria outlined below. However, due to the extent and age of the faculty’s space holdings and the institutional approach to the incremental refurbishment of buildings, it has not been possible completely to refurbish one building before commencing another. As a result, the faculty’s buildings are a patchwork of high and low quality space. According to a UQ Properties and Facilities Building Condition Assessment report, the total rehabilitation cost for all Science buildings rated as three stars or lower (on a 6 star scale) is estimated to be in excess of $90 million.

The variable quality of the faculty’s space does not provide ideal learning spaces for students, nor an ideal student experience, and risks that students will choose study paths based on the quality of space rather than academic interest or their own performance. There are also issues for staff, as schools are forced to split their operations and staff across multiple buildings, reducing opportunities for intra-School collaboration.

The inefficiency generated when facility capacity fails to keep pace with the growth in demand is particularly evident when it comes to practical (laboratory) classes for large first year BSc courses. For example, each semester up to 2,000 students enrol in first year chemistry. It is best practice in Australia and abroad, (and a requirement for the accreditation of the BSc by the Royal Society of Chemistry and the Royal Australian Chemical Institute), for students to complete at least 10 three hour practical sessions (> 25 hours) per semester. It has been extensively demonstrated that this quantity of laboratory time is beneficial to student learning outcomes and underpins students’ later study and research. Achieving best practice in the first year of the BSc is not possible due to space restrictions. The first year chemistry teaching laboratory at UQ has a capacity of only 90 students at a time and so simple logistics dictate that students are restricted to fortnightly sessions and are unable to complete more than five laboratory classes per semester, despite classes running morning, afternoon and night (5.00 to 8.00pm). Similar restrictions exist in Biology and Physics. Significant investment is required to lift our teaching and learning programs to best practice.

Student feedback on learning spaces

In December 2014, surveys of UQ students and staff provided the first quantitative data on perceptions of how students use UQ spaces to study on campus. The student survey asked where students study, and how they study in both formal (that is, timetabled) and informal learning spaces. The key results are as follows:

- Students typically undertake two thirds of all their study on campus, and 40% of their on-campus study is in informal spaces.

- Many students are quite concerned about the quality and availability of informal study spaces.

- Students generally expressed a strong preference for less time with traditional (“listen and watch”) teaching modes in favour of more interactive modes.

There were 5054 responses to the student survey; of these, 930 were complete responses from students identifying Science as their faculty. We report the results for the Science students only. As shown in Figure 112 science students unsurprisingly report spending a relatively high fraction of time in laboratory spaces (16.3% compared to the UQ average of 10.5%).
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<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class rooms and lecture theatres</td>
<td>24.1%</td>
</tr>
<tr>
<td>Laboratories, specialised spaces or studios</td>
<td>16.3%</td>
</tr>
<tr>
<td>Library spaces</td>
<td>18.7%</td>
</tr>
<tr>
<td>Other informal study spaces on campus</td>
<td>9.0%</td>
</tr>
<tr>
<td>Studying off campus or at home</td>
<td>32.0%</td>
</tr>
</tbody>
</table>

**Figure 112.** Locations in which science students undertake study, 2014.

**Figure 113** presents results for how students currently spend their time in laboratories, classrooms, and lecture theatres. Science students report a higher fraction of time spent in passive learning modes (48.3%) compared to the UQ average (44.4%) and desire a slightly stronger shift away from this mode (-9.8% compared to the average of -8%). There is strong support for spaces designed for flexible teaching and learning, as evidenced by comments such as: “I personally prefer to work in groups, that are started off by watching and listening to the lecturer, so a design where it is both easy to work in groups and also ‘face the lecturer’ when they talk would be ideal”.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Current</th>
<th>Preferred</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Listening and watching</td>
<td>48.3%</td>
<td>38.5%</td>
<td>-9.8%</td>
</tr>
<tr>
<td>Working as individuals</td>
<td>17.6%</td>
<td>18.5%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Working on activities in pairs</td>
<td>10.6%</td>
<td>13.7%</td>
<td>3.1%</td>
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<tr>
<td>Working on activities in groups</td>
<td>15.5%</td>
<td>17.2%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Working as a whole class</td>
<td>7.1%</td>
<td>11.1%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Other activities</td>
<td>0.9%</td>
<td>1.0%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

**Figure 113.** Activities undertaken by science students in formal learning spaces, 2014.

Many students expressed strong views about the importance of on-campus informal study areas and how these can support or discourage effective study. The key factor was the availability of quiet (but not silent) spaces. They also mentioned the importance of being able to study close to fellow students in the same field, so as to be able to call on others for assistance. This last point shows the importance of faculty-level spaces, as these are the locations in which students know they will be near fellow students studying in the same field. The Science Learning Centre, which was developed in 2008 as an informal space for students, is a hub of student activity year round, but it can only accommodate at most 100 people, and is insufficient for the numbers of students who wish to use such a space. The Faculty of Science also operates a number of undergraduate computing laboratories, which are available for informal study outside booked class times. Unfortunately, due to heavy demand for timetabled classes, informal access by students is limited.

**New science precinct**

The faculty acknowledges that the number of building works that can be undertaken is limited by available resources. Particularly in the present climate, available resources need to be directed where they will have the greatest benefit for students, the faculty and the university. Included in the Faculty 2013 Strategic Plan is a commitment to direct resources to capital projects that:

- improve the overall quality of the teaching and learning environment across the faculty, and
provide strong support for excellent and world-leading research and research infrastructure. Accordingly, the faculty has developed four criteria to evaluate and prioritise proposed refurbishments to ensure resources are used effectively:

1. Compliance and safety.
2. Modernisation of teaching and research space.
3. Accommodating growth.
4. Efficiency of location.

Given the sub-standard quality of much of the 83,167 m² Usable Floor Area held by the Faculty of Science, it is not possible to document all of the capital refurbishments that are necessary in order to bring all faculty facilities to an acceptable standard. As part of the Faculty Capital Management Plan, projects have been identified as being strategically important to achieve faculty and university strategic goals. These projects are listed in the Faculty Capital Management Plan, which is available upon request.

The faculty has identified a strategically important project for new space, albeit with very significant cost and other implications. It is acknowledged that the project is unlikely to be viable until these issues have been resolved but it is included in this submission to highlight its long-term importance to the faculty. This proposal envisages the development of a new science precinct on the site occupied by the Seddon complex and Small Animal Hospital and Clinic at St Lucia. It could comprise two major academic and research buildings configured for science teaching and research and include a large auditorium, a science interactive centre, amenities (coffee shop, bike racks, car parking, etc) plus support services. Provision would be made for a third building to be incorporated into the development. Inter-disciplinary research and teaching would be the driver for populating these new facilities. The aim would be to support collaboration across the biosciences, geosciences, physical sciences and mathematical sciences to address major contemporary and future challenges (such as energy and sustainability in a changing environment). The faculty would engage with other units to discuss the benefits of co-location and work with interested parties in the design of the buildings.

The cost of the proposal is estimated at $250 M, much of which would need to be secured from various external sources. It would, however, provide purpose built science infrastructure and reduce the need to divert capital resources to upgrading existing faculty infrastructure. Moreover, it would unlock many other development opportunities across the campus by releasing space in key buildings for reallocation to other units. The proposal aligns with the faculty’s strategic plan by providing strong support for excellent and world-leading research and research infrastructure and improving the overall quality of the teaching and learning environment in the faculty. Significant funding needs to be allocated to revolutionising first year teaching spaces to bring them up to world-class standard, the results of which will be felt by students through the later years of study as they progress through their degrees. The faculty acknowledges additional central resources would be required to achieve this aim, and would probably require the construction of a dedicated teaching building.

**Suggestion**

That institutional support for the BSc be further strengthened by ensuring that construction and redevelopment of teaching spaces focus on enabling effective learning in both formal and informal learning spaces, prioritising the needs of large classes.
CHAPTER 7: CHANGES TO THE DEGREE

This concluding chapter outlines some proposed changes to the degree structure. These include prerequisite courses, compulsory courses, interdisciplinary courses, specialisations within the degree, capstone courses, honours, specialist degrees and the BAdvSc(Hons). This chapter includes suggestions to the review panel at the end of Section 7.1 [Page 125], Section 7.2 [Page 141], Section 7.3 [Page 143], Section 7.4 [Page 145], Section 7.5 [Page 149] and Section 7.6 [Page 152].

7.1 Prerequisite courses

Within the Faculty of Science there are many courses which list other courses as being prerequisites. Generally, completion of a prerequisite course is considered important for student success in the course(s) that requires the prerequisite. The assumption is that students learn information or skills which are then built upon in subsequent courses. Completion of the prerequisite course should have a positive impact on student performance in the course that requires the prerequisite.

The implication is that students are not permitted to enrol in the subsequent course without having previously passed the identified prerequisite(s). As some, but by no means all, students are aware, for about 15 years the university has not enforced completion of prerequisites. That is, students are free to enrol in any courses they choose, irrespective of whether or not they have previously enrolled in, or passed, any prerequisites. Students generally are not actively advised that prerequisites are effectively optional. However, any student who explicitly asks is usually advised to complete prerequisites, and that they take a significant risk if they attempt a course without the necessary background knowledge.

The lack of enforcement of prerequisites means that a significant number of students ignore the advice to complete prerequisites and proceed with advanced courses without having done the prerequisite(s). This results in difficulties for academics teaching the advanced courses and for the students attempting to catch up on the knowledge and/or skills they lack. There is also some concern about a duty of care to students: should they be allowed to enter a course without having completed a prerequisite when data suggest that a significant number will fail? This issue may become even more prominent in a deregulated market, with higher fees. A counter argument to this is that students can and should take responsibility for their own decisions. Provided the advice they receive is accurate, timely and clear, they can decide for themselves whether or not to follow the advice.

To help answer the question of whether or not prerequisites should be enforced, an analysis of a number of second and third year courses was undertaken. Figure 114 shows student failure rates in such courses, broken down by whether or not students had completed the recommended prerequisite course(s). The data show that the proportion of students attempting these courses without having completed the prerequisites ranges from 14% to 34%, with the average around 25%. There is a clear advantage to having completed the prerequisite, with lower failure rates amongst such students in all courses. Despite this, on average, 75% of the students who have not completed a prerequisite passed the follow-on course. In all cases, more than 50% of such students passed the course. In one case, almost 90% of such students passed the course.
There are various advantages and disadvantages that would accrue from enforcing prerequisites.

### Advantages

1. There would be greater certainty in knowing what students have done, which in turn affects the way a course is taught. Even if a student can pass a course without having completed a prerequisite, their understanding of the subject may be far greater having completed the prerequisite.

2. Pass rates would probably increase, and enforcing prerequisites might reduce a student's time at university, as it reduces the risk of failure and the necessity to repeat courses.

3. Lecturer workload may reduce, because many of the weaker, failing students would be denied entry to the follow-on course. Giving remedial help and feedback to struggling students who do not have the background knowledge and skills has been identified as a serious workload concern for academics.

### Disadvantages

1. The number of students eligible to take the follow-on courses would reduce, at least in the first

---

**Table:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Prerequisite</th>
<th># students</th>
<th># failed course</th>
<th>% of students who have not passed prerequisite</th>
<th>Of those who passed prerequisite, % who failed course</th>
<th>Of those who have not passed prerequisite, % who failed course</th>
<th>Of those who have not passed prerequisite, number who passed vs failed this course</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH2000</td>
<td>MATH1051</td>
<td>507</td>
<td>57</td>
<td>15.4</td>
<td>7.7</td>
<td>30.8</td>
<td>54 vs 24</td>
</tr>
<tr>
<td>MATH2000</td>
<td>MATH1052</td>
<td>503</td>
<td>55</td>
<td>13.7</td>
<td>9</td>
<td>23.2</td>
<td>53 vs 16</td>
</tr>
<tr>
<td>BIOL2200</td>
<td>BIOL1020</td>
<td>666</td>
<td>84</td>
<td>19.1</td>
<td>9.8</td>
<td>24.4</td>
<td>96 vs 31</td>
</tr>
<tr>
<td>BIOC2000</td>
<td>BIOL1020</td>
<td>629</td>
<td>103</td>
<td>32.4</td>
<td>11.8</td>
<td>26</td>
<td>151 vs 53</td>
</tr>
<tr>
<td>BIOC2000</td>
<td>CHEM1020, 1021, 1022</td>
<td>622</td>
<td>103</td>
<td>15.6</td>
<td>13.9</td>
<td>30.9</td>
<td>67 vs 30</td>
</tr>
<tr>
<td>BIOM3002</td>
<td>BIOL2200</td>
<td>104</td>
<td>9</td>
<td>17.3</td>
<td>5.8</td>
<td>22.2</td>
<td>14 vs 4</td>
</tr>
<tr>
<td>BIOM3002</td>
<td>BIOM2011</td>
<td>104</td>
<td>9</td>
<td>33.7</td>
<td>5.8</td>
<td>14.3</td>
<td>30 vs 5</td>
</tr>
<tr>
<td>BIOM2011</td>
<td>BIOL1020</td>
<td>385</td>
<td>60</td>
<td>19.2</td>
<td>10</td>
<td>39.2</td>
<td>45 vs 29</td>
</tr>
<tr>
<td>BIOM2011</td>
<td>BIOL1040</td>
<td>383</td>
<td>58</td>
<td>13.6</td>
<td>11.2</td>
<td>40.4</td>
<td>31 vs 21</td>
</tr>
<tr>
<td>MATH2010</td>
<td>MATH1052</td>
<td>197</td>
<td>38</td>
<td>17.3</td>
<td>18.4</td>
<td>23.5</td>
<td>26 vs 8</td>
</tr>
<tr>
<td>BIOL3003</td>
<td>MICR2000</td>
<td>140</td>
<td>29</td>
<td>27.9</td>
<td>17.8</td>
<td>28.2</td>
<td>28 vs 11</td>
</tr>
<tr>
<td>BIOL2010</td>
<td>BIOL1030</td>
<td>210</td>
<td>45</td>
<td>22.9</td>
<td>18.5</td>
<td>31.3</td>
<td>33 vs 15</td>
</tr>
<tr>
<td>MICR3002</td>
<td>MICR2000</td>
<td>128</td>
<td>10</td>
<td>21.1</td>
<td>6.9</td>
<td>11.1</td>
<td>24 vs 3</td>
</tr>
<tr>
<td>BIOL2006</td>
<td>STAT1201</td>
<td>161</td>
<td>22</td>
<td>23.6</td>
<td>11.4</td>
<td>21.1</td>
<td>30 vs 8</td>
</tr>
<tr>
<td>MICR3003</td>
<td>MICR2000</td>
<td>112</td>
<td>15</td>
<td>27.7</td>
<td>12.3</td>
<td>16.1</td>
<td>26 vs 5</td>
</tr>
<tr>
<td>NEUR3001</td>
<td>BIOM2011</td>
<td>110</td>
<td>25</td>
<td>33.6</td>
<td>21.9</td>
<td>24.3</td>
<td>28 vs 9</td>
</tr>
<tr>
<td>NEUR3001</td>
<td>BIOL2200</td>
<td>110</td>
<td>25</td>
<td>15.5</td>
<td>20.4</td>
<td>35.3</td>
<td>11 vs 6</td>
</tr>
</tbody>
</table>

**Figure 114:** Failure rates and prerequisites in second and third year courses, Semester 1, 2014.
instance. This could have ramifications for service teaching and income generated from those course enrolments.

