UNSW Learning and Teaching Grants and Fellowship Program

Final Report

Grant: Strategic Educational Development

Title of project: The greatest show on earth: Engaging 1st year biology students through interactive on-line and practical content

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1. Acknowledgements

We thank the input from Scott Mooney (the director of learning and teaching in the School of BEES), and the Learning and Teaching Unit at UNSW. Francine Gregory in the School of BEES helped with the purchasing and the grant budget. Dr Mike Kasumavic (School of BEES) helped with developing ideas behind online video games and apps.

2. List of acronyms used

Provide a list acronyms used in this report.

BABS	Biotechnology and Biomolecular Sciences
BEES	Biological, Earth, and Environmental Sciences
BIOS1101	Evolutionary and Functional Biology (a first year biology course)
BABS1201	Molecules, Cells and Genes (a first year biology course)

3. Executive summary

Our overall aim is to teach and inspire students to understand and explore biological concepts. In a combined effort to enhance the quality of BIOS 1101 (Evolutionary and Functional Biology) and BABS 1201 (Molecules, Cells and Genes). Our project addressed three main aims: the development of more up-to-date and engaging practical activities; the development of comprehensive online learning resources; and the establishment of connections between course theory and current scientific advances.

Project outcomes

- The introduction of new course exercises that combine online material (and advances in technology), cooperation between students, and enhanced interactions with academic staff within the courses.
- Established a growing and flexible video library with content that compliments course material (in lectures and in labs), explores new and exciting biological research, and highlights research currently being conducted by academic staff involved in lecturing these courses and more broadly at UNSW.
- Ongoing development of apps to be used by students to enhance their learning experience.
- Acquisition of hardware (tablet computers, 3-D printer) to facilitate the presentation of biological concepts in the labs.
- Appointment of continuing staff who's primary responsibility is the development of teaching strategies and the improvement of course content and course delivery. These proactive staffing decisions ensure the sustainability of teaching strategies developed as part of this project, and will allow us to implement these ideas in courses throughout the biological sciences.

Recommendations

- *Be inspiring but keep it simple*. Students are not particularly inspired by the technology they use; they are more inspired by the content, and how they can explore biological concepts.
- *Students demand on-line course material but need face to face interactions.* Despite the obvious and increasing demand by students for on-line content and falling attendance in lectures, students perform better, have greater course satisfaction, and more effectively explore biological concepts when facilitated by face to face interactions with lecturers and academics. Maintaining or increasing interactions with students in large courses in a post-lecture course format remains a significant challenge in university teaching.
- *Try a range of approaches*. We attempt to be flexible in the presentation of these courses, continually trying new things and keeping things that work. Simply introducing technology to the course is not

necessarily inspiring to students – these technologies are not new to them. Students engage with concepts, not technologies.

- *Change in courses is a continuous process*. This project was a chance for us to see what works in course development, and establish links with other staff and academics capable of enacting these changes. We now have a framework for implementing further course changes and will continue to try new approaches to teaching biology.

4. Key stakeholders

- Academics and staff in the School of Biological, Earth and Environmental Sciences, particularly those associated with the delivery of BIOS 1101. More recently, the framework established under this course is being used in other introductory biology courses (BIOS 1301 – Ecology and Sustainability)
- Academics and staff in the School of Biotechnology and Biomolecular Sciences, particularly those associated with the delivery of BABS 1201.

5. Project objectives, approach and evaluation

Objective 1) Shift primary course material from static display material to interactive lab and on-line exercises

***Proposed outcomes*:** 1) Shift static practical and in-lab content to online and interactive content; Design and implement virtual lab exercises

Theoretical and conceptual framework

Prior to this project, first year biology teaching practices in the practicals were dominated by static exercises. In BIOS 1101, practical material relied on the presentation of information adaptation, and the evolution of the major divisions of life on a series of displays or posters. In BABS 1201, many of the practicals relied on both static microscope slides and demonstration material. In our project, we proposed to address the problem of the static using two approaches: 1) Developing digital material promoting interactive engagement of students in the practicals, and increasing the availability of lab material on Moodle, where students can learn and revise anytime; and 2) Introducing new practical material based on experiments, games and simulations, and on-line resources. Together, these goals represent primary innovations in the presentation of our first year biology courses