2. If the Faculty of Science were to introduce such changes unilaterally, this would cause a substantial inconsistency within individual courses and the university more broadly. A number of our courses are required for completion of other programs outside the faculty. It is not clear how, or indeed whether, prerequisites could be enforced for such students. If this were at the discretion of the faculty managing the program in which the student is enrolled, then there would be a very difficult situation in which (say) BSc students were not permitted to enrol in a course because they had not passed a prerequisite, but a student enrolled in a different program who had completed the same course would be permitted to enrol.

3. Most students who have not passed a prerequisite course are currently passing the follow-on courses, as shown in the preceding table. It does not seem to be particularly useful or helpful to deny such students permission to enrol in such courses.

4. The faculty or university would need to develop a robust, workable mechanism for waiving prerequisites. This would be quite resource intensive, requiring: students to submit explicit requests for waiver; individuals at the discipline level to analyse student achievements and recommend waiver to the faculty (perhaps the course coordinator or T&L Chair); and an administrator within the faculty to add students to a permission list. It is possible that some hundreds of students could request such waivers each semester. Is the consequent effort justified?

Every Go8 university, apart from UQ, enforces prerequisites. QUT has recently changed and is now also enforcing prerequisites. Conversations with staff from these universities suggest that the administrative burden is not onerous, although interestingly, UMelb may be looking at moving away from enforcement as part of a general restructure. In general, students requesting waivers are assessed by academic coordinators and if approved, are manually enrolled in the course by administrators at the faculty level.

One approach would be to continue with non-compulsory prerequisites, but to inform students more clearly that their risk of failure is significantly heightened if they have not completed the prerequisites, and to place the responsibility for making the choice on the students. We might be able to define more clearly what we expect students to know and be able to do when they enter a particular course (e.g. diagnostic quiz). Armed with such information, students might be better placed to make informed decisions.

However students do not always make the correct choices. For example, a student wishing to graduate quickly may perceive the prerequisite as an unnecessary course he/she is being forced to undertake. It is necessary to balance the responsibilities placed on students with the responsibility the institution has towards them. Enforcing prerequisites would reduce the risk of failure for a significant number of students.

**Suggestion**

That academic quality within the BSc be further strengthened by enforcing course prerequisites across all UQ degree programs.
7.2 Structure of first year, core courses and interdisciplinary courses

The most recent BSc review made some significant changes to the structure of the degree program, particularly in first year. A statistics course was made compulsory, and the number of first year courses in each discipline area was reduced, so that each major can only require students to complete at most three first year courses in order to progress in that major in later years. This enables all students to leave open their options to complete any two majors after their first year. For example, a student who was undecided about studying biology or mathematics (or who might choose to study both) would typically complete three courses in biology or chemistry, three mathematics courses, the compulsory statistics course and one other course (often SCIE1000, discussed below).

There is no particular view that the UQ BSc should undergo radical changes to the structure of first year, or indeed to the degree more broadly. Demand is high, the quality of entering students is improving, and there are comparatively high levels of student satisfaction. However, this does not mean that there should be no changes. In particular, decisions need to be taken about the possible inclusion of additional compulsory course(s), and strengthening the cross disciplinary nature of the BSc, perhaps by the development and introduction of additional cross-disciplinary courses, designed to address contemporary issues with significant global impact, and be of general interest as well as to provide students with a broad range of generic skills and GLOs.

Compulsory courses

The BSc currently includes one compulsory course: all students must complete an introductory statistics course, most commonly STAT1201/STAT1301 (psychology and engineering students instead complete equivalent statistics courses in their own discipline areas). Discussion of compulsory courses formed a significant component of the most recent BSc review. The following is an extract from the review recommendations:

The submission to the review outlined a proposal to introduce two new compulsory courses, the “Foundations of Science”, and the “Analysis of Scientific Data and Experiments” into the new BSc program to provide an introduction to the principles of science and scientific inquiry through the extensive use of interdisciplinary examples. The Review Committee commends the faculties for their work in the development of these courses and enthusiastically supports their introduction. The Committee notes that it is critical that these courses be taught with aplomb, creativity, excitement, and relevance. They must be taught by genuinely interdisciplinary teams of accomplished teachers and established researchers who work together to plan and review the course material and teaching strategies. Experienced teachers from amongst the staff of the research institutes could make important contributions to these foundation courses.

Recommendation 5: That all BSc students will be required to take two new courses, “Foundations of Science”, and “Analysis of Scientific Data and Experiments”, which will be developed and delivered by accomplished teachers working in interdisciplinary teams.

Essentially, both the faculty and the review panel took the view that there is a range of core skills and content that should be taken by all students. This included: statistics, ethics, computer programming, mathematical modelling and quantitative skills, and philosophy of science. The statistics and ethics were made compulsory in STAT1201, and the remaining aspects were placed into the course SCIE1000, which was designated highly recommended rather than compulsory.

We have undertaken extensive discussion amongst academic staff and students about which, and how many, courses should be compulsory into the future. Two principles that underpin the decision are that a course should only be made compulsory if:

- it develops skills or knowledge required by all students
• the benefits of making the course compulsory outweigh the costs (for example, in terms of reduced flexibility in student choice).

Specific questions to consider in the context of the BSc include:

• whether STAT1201 is functioning effectively in terms of content and teaching, and whether it should continue to be compulsory (perhaps with some changes);
• whether SCIE1000 is functioning effectively in terms of content and teaching, and whether it should become compulsory or continue to be highly recommended (again, perhaps with some changes);
• whether there should be more substantial changes to STAT1201 and SCIE1000, perhaps with blurring of content between them if both become compulsory, or perhaps extracting the most important components of each in order to form a new compulsory course;
• whether one or more compulsory courses should be designed, from new, which may be better suited to our objectives than either STAT1201 or SCIE1000.

To inform the discussions, extensive information about content, student performance and student feedback in the two current courses is given in the following sections.

STAT1201: “Analysis of Scientific Data and Experiments”.

The learning objectives for STAT1201 are that students who complete the course will be able to:

1. Explain the nature of scientific data and the need for statistical analysis.
2. Identify factors related to the design of a scientific study, including sample size and power, the need for comparative designs, and ethical considerations.
3. Identify and critically evaluate the role of data analysis and statistics in scientific research and publications.
4. Demonstrate a foundational knowledge of statistical methods by being able to carry out simple statistical procedures by hand.
5. Use statistical software appropriately and confidently for exploratory data analysis and to make relevant statistical conclusions.
6. Effectively and appropriately communicate insights from data as evidence within a given context for both a professional and lay audience.

STAT1201 is taught at both the St Lucia campus (all three semesters each year) and Gatton campus (from 2014). Figure 115 shows the distribution of grades by campus, from 1 (lowest) to 4 (pass) to 7 (highest) in 2014 (Semesters 1 and 2 combined, including internal and external offerings of STAT1201, as well as STAT1301). Average student grades are much lower amongst the Gatton cohort (n=290) than the St Lucia cohort (n=1376), perhaps reflecting the fact that the Gatton offering is also taken by students from a number of other programs with lower entry rank than the BSc. (The St Lucia offering is also taken by students from programs other than the BSc, but those programs have comparable or higher entry standards.) The overall failure rate and grade distribution are comparable to those of most large, introductory science courses.
Figure 116 shows the eight standard UQ course evaluation questions. Students are asked to rate their response to each question on a scale from 1 (lowest) to 5 (highest). The mean student evaluation of course scores (SECaT score) for STAT1201 for each of these questions in Semester 2 2014 (the semester in which the majority of BSc students enrol in the course) and Semester 1 2014 are shown in the table, along with some information about numbers of enrolled students and response rates. The final column presents equivalent data averaged over 18 large-enrolment first year Faculty of Science courses offered during 2014, for context.

<table>
<thead>
<tr>
<th>Question</th>
<th>STAT1201 mean Sem. 2, 2014</th>
<th>STAT1201 mean Sem. 1, 2014</th>
<th>Mean, 1st year science courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear understanding of aims and goals</td>
<td>3.43</td>
<td>4.01</td>
<td>4.07</td>
</tr>
<tr>
<td>The course was intellectually stimulating</td>
<td>3.18</td>
<td>3.66</td>
<td>4.08</td>
</tr>
<tr>
<td>The course was well structured</td>
<td>3.32</td>
<td>3.91</td>
<td>3.96</td>
</tr>
<tr>
<td>The learning materials assisted</td>
<td>3.49</td>
<td>3.88</td>
<td>4.02</td>
</tr>
<tr>
<td>Assessment requirements made clear</td>
<td>4.03</td>
<td>4.31</td>
<td>4.11</td>
</tr>
<tr>
<td>Received helpful feedback</td>
<td>3.27</td>
<td>3.88</td>
<td>3.67</td>
</tr>
<tr>
<td>I learned a lot in this course</td>
<td>3.37</td>
<td>3.88</td>
<td>4.13</td>
</tr>
<tr>
<td>Overall, how would you rate this course?</td>
<td>3.23</td>
<td>3.83</td>
<td>3.93</td>
</tr>
<tr>
<td>% of respondents giving the previous question a score of 4 or 5 out of 5</td>
<td>42%</td>
<td>70%</td>
<td>72.7%</td>
</tr>
<tr>
<td>Total number of respondents</td>
<td>260</td>
<td>104</td>
<td>4492</td>
</tr>
<tr>
<td>Total number of enrolled students</td>
<td>944</td>
<td>693</td>
<td>13224</td>
</tr>
<tr>
<td>Response rate</td>
<td>28%</td>
<td>15%</td>
<td>33.97%</td>
</tr>
</tbody>
</table>

Student feedback varies somewhat between semesters, depending on a range of factors such as response rates, degree programs of enrolled students, teaching team and class sizes. It is well-known that teaching introductory statistics in compulsory courses with very large classes presents particular and substantial challenges. We are fortunate that the regular course coordinator for STAT1201, Dr Michael Bulmer, is a recognised expert at conducting effective and engaging statistics teaching, and has won institutional and
national teaching awards. The STAT1201 teaching team has trialled (and retained where appropriate) a number of innovations to enhance the effectiveness of the course and student engagement with the course. These include:

- The development of ‘The Island’ by Dr Bulmer, which is a virtual population to support learning and teaching in experimental design, epidemiology and statistical reasoning. All students in STAT1201 use this virtual population to conduct a substantial project, with a wide choice of specific content to match their interests and needs. The Island is being used by a number of schools and universities around Australia and internationally.
- Substantial changes to the assessment style, rigour and expectations, including calculation-based short answer examinations as opposed to examinations that were heavily computation based.
- Receiving funding from a number of internal and external sources to support projects that aimed to address various aspects raised in student feedback. This includes a comprehensive review and analysis undertaken by an external, national expert in statistics education.
- Incorporating examples and concepts from a range of areas of science, and including academics from different discipline areas in the teaching team.
- Modifications to core course content, including removing a database component that did not sit comfortably with the remainder of the course content, and changing the software package used for all computation (it is now the statistical programming language R).

In 2014, as part of introducing the new Bachelor of Advanced Science, we also introduced an advanced offering, STAT1301 “Advanced Analysis of Scientific Data”. The new course includes all of the STAT1201 material, but extends the content and concepts, and also includes additional learning experiences and varied assessment. Students in STAT1301 have increased interaction with each other and with academic staff. STAT1301 is open to high achieving BSc students, in addition to being compulsory for students enrolled in the BAdvSc (Hons).

It is clear that the STAT1201 teaching team is reflective and aims to support student learning and a good student experience, and that the course will continue to evolve over time. It has been suggested by some academic staff that STAT1201 is not the most useful compulsory foundational course for certain disciplines, and there certainly are concerns about some aspects of student feedback on their experience in the course. The broad view is that statistics is an essential requirement for all students in the BSc and plays an essential role in establishing BSc students’ quantitative skills, which is a stated GLO for all BSc students. For this complex skill to be developed, foundational knowledge from STAT1201 must be expanded upon in other courses and more effectively integrated into the curriculum at all year levels. In many cases, students are currently not seeing the value and use of statistics in their individual disciplinary contexts.

SCIE1000: ‘Theory and Practice in Science’. The previous BSc review recommended introduction of a new compulsory course, Foundations of Science. An interdisciplinary team was established, and the course SCIE1000 Theory and Practice in Science was introduced in 2008. Unlike STAT1201, which already existed and had been offered for a number of years, SCIE1000 was completely new. It was envisaged that the course would combine mathematical modelling, computer programing, philosophy of science and a range of interdisciplinary scientific contexts. It was perceived to be risky to make such a new, untested course compulsory, so it was instead initially highly recommended for all students, with an intention that it become compulsory after a year or two of operation, although this did not happen. As part of the BSc review preparation there has been substantial discussion as to whether SCIE1000 should now become compulsory. Extensive information is given here to assist with that decision.
The learning objectives for SCIE1000 are that students who complete the course will be able to:

1. Analyse the interdisciplinary nature of modern science, including some of the similarities and differences across a range of discipline areas.
2. Explain the importance of modelling in science by demonstrating the skills required to produce and analyse such models.
3. Apply fundamental mathematical techniques that are important to problems across a range of scientific discipline areas.
4. Explain key introductory concepts in computer science, design and write simple computer programs in the language python, and interpret the output of these programs.
5. Describe and discuss some philosophical accounts of scientific reasoning.
6. Communicate responses to quantitative and science-based problems in a correct, logical and scientifically appropriate style.
7. Describe and discuss some of the current key issues in science, including relevant social and ethical issues.

As recommended in the previous BSc review, the SCIE1000 teaching team is drawn from a range of disciplines, with a mathematician, parasitologist, computer scientist and philosopher having taught in every offering since 2008, a 50% CSIRO/50% UQ mathematical biologist joining the team in 2014, and a plant biologist joining in 2015. The content also reflects this interdisciplinarity, comprising interlinked mathematical modelling, scientific contexts, computer programming and philosophy of science. A summary of the current content follows; it should be noted that the four areas (mathematics, science, programming and philosophy) are all taught in highly interleaved blocks; the separate headings are only for ease of presentation.

**Science:** blood alcohol content; fluid flow; heart disease; atmospheric CO$_2$; temperature; species abundance; climate change; biodiversity; UV light; wind chill; breathing; daytimes/seasons; radioactive decay; pH scale; breast cancer; pharmacokinetics; recreational drugs; contraception; alcohol; diabetes; glycaemic index; bioavailability; bioequivalence; populations; unconstrained growth; constrained growth; resource management; lifecycle models; turtles; predator/prey interactions; epidemics; rubella; catastrophes

**Mathematics:** straight lines; quadratics; power functions; periodic functions; exponentials; logarithms; average rates of change; derivatives; Newton’s method; integrals; areas under curves; differential equations; Euler’s method; exponential DE; logistic DE; systems of DE; Lotka–Volterra model; SIR models

**Computing:** software design; Python programming; errors and debugging; input and output; variables; calling functions; conditionals; loops; arrays; plotting; writing functions; sorting algorithms; complexity; simulation, complex systems and netlogo

**Philosophy and scientific thinking:** the nature of science; scientific thinking; modelling; units; hypotheses; history and progression of scientific thinking; inductive reasoning; Popperian science and falsificationism; quantitative reasoning; medical science; science in the media

In 2014, as part of introducing the new Bachelor of Advanced Science, we introduced an advanced offering of SCIE1000, called SCIE1100 “Advanced Theory and Practice in Science”. The new course includes all of the SCIE1000 material, but extends the content and concepts, and also includes additional learning experiences and varied assessment. SCIE1100 is open to high achieving BSc students, in addition to being compulsory for students enrolled in the BAdvSc (Hons).

As noted, SCIE1000 still remains a highly recommended course in the BSc rather than a compulsory one. Reasons for this are discussed below, although it should be noted that SCIE1000 is a compulsory course
in the Bachelor of Biomedical Science, and SCIE1100 is compulsory in the BAdvSc (Hons). Enrolment numbers in SCIE1000 were 569 in 2008, reached a low of 457 in both of 2011 and 2012, and were 753 in 2014 and 793 in 2015 (combined SCIE1000 and SCIE1100 from 2014). Variations in numbers were caused partly by improvements in the course resulting in improved student perceptions, fluctuations in degree enrolment numbers, SCIE1000 becoming compulsory in BBlomedSc (Hons), and the introduction of SCIE1100.

SCIE1000 and SCIE1100 are taught only at the St Lucia campus, and only in Semester 1 each year. Figure 117 shows the distribution of grades, from 1 (lowest) to 4 (pass) to 7 (highest), from Semester 1 2014 for SCIE1000 (n=636) and SCIE1100 (n=75). Note the small enrolment number in SCIE1100 compared with SCIE1000.

As expected, average grades are much higher for students enrolled in SCIE1100 than for students enrolled in SCIE1000, reflecting the higher comparative academic performance of students enrolled in the Bachelor of Advanced Science. The overall combined failure rate and grade distribution are comparable to those of most large, introductory science courses taught within the faculty.

Figure 118 shows the eight standard course evaluation questions issued to all students enrolled in all courses. Students are asked to rate their response to each question on a scale from 1 (lowest) to 5 (highest). The mean student evaluation of course scores (SECaT score) for SCIE1000 for each of these questions in Semester 1 2014 are shown in the table, along with some information about numbers of enrolled students and response rates. The final column presents equivalent data averaged over 18 large-enrolment first year Faculty of Science courses offered during 2014, for context.
CHAPTER 7: CHANGES TO THE DEGREE

<table>
<thead>
<tr>
<th>Question</th>
<th>SCIE1000 Mean response</th>
<th>Mean, 1st year science courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear understanding of aims and goals</td>
<td>4.38</td>
<td>4.07</td>
</tr>
<tr>
<td>The course was intellectually stimulating</td>
<td>4.52</td>
<td>4.08</td>
</tr>
<tr>
<td>The course was well structured</td>
<td>4.55</td>
<td>3.96</td>
</tr>
<tr>
<td>The learning materials assisted</td>
<td>4.44</td>
<td>4.02</td>
</tr>
<tr>
<td>Assessment requirements made clear</td>
<td>4.36</td>
<td>4.11</td>
</tr>
<tr>
<td>Received helpful feedback</td>
<td>3.70</td>
<td>3.67</td>
</tr>
<tr>
<td>I learned a lot in this course</td>
<td>4.40</td>
<td>4.13</td>
</tr>
<tr>
<td>Overall, how would you rate this course?</td>
<td>4.34</td>
<td>3.93</td>
</tr>
<tr>
<td>% of respondents scoring the previous question 4 or 5</td>
<td>90%</td>
<td>72.7%</td>
</tr>
<tr>
<td>Total number of respondents</td>
<td>502</td>
<td>4492</td>
</tr>
<tr>
<td>Total number of enrolled students</td>
<td>675</td>
<td>13224</td>
</tr>
<tr>
<td>Response rate</td>
<td>74%</td>
<td>33.97%</td>
</tr>
</tbody>
</table>

Figure 118. SECoT responses for SCIE1000, 2014.

In addition to formal student evaluations, we have also received informal feedback on the impact of SCIE1000 from the perspective of some students. The faculty offers the Advanced Studies Program in Science (ASPinS) which is a formal, research enriched study program open to high achieving science students in each year of their degree (the program is not open to students enrolled in the Bachelor of Advanced Science). Students can apply formally to enter this program after semester 1 of their first year, and typically around 50 high achieving students choose to do so. One of the questions asked at the interview to select students for entry is "Which course in first semester had the largest impact on you, and why". By far the most commonly identified course by these students is SCIE1000, because it "changed the way that I [the student] think".

The SCIE1000 course content does not sit within any single discipline area. There is a large component of mathematical modelling, yet the bulk of the mathematical content is not new to students, all of whom have previously completed (at least) intermediate level high school mathematics. The new aspect is how the mathematics can be applied to real problems. The science is not all chemistry, or physics, or human biology, or any other discipline area. Instead, aspects of all of these areas are linked in the contexts that are considered. It is not a formal course in software engineering, but students learn how to combine programming concepts and constructs (loops, conditionals, functions, data structures) to analyse scientific problems. The philosophy of science is not presented as an abstract concept, but instead ties together the other components of the course.

SCIE1000 classes are heavily discussion based, with students regularly invited to discuss the problems being considered (both mathematical and broader problems), to talk to the people around them about how to approach the problem and what the answer might be, to indicate whether they agree with a proposed solution, and to discuss why certain answers are not correct. Questions posed to the class have been chosen with care, both to illustrate important concepts, and also to provoke discussion and to elicit unexpected (and often incorrect) answers.

All lectures (apart from the four philosophy lectures) have two lecturers jointly interacting with each other and
with the class. Rather than encountering content and learning from the perspective of one lecturer, students see a range of explanations, learning styles and perspectives. It is often the case that the lecturers disagree on something, or at least present alternate viewpoints. Students are then involved in the discussions in a mature, friendly and guided fashion. Importantly, the two lecturers are drawn from different discipline areas, increasing the likelihood of them bringing different, equally valuable perspectives to the class. It also increases the likelihood of one of them making an error but the error being identified by the other, which directly models the process of “real science”, and creates an environment in which making mistakes is actively modelled as being inevitable, reasonable, and an opportunity for learning.

The exam is open book, with any written or printed materials permitted. It is explicitly stated that the examination does not cover learned facts, instead assessing effectiveness of student thinking. Having an open book exam, with all questions unfamiliar to the students and none based on recall of facts, promotes development of problem solving and critical reasoning skills.

**Compulsory courses**

We have held a number of meetings to discuss whether compulsory or highly recommended courses should be included in the BSc, what form they might take, and how the benefits might balance with the resulting loss of flexibility in student choice. The structure of BSc dual degrees also needs to be considered when introducing any new compulsory course. The number of students doing a dual degree with the BSc has risen considerably in recent years. Dual programs have less flexibility to cater for the introduction of additional compulsory courses.

There has not been a unanimous view about whether SCIE1000 should be made compulsory. Here are some arguments that have been raised in favour of such a move:

- It is the most interdisciplinary first year science course we offer, and expanding students’ views beyond discipline boundaries is likely to be useful.

- It is compulsory in the closely related Bachelor of Biomedical Science and also in the Bachelor of Advanced Science, and some majors within the BSc strongly support it becoming compulsory.

- The course plays an important role in the first year student transition into the BSc, through the social dynamic of active learning in lectures and tutorials that fosters social connections between students from all discipline areas, in their first semester.

- If it were compulsory, then the skills and knowledge developed by students could be relied upon and expanded across all majors. For example, it cannot be assumed now that all students have encountered computer programming; if the course were compulsory, this could be assumed, and built upon.

- Improving students’ quantitative and computational skills are identified goals of the BSc, and indeed of national and international studies into what should constitute a modern science degree.

- Most students already take the course; perhaps many of those who choose not to do so are the ones who could benefit most from it. (We know that students with weak quantitative skills find SCIE1000 and STAT1201 difficult. They have to complete STAT1201, but can choose not to take SCIE1000. Recall that quantitative skills are an identified GLO of the BSc.

- Apart from the relatively small number of students who take introductory computer science courses, there is no other place in first year in which students learn how to write a “real program”. They use computation in STAT1201 and in maths courses, but that computation does not involve writing
programs. Interestingly, in a survey conducted in the introductory programming course taught by the School of Information Technology and Electrical Engineering in 2014, 37 students identified that they were enrolled in the programming course predominantly because they encountered programming in SCIE1000 and decided they wanted to study more. For those students, taking SCIE1000 had an unexpected, transformative effect on their academic development.

- Overall student feedback is very high (although this would be expected to reduce if the course were made compulsory). There does not appear to be a particular risk that making the course compulsory would impact negatively on student numbers.

Here are some arguments that have been raised against making SCIE1000 compulsory. The arguments fall into two broad categories: arguments against making any particular course compulsory, and arguments against SCIE1000 specifically.

- Making any course compulsory will reduce the breadth of disciplines available to students in their first year. With two compulsory courses (STAT1201 and possibly SCIE1000), that only leaves six course slots available for other courses. This allows students sufficient scope to take two majors in later years (because each major builds on three first year courses), but it does not (for example) give them the option of also taking a language or another course.

- Passing STAT1201 is a significant intellectual challenge for some students, a number of whom require multiple attempts to succeed. It is likely that SCIE1000 would be similarly challenging for some students.

- There are clear and significant workload issues that would arise from making it compulsory. As noted above, teaching in this course is more resource intensive than in other courses. If SCIE1000 were made compulsory, it would need to be taught multiple times each year.

- The broad (but not unanimous) view of academic staff in the mathematics discipline is that SCIE1000 should not be made compulsory. They argue that while some components of the course are valuable, it does not add sufficient value to their students, who already encounter mathematical content that is significantly more sophisticated than that covered in SCIE1000. They suggest that students would be better served by choosing a different course as an elective.

In conjunction with discussions around SCIE1000, we have also considered the possibility of introducing other compulsory or highly recommended courses, either in addition to, or instead of, SCIE1000. Views have been canvassed from staff and from students; the general consensus is that if such courses were to be introduced, it is most likely that they would be interdisciplinary in nature, rather than being directly situated within a specific discipline area. Any such courses could be based around “big picture science issues”, possibly including selections from:

- Evolutionary biology – from Darwin to DNA
- Are we alone – humanity and the cosmos
- Communication in science
- An introduction to problem solving in science
- Global change and sustainability
- Climate change and the preservation of life
Any of the following models could be adopted:

- Students must complete an identified course; or
- Students must complete at least one of a small number of courses; or
- Students are encouraged to complete one or more courses.

Appropriate courses could be developed from new, or there are existing courses that could be broadened to be of value to many students (for example, *Food for a Healthy Planet*, *One Health*, or *Environment and Society* amongst others). There are also a number of MOOCs that may be suitable, including one focusing on climate change and denial.

It is not clear as to the most appropriate place for any compulsory or highly recommended course(s) within the degree structure. There are arguments in favour of first year, particularly because such a course would most likely include a range of skills linked to our stated GLOs that are useful across all years of study. Also, students may decide that they enjoy or value components of the course and wish to change their intended major, and this is easier at first year. However, students typically value the wide range of choices available at first year, and reducing this flexibility is seen by many as undesirable. There may be more scope to introduce a compulsory course at second year, although great care would be needed to ensure that the content was sufficiently advanced to warrant being labelled second year, but did not rely on a particular disciplinary background given the diversity of students who would complete the course. A course in critical thinking or advanced communications skills could be suitable for second year.

**Results from student and staff survey on interdisciplinary courses.**

All BSc and BSc dual degree students enrolled in semester 2, 2014 (n = 3915) were invited to complete an online survey. The survey was modified to gauge academic perceptions, and then distributed to all academic staff with a substantial teaching contribution into the BSc. Two of those questions related to the possible introduction of one or more interdisciplinary courses, built around big picture issues in science rather than being based within a particular discipline. The questions posed to students were:

- Would such a course improve the science degree program?
- Would you enrol in such a course?

(Note that it was not suggested to students that the course would become compulsory; instead we gauged their views about enrolling in such a course voluntarily.)

The questions posed to academic staff were:

- Would such a course improve the science degree program?
- Would you encourage students to enrol in such a course?

Students and academics responded on two 4-point rating scale questions (ranging from 1 – Absolutely no, to 4 – Absolutely Yes), and were invited to submit an open-ended comment if they wished. A total of 893 students answered the Likert scale questions, and 383 students entered open-ended comments from which 544 individual statements (multiple statements within one comment) were coded using a thematic analysis. A total of 82 academics answered both Likert scale questions, and 45 academics answered the open response question, from which 58 individual statements were coded using a thematic analysis. **Figure 119** and **Figure 120** summarise the responses to the two Likert scale questions by students and academics.
Overall, the quantitative data indicate that both students (71%) and academics (56%) are more likely to view introduction of such a course as an improvement to the BSc than not (Figure 119). For enrolment, academics (61%) would be more likely to encourage students to enrol in such a course than not, and students (58%) would be more likely to enrol than not (Figure 120). Open qualitative responses highlighted academics’ and students’ enthusiasm and concerns. These responses fell across a number of broad themes for both academics (Figure 121) and students (Figure 122). These themes were quantified (Figure 123 and Figure 124) to demonstrate the spread of perceptions.
### Theme | Example/Definition
--- | ---
Content | Amount/breadth or depth of content covered in the course, who would decide which “big issues are taught”?  
Relevance | How relevant such a course would be to students  
Interdisciplinary | The importance or problems with interdisciplinary courses/content  
Structure and Curriculum | Year levels, pre-requisites, overall structure, curriculum (coherence, fragmentation). Practicalities of implementation, integrating into curriculum.  
Skills and Outcomes | Potential development of skills or learning outcomes

**Figure 121.** Academic staff responses to the idea of introducing interdisciplinary courses.

### Broad Theme | Example/Definition
--- | ---
Structure and Administration | Requirements (year level, compulsory or prerequisite), Fit into the degree program (logistics of implementation)  
Skills, Outcomes, and Employability | Employment outcomes (advantages or disadvantages for employment); Personal Relevance (to an individual’s study or career path); Learning outcomes and practical skills (gained as a result of the course)  
Content | Topics and teaching approach (which big issues taught and how would they be delivered?); Breadth and depth (depth of content, spread across disciplines)  
Vision and Focus | Interdisciplinary thinking (interdisciplinary content and collaboration); “Real world” context (putting science into the context of practical applications); Defining focus (for study or career path)  
Other | General comments

**Figure 122.** Student responses to the idea of introducing interdisciplinary courses.

Students and academics both commented on course content and structure, and administrative issues such as the fit in the degree program. While both students and academics commented on the skills and outcomes of such a course, academics focussed predominantly on learning outcomes whereas students were more focussed on the employment relevance of the skills taught in the course. Figure 123 shows that the majority of academic staff comments were focussed on issues regarding what content might be taught in such a cross-disciplinary course, and how such a course might fit into the degree program or be structured. Figure 124 indicates that students’ comments were relatively evenly distributed, but with most comments on issues regarding structure of the course and general “fit” into the degree program.
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Figure 123. Summary of academics’ views on introduction of interdisciplinary courses, 2014.