Strategies for project evaluation and outcomes

- For each of the course objectives, we are planning on assembling a group of interested students to provide more detailed feedback on student expectations, progress, and satisfaction with aspects of the course presentation. We are planning on starting the use of the student feedback groups in 2017.
- More broadly, within the school of BEES, a panel of academics will be assessing course material, teaching strategies, and student satisfaction across courses within the school. This panel will first focus on the key first and second year courses to maximise student satisfaction and retention from introductory to more advanced courses.
- We have successfully trialled interactive tablet based activities with multi-touch interfaces in the lab class. We utilised questionnaires to gain student feedback on these activities. Based on student questionnaire responses these lab activities were well received. We also discussed questionnaire results with students and used their feedback to improve subsequent lab activities.

- We are currently assessing student performance on practical exam questions based on practical material supported with interactive and on-line content with material that is currently not supported with this content. Data from BIOS1101 in 2015 are currently being collated and 2016 data will be available at the end session 2. Early assessment of these teaching techniques suggests an increase student performance with the addition of interactive learning material.
- Student feedback through Catei and discussions with students in the pracs will be used to assess the success of the implementation of this part of the project.

Objective 2) Develop and employ on-line content to engage and excite students in biological concepts

Proposed outcome: Develop infrastructure and on-line learning activities on Moodle to cater to students of different biological backgrounds

Theoretical and conceptual framework

In our project, we proposed a streamlined approach in the lecture of practical components of BIOS 1101 and BABS 1201, and the development of on-line content with the common goal of engaging students and promoting them to explore biological concepts and theories. A major driving force behind our desire to develop and integrate new on-line resources is the wide-ranging diversity of the first year biology student population in terms of their learning modes and their existing background knowledge in biology. We acknowledge that students can learn optimally in different ways. This problem has traditionally been addressed by attempting to link lecture material to practical material, and in assigning textbook readings. We now have new and unprecedented opportunities to present concepts and ideas in a range of on-line formats, and we will capitalise on these opportunities in the first year biology courses. Furthermore, this approach will also be employed to develop a suite of online resources that revise basic concepts in life science and function as supplementary material for students with little or no background in biology.

Strategies for project evaluation and outcomes

- Student feedback groups (see strategies for project evaluation under objective 1, above).
- Assessment of courses by a panel of academics (see strategies for project evaluation under objective 1, above).
- Student feedback through Catei and in interactions in practicals

Objective 3) Establish the intellectual connections between introductory biology courses, and the links between course content and current scientific advances

***Proposed outcome*:** To provide students with a framework for understanding connections between organismal, and cell and molecular biology, how the material links with their degrees, and the link between course material

Theoretical and conceptual framework

A problem we have encountered in presenting first year courses is that biology students are often uncertain as to how the their first year courses fit within their broader programs and why the course material maters. Further, our first year students can believe that the ideas and concepts in their courses are long established scientific principles, and they are distant from the leading edge of scientific advances. Our objective in this part of the project was to put the course content of these first year biology courses into a broader context and emphasise the relationship between course content and leading biological research

Strategies for project evaluation and outcomes

- Student feedback groups (see strategies for project evaluation under objective 1, above).
- Assessment of courses by a panel of academics (see strategies for project evaluation under objective 1, above).
- Student performance will be used to assess student engagement and understanding of key biological concepts.
- A fundamental aspect of project evaluation (and in evaluating the overall approaches to first year teaching) will be in the change in student enrolment numbers in upper year biology courses and in the first year courses focussed on here. An increase in student numbers would be an important project outcome.
- We have consulted with lecturers for BABS1201 and have started developing flipped classroom activities to improve constructive alignment between lab and lecture content.

6. Project outcomes and deliverables

Objective 1) Shift primary course material from static display material to interactive lab and on-line exercises