Figure 124. Summary of students’ views on introduction of interdisciplinary courses, 2014.

Here are some representative open-ended comments from students and academic staff.

1. **Content**

   While a general course might have some advantages, the danger is a course that is vague and does not advance or challenge the students. The courses listed seem more like social engineering and high school subjects. (Academic, SCMB)

   It is more important that students learn facts. Critical thinking, analyzing, scientific communication, writing and team work can be learnt very well in biology, physics or chemistry courses. Instead there are no real answers to the “big issues”. (Academic, Biomedical Sciences)

   I would be wary of enrolling in this course unless I was 100% confident I would receive a balanced argument of the issue and allowed to come to my own conclusion. This would be an interesting addition to the course content as this would enhance my knowledge of world issues. (Student, Yr1, BioMed)

   I come into my degree program with a specific set of knowledge in mind...unless this course was a later year course, it would likely only give a very cursory understanding of the big issues since it could not expect students to consume the same quantity and depth of knowledge from one course. (Student, Yr3, Genetics)

   Climate change and sustainability are becoming ever increasing issues in modern society. If well-structured with relevant content a course like this should be recommended to first year BSc students. As long as enthusiastic lectures and interesting practicals are in place, I believe a course like this would be very successful. (Student, Yr2, Geography)

2. **Structure**

   I would prefer to see big issues integrated in many courses, as a way of bringing together and applying knowledge gained within that course. (Academic, Biomedical Sciences)

   Really I would imagine that these should be introduced at a masters level when students have had
exposure to all of the ideas and already have a solid science degree. If they were to be introduced they should only be available to second or third year students ie with prerequisites of at least 16 units and only if the first year programme was fixed as expressed above. (Academic, SCMB)

The Bachelor of Science is already so broad, and with electives you can already cover a range of subjects. I think it’s important to have more specific courses to better prepare students for postgraduate study. (Student, Yr3, BioMed)

These ideas should be emphasised in specific courses. E.g. in “Climate Change Physics” with applications and extensions in physical biology or chemistry etc. (Student, Yr5, Mathematics)

Wait till people are in their second years and offer the courses as a subject to those who only wish to work in that field so you don’t have heaps of people (like now) doing subjects only because it’s a prerequisite. (Student, Yr1, Physics)

Definitely has to be a first year course, done in the first semester and needs to be built upon by other courses, otherwise, what use is the course? (Student, Yr3, Microbiology)

This course would need to be a higher level course so that prerequisite knowledge does not need to be retaught. (Student, Yr3, BioMed)

I think it’s a pretty bad idea. Students wouldn’t want to take a course in something irrelevant and doesn’t relate to their course. (Student, Yr2, Food Science)

3. Skills and outcomes (and employability – students only)

(Interestingly, employability was not mentioned by academics. Students focussed on the advantages or disadvantages of such a course for employability.)

The BSc needs an overarching course that focuses on the fundamental concepts and approach of science. i.e. scientific theory, history, scope, application, overview of discipline areas, increasing needs for inter-disciplinary approaches, role of non-technical attributes in science, limitations and strengths of scientific approach. Perhaps such learning objectives could be promulgated through courses such as those proposed, but the subject area would simply be a “flavour” that’s applied to the core learning, not a chance to learn significant material on climate change. (Academic, Vet Science)

Large, general education requirements are a good thing in my opinion. This would mirror a more North American style education where students have some input into their 1st year courses, and are free to meander a bit. (Academic, GPEM)

The introduction of these courses would be favoured by many employers as it has become a very important part of the current economic environment that we live in, it would be a valuable skill which has not been covered much (if at all) in any of my courses. (Student, Yr2, Psychology)

This would improve interdisciplinary communication and the ability to communicate to a wider audience. I would ask that such a course be genuinely collaborative with a strong team project component where each member of the team has a distinct skill set and thus the project requires genuine collaboration and communication to complete. (Student, Yr3, Mathematics)

4. Relevance

I question having an entire course on such a broad topic. Invariably, you will be teaching sections of the cohort at any given time, and boring the remainder. This sounds like a PBL scenario - or a different version of the Capstone course. (Academic, Biomedical Science)

In theory this is a great idea but in practice Schools become bogged down in ownership of such a course that breaks down the cross disciplinary aspect of such a course. Some Schools have already developed such courses and perhaps rather than reinventing the wheel look at existing courses and perhaps allowing students to choose from a list of these courses - which in turn may be more relevant in terms of student majors/interests. (Academic, GPEM)

As a maths student, I would want something which I could see how what I’m doing could apply to
these kind of issues. For example “health-related” I would assume would be more focussed on areas completely irrelevant to my future career compared to how such an issue linked in with other disciplines. (Student, Yr3, Mathematics)

These courses often seem airy-fairy and irrelevant. (Student, Yr3, Computer science)

5. Interdisciplinarity

Students arrive in first year university already viewing science in discipline silos. A course that demonstrates how two or three complex issues draw on and integrate expertise from many areas of science would I think inspire and provide students with insight into where the pursuit of specific disciplines can take them (careers) and the relevance of different disciplines to their personal lives and career options. (Academic, Biological Sciences)

This is a terrible idea and will clearly be seen as a soft subject. True cross-disciplinary subjects and interaction require deep knowledge of a number of different subjects which these courses could not possibly hope to provide. (Academic, SMP)

I think this would be a great idea because in reality the disciplines aren’t isolated from each other so it would be good to have courses that incorporate different disciplines whilst also covering a subject matter that is relevant to everyone. (Student, Yr2, Chem)

This would be a fabulous idea and would also give students a chance to interact with other students from different disciplines. (Student, Yr1, Unsure)

I think this is an excellent idea. I did SCIE1000 and it was a course very similar to what it sounds like you are trying to introduce. I finished the course appreciating all the different topics that were offered. (Student, Yr3, Mathematics)

6. Vision and focus (students only)

(This theme was only mentioned by students, not by academics. Students focussed here on placing science in a “real world” context and the use of a course for helping students to define their focus for choice of courses, majors, or careers.)

I think this would be a great idea, to have in conjunction with the “Core” sciences (Bio, Physics and Chem). I feel it would provide context to the theory that is learnt in those courses, which would be great for allowing students to think about how to actually apply the knowledge that they’ve learnt in those courses in a “real world” context. (Student, Yr3, Marine Science)

I think this would detrimentally narrow students’ view on the world, belittle their potential as well-rounded, conscientious thinkers, and stifle creativity and freedom to decide for ourselves what we deem as the “big issues” on which to focus our lives. (Student, Yr2, BioMed)

Having a course like this can give physics students a direction for what they want to do when they graduate. As a first year, I often lost sight of why I was doing physics while under the pressure of learning the physics course content. (Student, Yr4, Physics)

Conclusion

As with the question about whether SCIE1000 should be made compulsory, there is no clear view on whether other interdisciplinary courses should be introduced, and how strongly students should be encouraged to complete one or more of those courses. The general view of academic staff is that there is a role for compulsory courses which improve students’ quantitative skills, as well as contextualising those skills with real world, interdisciplinary examples. Such compulsory courses should also address key skills in other areas such as critical thinking, philosophy or communication. There would be general (but certainly not unanimous) support for up to two such core compulsory courses, but introducing more than two such courses would be viewed quite negatively.
If the decision were made to retain STAT1201 and make SCIE1000 compulsory, then there would be an opportunity to redevelop and rearrange some of the courses’ content. Some material could be moved from one course to the other, and there may be scope to introduce other concepts or material that would benefit all students. For example, the ethics module currently included in STAT1201 may sit more comfortably in SCIE1000 (with scope to expand its coverage), and some of the contextual mathematical modelling in SCIE1000 may match well with some of the data analysis in STAT1201. There may also be more scope to introduce a module in scientific communication.

Designing and implementing a high quality interdisciplinary course is notoriously difficult, and requires a great deal of trust, cooperation and shared vision by academics across multiple discipline areas. Development would need to be undertaken by small teams, focusing on how to improve students’ critical thinking and problem solving skills, and also linking appropriately with other discipline based courses. Given the heavy time and resource demands, if we decide to produce such courses then the number should be strictly limited. Any such courses should probably not be made compulsory in the short term, until there is sufficient evidence that they are operating smoothly and effectively.

We particularly welcome the views of the review panel on the issue of compulsory and interdisciplinary courses. As noted, there is no consensus view amongst staff or students on how we should proceed. However, the following suggestions reflect the views of a significant number of participants in the discussions.

**Suggestions**

That the development of interdisciplinary thinking and contextualized skills in statistics, data analysis, quantitative reasoning, programming, ethics and the philosophy of science be further strengthened by:

- increasing the number of compulsory courses from one to two.
- expanding the use of relevant, authentic, contemporary examples within these courses.
- better embedding development of these skills into the subsequent courses and learning activities within each major.
- undertaking regular review of the form, content and delivery of the compulsory courses by the Science Curriculum Group.
- developing a small number of interdisciplinary courses.

### 7.3 Specialisations

The previous BSc review focused to a large extent on the BSc structure, in particular on the type, number and broad requirements of majors. Currently there are three types of specialisation: (standard) majors (comprising 3 courses at level 2 and 4 courses at level 3), extended majors and dual majors (both comprising 5 courses at level 2 and 6 courses at level 3). Majors represent distinct discipline areas, extended majors are in the same discipline areas as majors but represent a larger volume of study, and dual majors represent cross- or multi-disciplinary areas. An additional type of identified specialisation that could be introduced is the minor.

It is relatively common to allow students to complete one or more minors in science degrees across Australia (e.g. UNSW, UMelb, USyd, Monash, ANU, QUT). The other large generalist degree offered at UQ (the Bachelor of Arts) allows students to do so. Minors typically comprise the equivalent of 8 units, with at least one course at level 2 or higher. Perceived benefits include: allowing students to obtain a
named specialisation to augment their major; promoting inter/cross disciplinary studies; aiding student progression; and encouraging students to follow a more coherent, structured sequence of study within their elective courses.

At pre-review meetings, all participating academic staff supported the introduction of minors into the BSc. At a meeting of students enrolled in the BAdvSc (Hons), there was strong support for minors to be introduced into BAdvSc (Hons); likewise informal feedback from students enrolled in the BSc has indicated support for minors in the BSc. Hence we will recommend that minors be introduced as a different type of specialisation within the BSc and the BAdvSc (Hons), requiring a smaller volume of study than a major. The rules for a minor could be to complete 8 units (say), with a minimum of 4 units being at Level 2 or higher.

We suggest that individual discipline areas have the option of proposing that a minor be introduced within that discipline, with the name of the minor matching that of the major. Students could, for example, be able to complete a major in chemistry and a minor in physics. In addition to offering minors in the same discipline areas as some majors, we note that the BSc is a broad, generalist qualification, aiming to meet a wide range of graduate outcomes and fulfil a range of expectations. There are some areas of study that do not fall into single disciplinary areas, but instead provide useful skills and expertise to students completing a range of majors. The following specialisations could be identified formally, by becoming named minors. Note that each is relevant to graduates of any major, but that it is not proposed to introduce majors in the same areas as these minors.

- Science education: comprised of courses taught by the school of education, this minor would aim to highlight the option of science/maths teaching as a career, and to help potential teachers develop pedagogical knowledge in tandem with their disciplinary knowledge
- Science communication: all majors aim to strengthen the communication skills of graduating students, but this minor would provide a visible, particular focus on a range of communication skills, within discipline and more broadly.
- Computation: the computational science dual major has not been particularly successful in terms of attracting students, but a minor may be of more appeal. (In effect, the current structure of the dual major is fairly similar to the proposed minor, but the increased visibility of minors may increase the appeal.)
- Science Law: it is increasingly useful for all graduates to develop some knowledge of aspects of law in the context of their broad discipline area. Representatives from the Law School are very confident that they could offer a minor in science law that would be interesting and beneficial to science students, and we believe that this minor would be popular.
- Big data: this has been proposed as a major for the future, but it may be the case that a minor is more appropriate.

It is also likely that minors will be introduced in some disciplinary areas for which majors are not offered. For example, the chemical sciences dual major may split into a major in chemistry and a minor in materials science.

Dual majors have generally proved to not be popular with students, and we suggest the dual major within the BSc be terminated, with current dual majors redesigned to become majors or extended majors, or be split into a major and a minor.

Currently there are dual majors in bioinformatics, biophysics, chemical sciences, computational science and food science & nutrition. Between 2010 and 2014, the numbers of these majors awarded were: 3 (bioinformatics), 12 (biophysics), 20 (chemical sciences), 8 computational science and zero (food science & nutrition, which is new so there has not been sufficient time for students to complete yet). In total, only 43 of the 3600 majors awarded were dual majors.
Detailed discussions have been held with the coordinators of the dual majors with the largest numbers of graduates (noting that these numbers are still quite small). The coordinator of the bioinformatics dual major has already proposed that bioinformatics become a single major. Meetings have been held with coordinators of the biophysics and chemical sciences dual majors, who believe that those dual majors can be redesigned as majors or a combination of a major and a minor. Computational science is more readily suited to being a minor than a dual major, as it already builds on a disciplinary major. Food science and nutrition can be rebadged as an extended major. In addition to potential academic benefits when coupled with the proposal to introduce minors, removing dual majors (particularly the computational science dual major) would provide benefits in the form of significant simplification from the perspective of students and staff, and also administratively.

**Suggestion**

That specialisations within the BSc be further strengthened by removing dual majors and introducing optional minors.

### 7.4 Capstone courses

During discussions about the size and structure of majors and extended majors, there was consensus that the current requirements are working very effectively and should not change, with the exception of a range of concerns with the success or otherwise of the compulsory capstone course within each major.

During the most recent BSc review, the decision was taken to introduce a compulsory, third year, capstone course in each major. Capstone courses are variously defined, however they tend to have the following attributes in common:

- They are offered towards the end of a degree.
- They allow students to integrate the skills and knowledge they have acquired as part of their university experience and to demonstrate that they have met the graduate learning outcomes for their major.
- They serve as a bridge to the next step, often asking students to extend and synthesise their knowledge, working either independently or collaboratively with peers.
- They provide information for academic staff about strengths and gaps in the curricula.

Note that capstones should not typically seek to fill gaps in the curriculum; once gaps are identified, it is usually more appropriate for changes to be made in the courses that lead to the capstone.

Compulsory capstone courses were introduced in all majors in 2010. Some funding was made available to support teams developing the capstones, and the faculty funded two visits by an international expert from Indiana University to offer advice and expertise.

Capstone courses have achieved very mixed success across the discipline areas. Some offerings have received high student feedback scores, and appear to be fulfilling the stated goals and requirements. However, in other majors the capstone courses are clearly not meeting the ideological goals of a capstone course, despite significant hard work and professionalism. Figure 125 shows the mean answers on student surveys to the question “Overall, how would you rate this course” (1 = lowest, 5 = highest), for a number of capstone courses, in the period 2010 – 2012.
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Figure 125. Student evaluation of capstone courses, 2010-2012.

For comparison, it should be noted that student feedback on third year courses is typically very high, with a mean response of well over 4 (for a range of reasons, including relatively small class sizes and also the disciplinary focus of most enrolled students). Responses for a number of the capstone courses were very high, but there were also a number of courses for which the mean response was very low. Indeed, some of the lowest student response scores over all courses in all years in some discipline areas were in the capstone courses.

In addition to the student feedback, comments were also sought from academic staff about how they viewed the effectiveness of capstone courses. Responses were both positive and negative.

- The course is designed to prepare students for Honours. The lecturers enjoy the course. The evaluation scores suggest that the students do as well.
- The course has been reasonably successful after some initial difficulties
- The key student outcomes are both experience in research (so they can make an informed decision about honours, and career options), and assurance that they have met the minimum standards for the major
- The course does not particularly function as a capstone. In fact I don’t think that the concept of capstone has much value.
- The course suffers from inadequate lab time
- The capstone concept means that rather than allowing students to determine which area they are interested in (a valuable process for attracting honours and PhD students) we rather require them to take yet another general course
- The capstone concept works a lot better in a 4 year university system where there is time to gain depth before coming back around to a general overview.

Clearly, there is no single “perfect model” for capstone courses or experiences. Implementation and operation is impacted by such factors as student numbers, understanding of what a capstone is meant to achieve, resources, staffing, and time required for effective implementation. There is a particular challenge in majors that are very broad, or have large numbers of students enrolled. In such cases, the capstone courses need to be very broad, and cannot assume a high level of shared skills, knowledge or experience (because students may have completed varying sets of courses prior to taking the capstone course).

Noting that a major only comprises four level 3 courses, the compulsory capstone course represents one quarter of the level 3 courses within the major. Academics from some discipline area have expressed the
CHAPTER 7: CHANGES TO THE DEGREE

view that this is an unreasonably large fraction of the advanced coursework to be allocated to a course that can be general in nature, and not well regarded by the students.

There has been strong support from academic staff for students to complete at least one compulsory course within each major, but that this course should be at level 2 or level 3, as appropriate to the discipline area. (Such courses at level 2 are sometimes called cornerstone courses; at level 1 they are called gateway courses.) Potential advantages of having the compulsory course at level 2 are that such courses can build foundational knowledge required by all students; and also support a valuable cohort-wide experience earlier in a student's sequence of study.

Thus, we are proposing that the requirement for a compulsory level 3 capstone course in each major be replaced by the requirement for a compulsory capstone (level 3) course or cornerstone (level 2) course. We anticipate that around half of the majors will retain the compulsory capstone course, and the other half will instead require a compulsory cornerstone course. Of course, some majors will include both within their structure. This change will be particularly useful in majors that cover a broad range of sub-disciplines: there is more commonality within the disciplinary knowledge required by an entire cohort at level 2 than there is at level 3.

A risk with replacing a capstone course with a cornerstone course is that the capstone can play a direct role in assuring that stated graduate learning outcomes have been achieved, whereas the cornerstone course occurs much earlier in the study sequence, so is more directed at developing fundamental skills and boosting the cohort experience. Other mechanisms are required to demonstrate a structure and coherence in the courses that comprise each graduating student's major, and that the stated graduate outcomes are achieved by all graduates. One method for achieving this is to link the learning objects and assessment activities in each course with the major-specific graduate learning outcomes, and changing course goals and activities to include any outcomes that are not developed within the sequence of study; this is considered further in the section on graduate learning outcomes.

Suggestion

That specialisations within the BSc be further strengthened by including a compulsory Level 3 capstone course or a compulsory Level 2 cornerstone course in each major.

7.5 Bachelor of Science (Honours)

The university has offered an optional BSc (Hons) degree for many years. Advantages that can accrue to a student completing an honours degree include: a range of learning and experiences that advance students towards becoming scientists; exposure to interesting questions, techniques and ways of thinking; preparation for subsequent research or employment; development of skills within a discipline area; a year of general personal and professional growth with opportunities for enhancing skills such as time management, problem solving, creative thinking and self-organisation. These skills not only increase students' abilities to undertake subsequent research, but are also very useful preparation for the workforce.

The recent implementation of the Australian Qualifications Framework (AQF) has caused a number of changes to the way that universities across Australia view and implement honours degrees (see www.aqf.edu.au/aqf/in-detail/aqf-levels). The graduate learning outcomes for the BSc (Hons) degree at UQ are listed in Appendix 4b and reflect the AQF guidelines in terms of knowledge, required skills, the application of those skills and the volume of learning. Honours in the BSc is an (optional) additional year of study, undertaken after graduating with a BSc. Students must complete honours with a particular named field (or "field of study"). All fields require students to undertake a substantial research project under guidance of a
supervisor, and to produce an appropriate research report or similar piece of work. The size of the research project varies between fields, depending on the needs of students and the characteristics of the specific discipline areas. The smallest research component in any field is 37.5% of the honours year, and the largest component is 100%. The non-research component (if any) comprises advanced coursework.

Implementation of the AQF also necessitated a significant rethink of the nature and meaning of the term “honours”. The following text is quoted from the AQF documentation:

“As it depicts a qualification type, the term “Honours” may not be used to recognise meritorious achievement for an AQF qualification. Other forms of recognition of merit may be used for this or any qualification type; this is a decision for the organisations authorised to issue AQF qualifications.

For many years, the term “honours” in degree titles has implicitly included a notion of merit, with only the “best students” proceeding to honours. Of course, the class of honours indicated student performance within honours, but simply being allowed to enter honours was regarded as being elite. Under the AQF, “honours” is simply the name of a qualification, corresponding to an AQF Level 8 qualification, and is not permitted to include an explicit or implicit connotation of merit or excellence. It should be noted that honours degrees in many discipline areas are now four or five year degree programs, in which students can enrol upon their entry to the University. Provided such students complete the overall requirements of the degree program, they are guaranteed to graduate with an honours degree, without reference to any meritorious level of achievement. For example, it is quite feasible for a student who achieves an overall failing average grade to be awarded an honours degree.

Even prior to the AQF, there was some national debate about the nature, role and future of honours as a qualification. It is not well recognized internationally, and some institutions have largely moved away from offering honours, instead offering more generalist undergraduate degrees and subsequent fields within masters degrees (sometimes termed a “3+2” model, and embodied, for example, in the so-called “Melbourne Model”). There are clear advantages offered by such degree structures, but their success currently depends critically on the fee and commonwealth support arrangements. Essentially, if students were required to pay much higher fees to complete a masters qualification after an undergraduate degree, then it may be unlikely that many students would choose to do so at this stage. Noting that more than 250 students completed BSc (Hons) at UQ in 2014, a large number of students would be affected by any move to change to a 3+2 model, so the funding arrangements would need to be quite clear up front. UQ has decided to not pursue such a significant change to degree program offerings at this stage, and it would not make sense for the Faculty of Science unilaterally to decide to make such a change.

As a result of discussions about the AQF, the university introduced a number of alterations to the General Award Rules regarding honours, with a particularly large impact on single year, graduate entry honours degrees (previously called “postgraduate honours”), such as the BSc (Hons). The relevant new General Award Rules and the previous rules are shown here; understanding the changes and the reasons for the changes is useful for understanding the context of honours at the university under the AQF.

**Relevant new rules:**

2.4.1 A class of honours must be awarded in a Bachelor Honours degree or an integrated program which includes a Bachelor Honours component.

2.4.2 The class of honours must be one of: honours class I; honours class II (A or B); honours class III (A or B).

2.4.4 The class of honours is calculated on the basis of the grade point average of the results obtained by a student in the first attempt at relevant courses in a Bachelor Honours Degree.

**Relevant old rules:**

2.4.1 A student undertaking a bachelors degree or an integrated bachelors/masters program may
be awarded the degree with honours if the student has reached the required level of academic performance set by the executive dean.

2.4.4 The class of honours is calculated on results obtained by a student in the first attempt at honours courses –

(a) for postgraduate honours – on the basis of weighted percentage mark; or

(b) for on-course honours – on the basis of weighted grade point average.

2.4.5 A student pursuing postgraduate honours must complete the requirements in consecutive semesters over —

(a) for full-time students, 1 year; and

(b) for part-time students, a period equivalent to 1 year full-time.

2.4.5A Despite GAR2.4.5, the Associate Dean (Academic) may, in exceptional circumstances, approve interruption of 1 year maximum duration.

The major resultant changes to the BSc (Hons) degree are as follows, with reasons for each change:

• All graduating students are awarded a class of honours, rather than students being required to achieve a particular level of academic merit before they receive a class of honours. There has also been a change to the available classes of honours, with honours class III now split into two classes, III A and III B. These changes were introduced because the AQF mandates that all students who complete an honours degree must receive a class of honours, even if their average overall GPA is less than a pass. Classes III A and III B reflect the difference between an overall passing average grade and an overall failing average grade.

• The class of honours is calculated on the student’s grade point average, rather than on an average percentage. This is because grades (rather than percentages) are the only measures of student performance that have official standing. The average grade cutoffs for the highest classes of honours (classes I and IIA) were concurrently increased.

• There are now (effectively) no limitations on the time a student can take to complete the BSc (Hons) degree, or on the number of courses that a student is permitted to fail, provided the student ultimately passes sufficient courses to complete the degree. This was already the case for so called “on course” honours degrees, and was inconsistent with the treatment of students enrolled in single year honours degrees. For example, previously a student enrolled in a four year Bachelor of Biomedical Science could fail multiple courses in honours, could enrol part time or take semesters off, and still be awarded honours. Conversely, a student enrolled in the BSc (Hons) had none of that flexibility. It was felt that these inconsistencies between the two types of honours degree should not be maintained, particularly given that the nature of the term “honours” has changed.

There have been several advantages arising from the AQF-induced changes, in particular the more consistent treatment of students enrolled in the different types of honours degree programs. However, the AQF statement that “honours” cannot be used as a term of meritorious achievement has posed a range of challenges when thinking about the role and nature of honours. Honours degrees still can and should be of high standard, and the classes of honours certainly reflect the level of student achievement, with class I corresponding to a very high level of performance. However previous rules around honours degrees that implicitly or explicitly implied or required meritorious achievement are no longer appropriate. For example, students enrolled in bachelor degrees, or four year honours degrees, or masters degrees, are all permitted to fail multiple courses and still complete their degrees. Students enrolled in any of those degrees, or PhD or MPhil degrees, are permitted to enrol part time or interrupt their studies, and take somewhat longer than the minimum time to complete. Prior to the rule changes, students enrolled in the BSc (Hons) degree
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were not permitted any such flexibility. Presumably the only argument in favour of disallowing the flexibility was the meritorious nature of honours degrees. With that removed by the AQF, the restrictions became indefensible.

Given the fundamental changes to the nature and role of honours resulting from the AQF, there will be challenges with maintaining the quality and rigour of the degree. Naturally, these challenges are in no way unique to this degree or this university.

The number of students completing honours has varied between years, with a dip in 2012, but in 2014 the enrolments showed an increase of around 20% above typical earlier numbers. There are degree programs within this university and in institutions across the country which have a significant problem with reducing honours enrolments, but that is not happening in the BSc (Hons) degree. Numbers are strong, and there is no evidence that this is likely to change in the foreseeable future.

Of the 1076 honours graduates in the period 2010 – 2014, around 69% graduated with Class I, 28% with Class IIA, 2% with Class IIB and significantly less than 1% with Class III. Overall students have shown a very high level of achievement. Given that so many students are graduating with Class I honours, we need to be certain that standards are appropriately rigorous.

The university has recently changed the way that classes of honours are calculated, at the same time raising the cut offs for Classes I and IIA. We will monitor the impact of this change, and also ensure that graduating with a high class of honours (particularly Class I) is a true reflection of outstanding academic achievement.

Fields of study in honours

There has been a small but increasing trend in recent years of students wanting to undertake honours in fields that do not fall into a particular discipline area. For example, some BSc graduates who are intending to pursue teaching as a career have wanted to complete projects in science education. Others who wish to work in the area of science communication have expressed interest in completing relevant project work. There have certainly been suitable supervisors available and willing to work with such students, from within Science schools and elsewhere on campus, but there have not been obvious named fields that the students could be awarded. We have resolved such situations in an informal manner, by choosing existing named fields in the broader area in which each student is conducting their project. For example, a student who was working on educational aspects of threshold concepts in mathematics was awarded honours in the field of mathematics. While this approach is not unreasonable, it is not ideal from the perspective of the student, the discipline areas, or the consistency of graduate outcomes for graduates with those fields. Hence we propose introduction of two new named fields in the BSc (Hons), which sit outside existing discipline areas. They are in the areas of science education and science communication. The exact names and details of their balance between research project and course work will be decided later.

Industry placements in honours

Many national bodies, including the Office of the Australian Chief Scientist, have been focusing on the need for Australian universities to graduate more high quality, work ready STEM graduates. Naturally, the skills developed by BSc (Hons) graduates in creative and critical thinking, problem solving, communication and deep discipline knowledge are all highly work-place relevant. However, one potential weakness of the BSc (Hons) program is that there is no current visible scope for industry placements or projects within the degree. The Bachelor of Engineering has a stream of honours in which students can conduct a substantial industry based project, where a limited number of students are embedded in a corporation, have both an academic and an industry supervisor, work on projects that have both technical and industrial merit, and write substantial reports in an academically appropriate style. We believe that the BSc (Hons) program would be further strengthened if it included more scope and increased visibility for such experiences.
It is not clear the mechanism by which industry placements in honours would be implemented. One approach would be to introduce a new field with the word “industry” in its name. Another would be to keep the fields as they currently are, but to have flexibility within some or all of them to allow students to complete an industrial project instead of the current combination of advanced coursework and/or an academic project. Naturally, any such changes would need to be consistent with the requirements of the AQF (for example, as quoted above). We note that numerous other degree programs have a substantial component of industry placement and practice in their honours requirements, so this proposal clearly is operationally possible. Care must also be taken to ensure that students who complete an industry placement are still eligible to enter subsequent higher degree study if they wish. Even though they may believe they have no intention of doing so, retaining the option of further study must be supported.

In addition to the broad issues discussed above, individual schools within the faculty have identified the following issues with some components of their honours offerings:

- Poor communication skills of some students (in both written and oral communication).
- Insufficient laboratory and research placements as numbers increase.
- Challenges with cohort size, showing substantial, unpredictable changes between years, or large cyclical changes in numbers over a longer time period.
- The need to interact more closely with the university’s range of research institutes.
- Managing student expectations around their likely class of honours.
- Concerns around the quality of some entering students.
- The use of professional editors to prepare student project reports.

Most of these can be addressed at the school level, although the final one (relating to professional editing of student work) is a question to be considered by the university.

In summary, there does not appear to be any compelling reason to make major changes to the BSc honours degree. In addition to the decision by the university to retain honours degrees, there are also sound academic arguments to retain the BSc (Hons) degree. Enrolments are healthy and even increasing in a number of discipline areas, most graduating students are awarded honours class I, and a significant proportion of those students who complete honours are subsequently entering postgraduate study, particularly PhD study. However, some changes are recommended to ensure that the program retains its strength and flexibility into the future. For example, there are four fields in honours with no graduates over the previous five years (biological chemistry, computational biology, drug design & development, nanotechnology). These fields will be removed unless there is a compelling reason not to do so.

**Suggestions**

That the relevance and quality of an honours qualification be further strengthened by:

- introducing fields in science education and science communication.
- removing honours fields with no or few graduates.
- introducing optional industrial placements and projects.
7.6 Bachelor of Advanced Science (Honours)

The four year BAdvSc (Hons) program was introduced in Semester 1, 2014. Marketing of the first year of the program was limited; despite this, 66 students enrolled in the initial cohort. In 2015, enrolments jumped to 112. The program has been well-received by incoming students with high levels of academic achievement, with 56% of incoming students in 2015 having an OP 1 entry score, and 77% having an OP of either 1 or 2. Figure 126 shows that, of the students who entered the degree in 2014, the proportion continuing into second year is high (> 80%). Of the remainder, 7 students have switched into other UQ programs including the BSc (2), BSc duals (1), or other non-science programs such as Bachelor of Occupational Therapy or BA. Six students are no longer studying at UQ. The retention rate (defined as the number of students enrolled at UQ following the census date 12 months after commencement) stands at 91%, well above the average for most UQ programs.

<table>
<thead>
<tr>
<th>Destination in 2015</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAdvSc (Hons)</td>
<td>53</td>
<td>80</td>
</tr>
<tr>
<td>Other UQ programs</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>lapsed</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

Figure 126. 2015 enrolments for BAdvSc(Hons) students who commenced in 2014.

Figure 127 summarises overall GPAs of students who completed Year 1 of the program in 2014. No such student received an overall failing GPA; the median GPA for the cohort is 6.25.

Figure 127. Cumulative GPAs for BAdvSc (Hons) students, at end of Year 1, 2014.

At the end of 2014, all students enrolled in the BAdvSc (Hons) were invited to participate in a feedback session about their first year experience, and 53 students (from a total of 66) participated. Students were asked the open ended question, “What has worked well in the BAdvSc(Hons) program this year?”. Their responses have been grouped into several main categories, shown in Figure 128. In response to the open ended question, “What improvements would you like to see in the program?”, students identified a range of specific course related items, as well as several program specific issues. Interestingly, it was the social experiences and interactions with researchers and with their peers which was the aspect of their program
they valued most highly, and was also identified as an area for improvement (Figure 129). As part of the compulsory course SCIE2111, students spent around 20 hours across the semester with academic staff from their chosen science discipline. This was an opportunity to get to know researchers and learn about research in a small group learning environment, and was highly valued. Following this feedback, we have increased opportunities for social contact and interactions, including holding a weekend camp for new students. The courses SCIE1100, STAT1301 and SCIE2111 were offered for the first time in 2014, and, as with any initial offering of a course, subsequent offerings will incorporate a range of improvements.

In summary, data show that demand for the program is high, the response from students thus far has been generally positive, and the retention rate after one year is strong. This suggests that the program is achieving its goal of filling a perceived gap in science program offerings. We have incorporated a number of changes based on student feedback, and we propose making the following substantial improvements to the program.

First, the number of majors in the program has been deliberately restricted and will remain so. However, there is an obvious gap in the area of biomedical science. When the degree was first introduced, it was agreed that this major would not be offered at that time, mostly because of substantial administrative
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changes that were concurrently taking place within the university. These changes are now complete, and the option to study neuroscience, immunology or microbiology in greater depth would be appealing to many students.

Second, it is difficult or impossible for students to study a second area of science because of the size of the major in BAdvSc (Hons). One of the distinctions between this degree and the BSc is that the higher-level graduate learning outcomes in the BAdvSc (Hons) are partly achieved at the expense of flexibility. The program was deliberately designed with this in mind, but it has become apparent that the degree is too inflexible. Without wishing to reduce the size of the current majors to a great extent, the degree should become slightly more flexible in a way which would allow students to complete a minor in a complementary area but still retain significant specialisation in their major. Elsewhere in this document it is proposed that minors should be introduced into the BSc. We propose a concurrent slight reduction in the size of majors in the BAdvSc (Hons), permitting students to complete a minor in a different discipline area, if they wish.

Third, we need to consider carefully the option of offering BAdvSc as a three year program, without an embedded honours year. A three year BAdvSc program would look very similar to the current four year offering of the same name, but with honours offered as an optional additional year. We believe that such a program would appeal to a group of students who want a science-heavy undergraduate experience, in an academically elite and challenging program, but who do not necessarily see science research as their career choice, or at least who do not wish to commit to a four year enrolment on entry. A three year BAdvSc program would be a much less flexible offering than the BSc, and would attract high achieving students who wish to focus almost exclusively on one area of science and to engage with their discipline area in great depth. There would be obvious advantages in terms of market perception of an “Advanced” degree, and the idea that it is a program which has a high OP entry cutoff.

Introducing a three year BAdvSc is not risk free, particularly in terms of the market perception of the BSc. The current BAdvSc (Hons) is not intended to be, or marketed as, a “better degree than the BSc for smart students”. It is certainly identified as a superior choice for some students, but conversely the BSc is identified as a more suitable choice for other students, including high achieving students. We would maintain the clear view that each of the BSc, BAdvSc and BAdvSc (Hons) are all strong degrees, designed to fulfil the range of needs of a large cohort of students. For students seeking a globally recognised, flexible degree with a large choice of majors and offered as a dual degree with other areas, the BSc will remain an outstanding choice. For students who achieve the higher entry requirements and want a focused, much less flexible degree with a substantial research component, one of the BAdvSc offerings would be appropriate. For such students who have a firm plan to commit to taking honours and probably pursue research in an area of science they can identify up front, the BAdvSc (Hons) would be the best choice. For other students who only wish to study for three years and then move to a different career path (while still retaining the option to continue on to honours and then higher degree study), the three year BAdvSc would be the best choice.

Suggestions

That the Bachelor of Advanced Science (Honours) be further strengthened by:

- introducing a major in biomedical science.
- reducing the size of majors and introducing minors.
- introducing a three year version of BAdvSc, with an optional honours year.
7.7 Specialist and generalist degrees

As UQ’s two large, generalist degree programs, the BSc and the BA are very valuable programs for the university, both financially and academically. Despite the prominent position of the generalist programs, there has been very little discussion at a university level about undergraduate pathways and the roles of specialised and generalist degree programs. For example, is UQ offering the right mix of programs for students? Is there more value in students doing a generalist undergraduate degree, or should there be more specialised offerings? Where does the BSc (and the BA) fit into the current environment, given the uncertainties around fee structures?

The introduction of BAdvSc (Hons) represents, in one sense, the introduction of a specialised degree, closely related to the BSc, but with reduced flexibility, so that students graduate with more depth in their chosen discipline. This degree of specialisation within BAdvSc (Hons) means that the BSc is more able to be a truly generalist degree for breadth in science and non-science areas. This has implications for the type of courses which can now be offered within the BSc. For example, the deep disciplinary specialisation available within the BAdvSc (Hons) increases the scope to introduce into the BSc interdisciplinary courses on contemporary issues in science, or courses which allow students to transfer specialty based knowledge into problem solving skills in general contexts.

In addition to the BAdvSc (Hons), the faculty offers a number of other specialist science programs, such as the Bachelor of Biomedical Science (Honours), the Bachelor of Biotechnology (Honours) and the Bachelor of Environmental Science (Honours). There is also a range of science-like specialised programs offered by other faculties in the university (for example, the Bachelor of Health Sciences, and the proposed introduction of an elite-entry Bachelor of Health and Medical Sciences). Different Australian educational institutions have taken widely differing approaches to the balance between generalist and specialised degrees. For example, the University of Melbourne and the University of Western Australia have adopted models in which very few undergraduate degrees are offered, and (for example) students who are intending to complete science-like studies all enrol in a BSc, and then specialise after completing that degree. The University of Sydney is proposing introduction of a similar model of a limited number of undergraduate programs framed by a four-year degree structure. UQ has not chosen this approach, and instead offers a wide range of different choices of undergraduate degree.

While the introduction of specialist degrees may make sense from a marketing perspective, any new specialised program must also make sense academically. Prior to the introduction of any new specialist degree, there should be careful consideration of how it fits with other degrees offered by the university, and in particular with the large, generalist degrees. Introducing new degrees that only or predominantly “compete for students” with existing UQ degrees has the clear potential to weaken the appeal and profile of the existing degrees.

An example of recent unintended pressure on the BSc is the move of the Bachelor of Health Sciences to St Lucia, following UQ’s withdrawal from the Ipswich campus. The move resulted in an increase in demand for the program, lifting the OP entry from 12 to 9 and attracting an intake of around twice the previous numbers. If this increase has attracted new students to UQ then the outcome is unarguably positive from the perspective of that degree and also UQ more broadly. But it is also likely that this degree is now competing for the same students who might previously have selected a BSc. Simply transferring students from one effective degree to another is not to the overall benefit of UQ.

The undergraduate degrees in health related areas offered by UQ are currently under review, with a proposal to introduce a Bachelor of Health and Medical Science, with a high entry cutoff, limited places, and a focus on academic excellence and clinical research. How this degree “fits” with the BSc, the BAdvSc (Hons) and the BBiomedSc (Hons) is a part of ongoing discussions, and should certainly remain so.

The BSc is clearly a stand out science program, and as judged by entry cutoffs, is perceived by students in Queensland as the premier science program in the state. However any generalist program with a relatively low (that is, less elite) academic entry cutoff than a more elite specialised program such as BAdvSc (Hons)
or the proposed Bachelor of Health and Medical Science may suffer from a marketplace perception issue. Some students see their high school qualifications as a currency which they do not want to “waste” on a program which cuts off at an entry score lower than their own score. Offering specialised programs with higher academic entry requirements is an obvious way of responding to this perception. Another is to increase the entry requirements for generalist degrees, which is happening with the BSc (having moved from OP 11 to 10 in 2015, it is proposed to increase this further, to OP 9 or better).

The faculty values the range of majors available in the BSc, and does not propose broad-scale introduction of additional specialised degrees. However, there is one discipline which we believe warrants consideration as a specialist degree in its own right, and that is the discipline of mathematics.

Science, Technology, Engineering and Mathematics (collectively known as STEM) skills are needed not only in STEM occupations, but in many other economic sectors. Governments are keen to lift overall scientific literacy and to draw secondary and tertiary students into studies in STEM. Much effort and thought is expended on how to improve levels of STEM participation and skills. At secondary school, students interested in STEM study subjects such as physics, chemistry, technology and mathematics. If they are keen to pursue this interest through into tertiary studies at UQ, they may undertake an identifiable degree program in any of science, engineering or technology. If, however, a student has interest in mathematics and they search for ‘mathematics’ in the Queensland Tertiary Admissions Centre guide, they will not find a UQ degree in mathematics. Mathematics is offered only as a major in either the BA or BSc or BAdvSc (Hons) at UQ, so it is not immediately visible to students.

Another local university, QUT, offers a Bachelor of Mathematics, both as a single degree and also as a dual degree with a range of other degree programs, most notably science and business. Those programs have a moderately elite OP cutoff (6, versus 10 for the UQ BSc), and around 100 students entered the single and dual programs in 2015. It could be argued that better marketing of the BSc major in mathematics might attract more mathematics students into the BSc, but there is evidence that students identify mathematics as being distinct from science. The fact that the acronym STEM lists science as separate from mathematics, and that students study mathematics as separate subjects in secondary school, are part of the reason that students view mathematics and science as being relatively distinct. This view is impacting on students’ tertiary study preferences: we have been informed by students and school guidance officers, on multiple occasions over several years, that some high achieving students are choosing to enrol at QUT to study mathematics because they believe that is their only option for studying mathematics in Queensland.

In addition to increasing visibility and market profile, there are academically sound reasons for introducing a specialised Bachelor of Mathematics. Analysis of the extent to which BSc students are achieving identified graduate learning outcomes across various disciplines (see Chapter 3) highlights that mathematics as a discipline may not “fit” completely naturally within the GLO framework as defined for our current BSc. A specialised Bachelor of Mathematics would include an explicit statement of GLOs tailored to the needs of graduates in that discipline area.

We are currently proceeding with the introduction of a Bachelor of Mathematics for offering in 2016. However, a major in mathematics will also remain in the BSc and continue as a major in the BA. The proposed new Bachelor of Mathematics would be offered as a single degree, and also as a dual degree with bachelor degrees in each of commerce, economics, engineering, arts and science. In particular, we believe that potential students would welcome the opportunity to obtain a dual qualification in a business area (commerce or economics) and mathematics. We recognise that introduction of these new degrees will inevitably impact on the BSc, because some students who currently major in mathematics in the BSc will instead undertake the new degrees. However, we also believe that new students will be attracted to study at UQ, so there will be a substantial positive impact arising from this initiative.
APPENDIX 1: NATIONAL QUALITY INDICATORS IN SCIENCE

This Appendix presents benchmarking data collected via the following three national surveys.

1. **Australian Graduate Survey**

   The Australian Graduate Survey (AGS) is administered to recent domestic and international graduates from bachelor pass and honours degrees, with a focus on graduate outcomes rather than the student experience. It comprises the Graduation Destination Survey (GDS), the Course Experience Questionnaire (CEQ), and the Postgraduate Research Experience Questionnaire (PREQ). This document presents data from the GDS and the CEQ.

   The AGS will be replaced by the Graduate Outcome Survey, tentatively planned for 2016. Whilst changes are planned for this survey, it is expected to continue to measure employment outcomes such as employment rates and salary.

2. **University Experience Survey**

   The University Experience Survey (UES) is administered to domestic and international students currently enrolled in bachelor pass and honours degrees. It measures the undergraduate student experience of first year students (“commencing students”) and third year students (“completing students”).

3. **Employer Satisfaction Survey**

   The Employer Satisfaction Survey (ESS) is a newly developed survey which looks at the overall employment outcomes for graduates as assessed by employers. It is currently being piloted at UQ. Data are presented in the Employability section of this document.

These survey instruments provide general and broad data on the quality of teaching and learning, allowing benchmarking with peer institutions. Data are drawn from the major fields of education of natural and physical sciences, mathematics, and biological sciences, as degree program level data are not available.

(A) **University science program generic skills: AGS**

The satisfaction levels reported by science graduates in relation to a range of generic skills (teamwork, analytic, problem solving, written communication, tackling unfamiliar problems, and planning) is examined in Figure 130 through to Figure 136. UQ is compared with Go8 and local universities. These same skills (as defined by the AGS) are then collated for the UQ single BSc (Figure 137) and the BSc dual programs (Figure 138) for the period 2010 – 2014.
Figure 130. Graduate satisfaction with overall generic skills (AGS).

Figure 131. Graduate satisfaction with development of teamwork skills (AGS).

Figure 132. Graduate satisfaction with development of analytic skills (AGS).

Figure 133. Graduate satisfaction with development of problem solving skills (AGS).
Figure 134. Graduate satisfaction with development of written communication skills (AGS).

Figure 135. Graduate satisfaction with ability to tackle unfamiliar problems (AGS).

Figure 136. Graduate satisfaction with development of ability to plan their own work (AGS).

Figure 137. UQ single BSc graduate satisfaction with development of generic skills (AGS).
UQ was consistently ranked in the midrange (4th – 7th) of the 10 universities used as benchmarks for development of generic skills. However, there was little variation between institutions, and the great majority of UQ science graduates (87% averaged over the years) were satisfied with the overall generic skill development of the UQ science degree programs. In general, feedback on the quality of science generic skills at UQ has increased from 2010 to 2013.

UQ single BSc students’ perceptions of the development of their generic skills improved in every category from 2010 to 2014; feedback from students in the UQ BSc dual programs was more varied. For the single BSc, student satisfaction averaged over the six generic scales increased from 76% in 2010 to 82% in 2014. 

Figure 139 shows the break down, by School, of UQ students’ satisfaction with development of generic skills, measured in 2014. With the exception of the School of Mathematics and Physics, all Schools with substantial teaching into the BSc (for example, Earth Sciences, Chemical and Molecular Bioscience, Biomedical Science, Psychology) rated above the UQ average for student satisfaction. (Response numbers were low for some schools.)
(8) **University science program teaching quality: AGS**

In the following set of figures, science graduates report their overall satisfaction with a range of teaching quality indicators, such as the helpfulness of staff feedback, whether they felt motivated by staff to do their best work and the clarity of explanations given by teachers. UQ is compared with other Go8 and local universities. These same teaching indicators (as defined by the AGS) are then collated for the UQ single BSc (Figure 147) and the BSc dual programs (Figure 148).

![Figure 140. Graduate satisfaction with overall teaching (AGS).](image1)

![Figure 141. Graduate agreement: The staff put a lot of time into commenting on my work (AGS).](image2)

![Figure 142. Graduate agreement: Staff normally gave me helpful feedback (AGS).](image3)
Figure 143. Graduate agreement: Teaching staff motivated me to do my best work (AGS).

Figure 144. Graduate agreement: Lecturers were extremely good at explaining things (AGS).

Figure 145. Graduate agreement: Teaching staff worked hard to make subjects interesting (AGS).

Figure 146. Graduate agreement: Staff made a real effort to understand the difficulties I might be having with my work (AGS).
Figure 147. Student perceptions of teaching staff by UQ single BSc students (AGS).

Figure 148. Student perceptions of teaching staff by UQ BSc dual degree students (AGS).
Discussion: Of the 10 universities used as benchmarks for teaching quality, UQ was typically ranked around the midrange on specific indicators. The majority of UQ science graduates (74% averaged over the years) were satisfied with the overall teaching quality of the UQ science degree program, although there does appear to be some scope for improvement. In most categories, UQ has shown a significant improvement from 2010 to 2013. Feedback from students enrolled in the UQ single BSc improved significantly in every category from 2010 to 2014, although feedback from students in the UQ BSc dual programs was more varied. For the single BSc, student responses averaged over the six good teaching scales increased from a disappointing 59% in 2010 to a very pleasing 76% in 2014. Figure 149 shows that in 2014, all UQ schools with a substantial teaching component in the BSc ranked higher than the UQ average for student satisfaction in relation to overall teaching quality. (Response numbers were low for some schools.)

![Figure 149](image)

Figure 149. UQ graduate satisfaction with overall teaching quality (AGS), by school, 2014.

(C) University science program learning environment: UES

The following figures show the percentage of third year science students who are satisfied with the learner engagement (Figure 150), learner resources (Figure 151) and student support (Figure 152).

![Figure 150](image)

Figure 150. Third year science students satisfied with the learner engagement (UES).
UQ’s rankings varied within the 10 universities used as benchmarks for learning environment indicators. All universities scored poorly on student support (Figure 74), but UQ scored more poorly than most other institutions, and showed a decrease from 2012 to 2013. UQ scored well for learner resources and learner engagement.

(D) Overall degree program satisfaction: (UES and AGS)

The following figures show satisfaction with the overall program for commencing science students (Figure 153), third year science students (Figure 154), and science graduates (Figure 155). UQ is benchmarked against Go8 and local institutions. Figure 156 reports student satisfaction for UQ students enrolled in the single BSc, and for those in BSc dual degrees. Finally, Figure 157 shows the percentages of UQ graduates satisfied with their program overall, broken down by schools which conduct most of the BSc teaching. (Response numbers were low for some schools.)
APPENDICES

Figure 153. Commencing student satisfaction with the program overall (UES).

Figure 154. Third year student satisfaction with the program overall (UES).

Figure 155. Graduate satisfaction with the program overall (AGS).
Compared with other benchmarking universities, UQ commencing, third year and graduate science students all rated UQ highly in terms of satisfaction with their program. However there was not a lot of variation between institutions. Of more interest is that levels of student satisfaction have increased from 2010 to 2014 for students enrolled in the UQ single BSc, with a particularly large increase in scores on the good teaching scale. Feedback from students enrolled in UQ BSc dual degrees has remained relatively static in that time period. Finally, schools with large teaching contributions into the BSc all rated above the UQ average for overall student satisfaction.
### APPENDIX 2: MAJORS REVIEW

#### SUMMARY TABLE

<table>
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<tr>
<th>MAJORS</th>
<th>RECENT CHANGES</th>
<th>WEAKNESSES/ISSUES</th>
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<tbody>
<tr>
<td></td>
<td>No changes</td>
<td>16) Laboratory spaces</td>
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<tr>
<td></td>
<td>Major/degree discontinued</td>
<td>15) Other resource issues</td>
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<td></td>
<td>Course/s discontinued</td>
<td>14) Failing enrolments</td>
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<td>New major/degree</td>
<td>13) Diverse cohort/campus</td>
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<td>New courses</td>
<td>12) Outcome issues</td>
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<td></td>
<td>SCHOOL</td>
<td>11) Vertical/horizontal integration</td>
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<td></td>
<td>6) Replacement courses</td>
<td>10) Active learning</td>
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<tr>
<td></td>
<td>7) Change rules for course requirements</td>
<td>9) Course redesign</td>
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<td>ITEE</td>
<td>8) Vertical integration</td>
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<tr>
<td>Bioinformatics</td>
<td>SCMB</td>
<td>7) Horizontal integration</td>
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<td>5) New major/degree</td>
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## MAJORS

<table>
<thead>
<tr>
<th>MAJORS</th>
<th>STRENGTHS</th>
<th>FUTURE CHANGES</th>
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<tr>
<td>Computer Science</td>
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<td>Microbiology</td>
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<td>Biophysics</td>
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<td>Biochemistry &amp; Molecular Biology</td>
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<td>Chemistry</td>
<td>x</td>
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<td>Physics</td>
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<tr>
<td>Statistics</td>
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<tr>
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<td>Mathematics</td>
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</table>
# APPENDIX 3: 2006 BSc REVIEW RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Recommendation(s) from Academic Board Review committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership and Governance</td>
<td>Recommendation 1: That a BSc Management Committee be formed that is comprised of the Deputy Vice Chancellor (Academic) (Chair), Executive Deans from the BACS, EPSA and SBS faculties, two nominated Institute Directors representing the scientific research institutes of the University and the Chair of the BSc Curriculum Review Committee (see Recommendation 2). This Management Committee has strategic oversight of and responsibility for the BSc degree at the University of Queensland.</td>
</tr>
<tr>
<td>Content, Structure and Quality of the BSc Program</td>
<td>Recommendation 2: That a BSc Curriculum Review Committee is formed comprised of the Directors of Studies from the BACS, EPSA and SBS faculties, a nominee of the scientific research institutes of the University, and the Chairs of the BSc First Year Coordination Committee (see Recommendation 3), the Science in Action Coordination Committee (see Section 8) and the BSc Honours Committee (see Section 11).</td>
</tr>
<tr>
<td>The Foundation Year</td>
<td>Recommendation 3: The development and delivery of the First Year of the BSc program will be the responsibility of the First Year Coordination Committee, which will be comprised of the First Year Course Coordinators and a BSc Program Advisor who will coordinate the allocation of student academic advisors and initiatives to support the transition of students to the University. Recommendation 4: All BSc students will be required to achieve the equivalent of Year 12 level in biology, chemistry, mathematics B, and physics before receiving their BSc degree.</td>
</tr>
<tr>
<td>Core Foundation Courses</td>
<td>Recommendations 5: That all BSc students will be required to take two new courses, ‘Foundations of Science’, and ‘Analysis of Scientific Data and Experiments’, which will be developed and delivered by accomplished teachers working in interdisciplinary teams.</td>
</tr>
<tr>
<td>Program Advising</td>
<td>Recommendation 6: A BSc Program Advisory Group should be formed comprised of academics who advise individual students and cohorts of students on the selection of optimal sequences of studies through the first 3 years of the program in the context of the student’s interests, aptitudes, and career aspirations.</td>
</tr>
<tr>
<td>‘Science in Action’</td>
<td>Recommendation 7: That an optional structured research apprenticeship experience (‘Science in Action’) be developed across years 1-3 of the BSc. Recommendation 8: That an optional structured industry placement course be created for students in year 3 of the BSc that builds on the relationships between faculties, students and industry stakeholders.</td>
</tr>
<tr>
<td>Majors</td>
<td>Recommendation 9: That the BSc Curriculum Review Committee determines the criteria for the introduction of new majors and new courses within the BSc program, reviews all proposals for majors in the BSc and makes recommendations to the BSc Management Group regarding approval of the criteria, structure and content of majors offered in the BSc. Recommendation 10: That the BSc Curriculum Review Committee identify criteria for the development of double major sequences of study within the BSc, which include courses provided by more than one faculty and which ensure that students are exposed to interdisciplinary approaches in emerging areas of strategic importance. Recommendation 11: That a BSc Major Planning Group for each identified major sequence of studies develop an achievable course plan for consideration by the BSc Curriculum Review Group prior to its approval by the BSc Management Committee. The BSc Curriculum Review Group should then institute a regular review process for each such major or double major to measure its delivery against this plan.</td>
</tr>
<tr>
<td>The ‘Capstone’ Experience</td>
<td>Recommendation 12: All majors should include at least one ‘capstone’ course or experience that represents the opportunity for students to experience the integration or synthesis of high level material, knowledge and/or skills from the component courses that comprise a major sequence of study.</td>
</tr>
<tr>
<td>Honours</td>
<td>Recommendation 13: That further investigation of the ‘3+2’ model of a 3 year undergraduate degree (possibly including a merit based ‘on-course’ honours qualification) followed by a 2 year research masters be undertaken as part of the forthcoming review of honours to be conducted by the Deputy Vice Chancellor (Academic).</td>
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<tr>
<td>Quality of Teaching Infrastructure and Laboratory Experiences</td>
<td>Recommendation 14: That a program of phased renovation and re-equipping of teaching laboratories and spaces be prepared as a matter of urgency and resourced to support the delivery of the new BSc program.</td>
</tr>
<tr>
<td>The Research Institutes</td>
<td>Recommendation 15: The Faculties and the Research Institutes cooperate to develop course plans and teaching strategies, which ensure that staff of the Research Institutes are fully engaged in all aspects of the planning and delivery of courses within the BSc degree.</td>
</tr>
<tr>
<td>The Science Teachers Centre</td>
<td>Recommendation 16: That the faculties continue to develop the proposal to establish a Science Teachers Centre at UQ.</td>
</tr>
<tr>
<td>Internationalisation</td>
<td>Recommendation 17: a) The BSc Management Committee should review current practice and define the optimal approach to the internationalisation of the BSc program; and b) Faculties should remove any structural barriers to students studying abroad in approved locations and award appropriate credit for studies carried out by students either before or during the course of their current enrolment in the BSc program.</td>
</tr>
<tr>
<td>Program Evaluation</td>
<td>Recommendation 18: That an independent systematic and comprehensive evaluation of the revised BSc program and its component majors be conducted.</td>
</tr>
<tr>
<td>Graduate Destinations</td>
<td>Recommendation 19: That the University establish and maintain a comprehensive database on graduate destinations which will provide data that contributes to the assessment of the attributes of the graduates from the BSc.</td>
</tr>
<tr>
<td>Resourcing Change</td>
<td>Recommendation 20: a) That the structural adjustment of the BSc program arising from this review be supported and facilitated by supplementary and strategic funding; and b) That any adjustments to the allocation of load-based funding caused by the implementation of changes to the BSc program resulting from this review be smoothed to allow a tapering in of the adjustments.</td>
</tr>
</tbody>
</table>
APPENDICES

APPENDIX 4A: BSc GRADUATE LEARNING OUTCOMES

In-depth knowledge and skills in the field of scientific study

• An in-depth knowledge of at least one area of science.

• Familiarity with, and the ability to apply, relevant techniques, technologies and industry practices.

• An understanding of the nature of scientific thinking, knowledge and research relevant to the major area of study.

• The ability to plan an investigation, select and apply practical and/or theoretical techniques or tools in order to conduct that investigation and to collect, interpret and draw logical conclusions from data.

• An understanding of the nature and significance of current advances in knowledge, thinking and techniques within the major area of study.

• An understanding of the significance, diversity and coherence of the major area of study within the context of global knowledge.

Effective Communication

• Be effective users and communicators of science by being able to-
  (i) collect, analyse, synthesise and critically evaluate information and ideas using the conventions and language of the discipline;
  (ii) select and use the appropriate level, style and means of communication, in oral and written form, when communicating in personal, professional and public forums;
  (iii) argue persuasively, based on sound evidential and/or analytical foundations;
  (iv) engage effectively and appropriately with information and communication technologies.

Independence and Creativity

• The ability to work and learn independently as well as cooperatively in teams.

• The ability to identify problems, create solutions and improve current practices.

• The ability to accept and adapt to changes in ideas, concepts and practices and an appreciation of the need for life-long learning.

Critical Judgment

• The ability to define and analyse existing and emerging problems.

• The ability to apply critical reasoning, independent thinking and informed judgment.

• The ability to evaluate, criticize and synthesise scientific arguments and to question claims that arise from myth, stereotype, pseudoscience and untested assumptions.
**Ethical, Social and Professional Responsibility.**

- Be accountable for their own learning and scientific work by demonstrating-
  
  (i) Knowledge of, and the ability to apply, relevant ethics and ethical standards;
  
  (ii) an appreciation of the philosophical and social contexts of science and its historical development;
  
  (iii) an understanding of social and civic responsibility and of the need to interpret scientific and ethical issues to the general public;
  
  (iv) knowledge of regulatory frameworks, including OH&S, relevant to the major area of study and an ability to apply them in the workplace;
  
  (v) the ability to work effectively, responsibly and safely in individual and team environments;
  
  (vi) an appreciation of cultural and social diversity;
  
  (vii) an understanding of the value of collegial and collaborative interactions and experience in collaborating to achieve a quality outcome;
  
  (viii) an understanding of how to build a career and an awareness of the value of engaging with relevant professional associations.

**APPENDIX 4B: BSc (Hons) GRADUATE LEARNING OUTCOMES**

**Advanced knowledge and skills in the field of scientific study**

- Advanced and coherent knowledge of at least one area of science.
- Familiarity with, and the ability to apply, relevant high level techniques, technologies and industry practices.
- Sufficient skills and knowledge to embark on higher research-based study, such as a PhD or MPhil.
- An in-depth understanding of the nature of scientific thinking, knowledge and research relevant to the major area of study.
- The ability to plan a complex investigation, select and apply high level practical and/or theoretical techniques or tools in order to conduct that investigation and to collect, interpret and draw logical conclusions from data.
- An ability to put into practice current advances in knowledge, thinking and techniques within the major area of study.
- An understanding of the significance, diversity and coherence of the major area of study within the context of global knowledge.

**Effective Communication**
APPENDICES

• Be effective users and communicators of science by being able to-
  (i) collect, analyse, synthesise and critically evaluate sophisticated information and ideas using the conventions and language of the discipline;
  (ii) select and use to a high level of proficiency the appropriate level, style and means of communicating introductory and advanced concepts, in oral and written form, when communicating in personal, professional and public forums;
  (iii) argue persuasively, based on sound evidential and/or analytical foundations;
  (iv) engage effectively and appropriately with information and communication technologies.

Independence and Creativity

• The ability to work and learn independently and as part of a research team.
• The ability to identify research problems, take responsibility for a significant aspect of investigating that problem, create solutions and improve current practices.
• An ability to accept and adapt to changes in ideas, concepts and practices and an appreciation of the need for life-long learning.
• An ability to prioritise tasks and manage a small project in a timely and effective manner.

Critical Judgment

• The ability to define and analyse existing and emerging problems at an advanced level.
• The ability to apply critical reasoning, independent thinking and informed judgment.
• An advanced ability to evaluate, criticize and synthesise scientific arguments and to question claims that arise from myth, stereotype, pseudoscience and untested assumptions.

Ethical, Social and Professional Responsibility.

• Be accountable for their own learning and scientific work by demonstrating -
  (i) knowledge of, and the ability to apply, relevant ethics and ethical standards;
  (ii) a deep appreciation of the philosophical and social contexts of science and its historical development as it applies to the major area of study;
  (iii) an understanding of social and civic responsibility and of the need to interpret scientific and ethical issues to the general public;
  (iv) knowledge of regulatory frameworks, including OH&S, relevant to the major area of study and an ability to apply them in the workplace;
  (v) the ability to work effectively, responsibly and safely in individual and team environments;
  (vi) an awareness of cultural and social diversity;
  (vii) an understanding of the value of collegial and collaborative interactions and experience in collaborating to achieve a quality outcome, particularly in the context of research;
  (viii) an understanding of how to build a career, including in research, and an awareness of the value of engaging with relevant professional associations.
APPENDIX 4C: BAdvSc (Hons) GRADUATE LEARNING OUTCOMES

In-depth knowledge and skills in the field of scientific study

• Demonstrate a deep and coherent knowledge of at least one area of science.
• Demonstrate knowledge of at least one area of science outside the area of specialisation.
• Familiarity with, and the ability to apply, relevant advanced techniques, technologies and industry practices.
• A deep understanding of the nature of scientific thinking, knowledge and research relevant to the major area of study.
• The ability to plan a complex investigation, select and apply sophisticated practical and/or theoretical techniques or tools in order to conduct that investigation and to collect, interpret and draw conclusions from data.
• A broad and coherent understanding of the nature and significance of current advances in knowledge, thinking and techniques within the major area of study.
• A deep understanding of the significance, diversity and coherence of the major area of study within the context of global knowledge.

Effective Communication

• Be effective users and communicators of science by being able to -
  (i) collect, analyse, synthesise and critically evaluate information and ideas from a range of sources, using the conventions and language of the discipline;
  (ii) select and use the appropriate level, style and means of communication, in oral or written form, when communicating sophisticated concepts in personal, professional and public forums;
  (iii) argue persuasively, based on sound evidential and/or analytical foundations;
  (iv) engage effectively and appropriately with information and communication technologies.

Independence and Creativity

• The ability to work and learn independently as well as cooperatively in teams.
• The ability to identify complex problems, create solutions and improve current practices.
• The ability to accept and adapt to changes in ideas, concepts and practices and an appreciation of the need for active, life-long learning.

Critical Judgment

• The ability to define and analyse existing and emerging problems, including cross-disciplinary problems.
• The ability to apply critical reasoning, independent thinking and make informed judgments.
• The ability to evaluate, criticize and synthesise complex scientific arguments.
APPENDICES

Ethical, Social and Professional Responsibility.

• Be accountable for their own learning and scientific work by demonstrating-
  (i) knowledge and respect of, and the ability to apply, ethics and ethical standards;
  (ii) an appreciation of the philosophical and social contexts of science and its historical development;
  (iii) an understanding of social and civic responsibility and of the need to interpret scientific and ethical issues to the general public;
  (iv) knowledge of regulatory frameworks, including OH&S, relevant to the major area of study and an ability to apply them in the workplace;
  (v) the ability to work effectively, responsibly and safely in individual and team environments;
  (vi) an appreciation of cultural and social diversity;
  (vii) an appreciation of the value of collegial and collaborative interactions and experience in collaborating to achieve a quality outcome;
  (viii) an understanding of how to build a career and an awareness of the value of engaging with relevant professional associations.

APPENDIX 5: PROGRAM RULES FOR THE BSc

1. Definitions
   In these rules –
   approved combination means a combination of courses approved by the executive dean;
   dual major means an approved combination of 22 units from Part B of the BSc course list;
   executive dean means the executive dean of the faculty to which the student has been allocated;
   extended major means an approved combination of 22 units from Part B of the BSc course list;
   major means an approved combination of 14 units from Part B of the BSc course list;
   pre-2008 student means a student who first enrolled in the program before 1 January 2008.

2. Field of study
   A student must undertake the program in an approved major or dual major or extended major.

3. Program requirements
(1) To complete the program, a student must complete 48 units from the BSc course list, comprising
   (a) 32 units from part A and B including –
       (i) 6 units from Part A; and
       (ii) 14 units from Part B; and
       (iii) 12 units from Part A or Part B or a combination of both; and
   (b) 16 units from the BSc course list or other course or courses approved by the executive dean.

(2) For rule 3(1)(a), a student must gain 12 units for late year courses.

(3) A student may count a course in Part B towards one major only.

(4) A student can gain no more than 24 units of level 1 courses in the program.

(5) Only students undertaking the BSc/MBBS dual program with a major in biomedical science may undertake courses in Part M of the BSc course list.

(6) Only students enrolled in the BSc/Ed(Sec) dual program may undertake a minor.

4. Maximum credit for other study:
   (1) The maximum credit that the associate dean (academic) may grant to a student for other study is 32 units.
       Note – See GAR 1.6 of the general Award Rules
   (2) Despite rule 4(1), the executive dean may only grant 8 units towards the 12 units of late year courses listed in rule 3(2) on the basis of prior study.

5. Honours
   5.1 Entry
   To enrol, a student must –
   (a) complete the requirements of the BSc at the university; and
       (i) gain the GPA set by the head of school which must include an overall GPA of 4 and a GPA of 4.5 for 8 units in late year courses from Part B which the executive dean decides are relevant to the chosen field; and
       (ii) satisfy any additional requirements set by the head of school; or
   (b) satisfy the executive dean and head of school that based on the student’s qualifications from the university or elsewhere and subject to completion of additional work if set by the executive dean, the student is qualified to undertake honours.

5.2 Field of Study
   An honours student must complete honours in a field approved by the executive dean.

5.3 Program requirements
   To complete the honours program, a student must complete 16 units from an approved field in Part H of the BSc course list.
5.4 Part-time honours
An honours student may enrol part-time if the executive dean decides that the student has commitments which require part-time enrolment.

6 Supplementary assessment
In addition to GAR 1A.17, the associate dean (academic) may grant supplementary assessment in a single course in which the student gains a grade of 3 and where the student –
(a) gains that grade in any semester of study; and
(b) has not been granted supplementary assessment in any other course in that semester; and
(c) has not previously been granted supplementary assessment under this rule; and
(d) makes an application for a supplementary assessment within 5 days of the release of results.

7 Transitional
(1) A pre-2008 student must complete the program under the rules in force on 31 December 2007.
(2) For students entering the program after 1 January 2008 with credit for other study, the executive dean may enrol that student in the current rules or the rules in force on 31 December 2007.

APPENDIX 6: SSSI QUESTIONS

Science Students Skills Inventory (SSSI) explores science-specific graduate learning outcomes across six indicators, listed below. Students were presented with the following questions; academics were presented with corresponding questions, but were not asked to rate confidence.

1. Importance:
   1.1. Survey asked, How IMPORTANT is it to have activities that develop the [insert graduate learning outcome] included in the Science degree program?
   1.2. Respondents selected from a 4-point Likert Scale: Not at all important (1); Not very important (2); Important (3); Very important (4)

2. Assessed:
   2.1. Survey asked, Throughout your entire Science degree program, how often were [insert graduate learning outcome] assessed?
   2.2. Respondents selected from a 4-point Likert Scale: Not at all (1); Not at all (2); Quite a bit (3); A lot (4)
APPENDICES

3. Included:

3.1. Survey asked, To what extent were activities to develop [insert graduate learning outcome] following INCLUDED in your Science degree program?

3.2. Respondents selected from a 4-point Likert Scale: Not included at all (1); Included a little (2); Included a moderate amount (3); Included a lot (4)

4. Improvement:

4.1. Survey asked, As a result of your overall Science degree program, please indicate the level of IMPROVEMENT you made in [insert graduate learning outcome]?

4.2. Respondents selected from a 4-point Likert Scale: No improvement (1); Little improvement (2); Moderate improvement (3); A great deal of improvement (4)

5. Future use:

5.1. Survey asked, Five years after you graduate from your Science undergraduate degree program, how much do you think you will be using your [insert graduate learning outcome]?

5.2. Respondents selected from a 4-point Likert Scale: Not at all (1); Not at all (2); Quite a bit (3); A lot (4)

6. Confidence:

6.1. Survey asked, Thinking about the [insert graduate learning outcome] you have acquired DURING YOUR SCIENCE DEGREE PROGRAM, how would you rate yourself?

6.2. Respondents selected from a 7-point Likert Scale: 1- Very poor; 2; 3; 4; 5; 6; 7-Very good

The SSSI has explored students’ perceptions of selected graduate learning outcomes. The survey was originally designed for final year students but has since been used to gain perceptions across year levels. Five specific outcomes have been explored since 2008, with two added since.

1. Scientific content knowledge
2. Scientific Writing skills
3. Oral Communication skills
4. Quantitative skills
5. Teamwork skills
6. Ethical thinking (added in 2011)
7. Critical thinking (added in 2014)
APPENDIX 7: TEACHING IN THE BSc: UQ RESULTS

For each of the eight survey categories, the UQ distributions are compared to the corresponding means and standard deviations for the UBC sample (Wieman & Gilbert 2014).
## GLOSSARY AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AAUT</td>
<td>Australian Awards for University Teaching</td>
</tr>
<tr>
<td>AGS</td>
<td>Australian Graduate Survey</td>
</tr>
<tr>
<td>ANU</td>
<td>Australian National University</td>
</tr>
<tr>
<td>APEL</td>
<td>Awards for Programmes that Enhance Learning</td>
</tr>
<tr>
<td>ATAR</td>
<td>Australian Tertiary Admissions Rank</td>
</tr>
<tr>
<td>ATE</td>
<td>Awards for Teaching Excellence</td>
</tr>
<tr>
<td>BAdvSc (Hons)</td>
<td>Bachelor of Advanced Science (Honours)</td>
</tr>
<tr>
<td>BOS</td>
<td>Board of Studies</td>
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<tr>
<td>CEQ</td>
<td>Course Experience Questionnaire</td>
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<tr>
<td>COCSL</td>
<td>Citations for Outstanding Contributions to Student Learning</td>
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<tr>
<td>EFTSL</td>
<td>Equivalent Full Time Student Load</td>
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<tr>
<td>ESS</td>
<td>Employer Satisfaction Survey</td>
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<tr>
<td>GDS</td>
<td>Graduate Destination Survey</td>
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<tr>
<td>GLO</td>
<td>Graduate Learning Outcome</td>
</tr>
<tr>
<td>Go8</td>
<td>Group of Eight</td>
</tr>
<tr>
<td>GPA</td>
<td>Grade Point Average</td>
</tr>
<tr>
<td>GU</td>
<td>Griffith University</td>
</tr>
<tr>
<td>HaBS</td>
<td>Faculty of Health and Behavioural Sciences</td>
</tr>
<tr>
<td>HaSS</td>
<td>Faculty of Humanities and Social Sciences</td>
</tr>
<tr>
<td>ICAC</td>
<td>NSW Independent Commission Against Corruption</td>
</tr>
<tr>
<td>iTaLi</td>
<td>Institute for Teaching and Learning Innovation</td>
</tr>
<tr>
<td>IVA</td>
<td>Identity Verified Assessment</td>
</tr>
<tr>
<td>M+BS</td>
<td>Faculty of Medicine and Biomedical Sciences</td>
</tr>
<tr>
<td>MBBS</td>
<td>Bachelor of Medicine and Bachelor of Surgery</td>
</tr>
<tr>
<td>MOOC</td>
<td>Massive Open Online Course</td>
</tr>
<tr>
<td>OLT</td>
<td>Office of Learning and Teaching</td>
</tr>
<tr>
<td>OP</td>
<td>Overall Position</td>
</tr>
<tr>
<td>PASS</td>
<td>Peer Assisted Study Session</td>
</tr>
<tr>
<td>QTAC</td>
<td>Queensland Tertiary Admissions Centre</td>
</tr>
<tr>
<td>QUT</td>
<td>Queensland University of Technology</td>
</tr>
<tr>
<td>SECaT</td>
<td>Student Evaluation of Course and Teacher</td>
</tr>
<tr>
<td>SES</td>
<td>Socio Economic Status</td>
</tr>
<tr>
<td>SSSI</td>
<td>Science Students Skills Inventory</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Mathematics</td>
</tr>
<tr>
<td>T&amp;L</td>
<td>Teaching and Learning</td>
</tr>
<tr>
<td>TEL</td>
<td>Technology Enhanced Learning</td>
</tr>
<tr>
<td>TLC</td>
<td>Teaching and Learning Committee</td>
</tr>
<tr>
<td>UAdel</td>
<td>University of Adelaide</td>
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<tr>
<td>UES</td>
<td>University Experience Survey</td>
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<tr>
<td>UMelb</td>
<td>University of Melbourne</td>
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<tr>
<td>UNSW</td>
<td>University of New South Wales</td>
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<table>
<thead>
<tr>
<th>USyd</th>
<th>University of Sydney</th>
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<tbody>
<tr>
<td>UWA</td>
<td>University of Western Australia</td>
</tr>
<tr>
<td>WIL</td>
<td>Work Integrated Learning</td>
</tr>
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</table>

REFERENCE WEBSITES FOR THE REVIEW COMMITTEE

- UQ organisation chart displaying the Faculty of Science in relation to other units and outlining the ‘schools’ that comprise the Faculty: [http://www.uq.edu.au/about/docs/org-chart.pdf](http://www.uq.edu.au/about/docs/org-chart.pdf)
- Bachelor of Science courses and program website listing all majors and courses (subjects): [https://www.uq.edu.au/study/program.html?acad_prog=2030](https://www.uq.edu.au/study/program.html?acad_prog=2030)
- List of courses that contribute to the BSc with each course linking to an Electronic Course Profile that details content, objectives, and assessment: [https://www.uq.edu.au/study/program_list.html?acad_prog=2030](https://www.uq.edu.au/study/program_list.html?acad_prog=2030)
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