- Purchase of 20 Surface Pro tablets. To bring the practicals alive- the tables compliment stationary specimens/models (for example a model of the heart) the tablet provides a platform where the students can see the specimen/model in motion (e.g. a video of a heart pumping blood). The tablets also allow the students to undertake interactive games to impart concepts as well as encourage flipped learning activities such as the plant safari.
- We are continuing to build the video and interactive app library to be used in the pracs. In addition, we are working with Dr Mike Kasumavic in developing new interactive apps and games for the pracs, and outside the classroom to compliment and consolidate course material.
- Purchase of a 3D Printer and Scanner, which will allow the courses to update and print state of the art new specimens- including access to rare museum scanned items.
- Video assignment and study database created by students for students. As a group, students are assigned a topic from one of the practical classes. Each group is required to research their assigned topic, and then create a video which could be used by their peers to help them study for the practical exam. The videos are uploaded to the course you tube channel. The top videos are also shown at an end of year student BBQ, and prizes are awarded.
- Safari field work App (flipped classroom) is currently being designed to replace our current campus plant safari. After learning how to identify different features of plants in the practical, students then venture outside and directly apply these skills in a field environment. The app is being designed as an amazing race style game, where students get assigned a GPS point for each station, complete a practical exercise and when correctly completed, acquire the coordinates to move on to the next station. The safari will be played as a game, where students work and compete as a team to finish.
- Catalytic lecturing- transforming the lecture style from passive to active whereby the students partake in the lecture.

Objective 2) Develop and employ on-line content to engage and excite students in biological concepts

- Development (and implementation of some early material) of Mastering Biology and an interactive E textbook- a study resource made available to every enrolled student in the course acquired from Pearson Publishers (the publisher of the text book used in these first year biology course). Mastering biology is a virtual/ active and adaptive resource that encourages independent and personalised learning, catered (algorithmically) to each students individual study needs.
- A video database has been built which directs students to state of the art videos from around the world, covering topics from both the lectures and practicals. New videos in this database highlight research topics emphasised by course lectures and academics in the schools of BEES and BABS.
- We found that while students want increased on-line content in their courses, the success of many students depends on direct interactions between students and teachers. We responded to this in BIOS1101 by starting open lab / tutorial times where we set up practice questions and prac exercises multiple times in a week (to accommodate as many students as possible). The open labs are staffed by Dr Bates, A/Prof Bonser, and some of the demonstrators willing to volunteer time. Students come in to ask questions on course content, and many aspects of biological research. These open labs are not mandatory, and no new course material is presented. Despite this, the attendance in the open labs is remarkably high, with the labs at capacity and students waiting to get in.

Objective 3) Establish the intellectual connections between introductory biology courses, and the links between course content and current scientific advances

- We are establishing a series of videos and documentaries addressing some of the big issues in biological sciences (see objective 2). These will be updated as new material is posted. For example, we will soon be able to post a documentary featuring Prof Mike Archer's (one of academics lecturing in BIOS 1101) on the Lazarus Project - an attempt by a global team of scientists to revive an extinct species.
- We have increased emphasis on current research in lectures and in lab exercises highlighting that the course material is frequently at the cutting edge of current biological research.
- In BIOS 1101, as part of our strategy to expose students to current biological research, we provide students with information on research opportunities within the school (the school of BEES maintains a volunteer student researcher list to match student research interests with research groups in the school). Numerous students from BIOS 1101 have started volunteering on research projects in the school of BEES in their second year, including three students in Bonser's research group.
- Other games (app platforms) are currently being created. These will feature as teaching aids for first year level biology-covering evolutionary concepts, anatomy and neuroscience (see objective 2).

7. Sustainability of outcomes

Two important developments in the project will help to ensure the sustainability of project outcomes. First, the School of BEES has appointed grant author Hayley Bates as an associate lecturer with a primary responsibility of managing BIOS 1101 (Evolutionary and Functional Biology), and developing new teaching strategies in this course. In addition, Dr Bates helped to manage BABS 1201 (Molecules, Cells and Genes) in 2016 (and may play an important role in the future), ensuring continued progress in our project objectives. In addition, Ms Bates manages the practicals and is developing course content in BIOS 1301 (Ecology and Sustainability). Dr Bates' appointment is continuing. This appointment recognises the commitment within

the schools of BEES and BABS to the ongoing development of new interactive and on-line resources for first year biology.

Second, Dr Toni Ferrara (the research associate hired under this project) was appointed in an ongoing position in the Learning and Teaching Unit in 2015. Part of Dr Ferrara's role at the learning and teaching unit will be to help in developing and implementing new teaching strategies in first year biology courses.

The schools of BEES and BABS have recognised the importance of developing new teaching strategies (often incorporating on-line resources) for the long term student satisfaction in these courses. The student experience in these courses has a tremendous influence on student enrolment other courses. BEES and BABS have ongoing commitments to providing computer resources (e.g. tablets) are used in the practicals to link hands on projects with video demonstrations and interactive applications.

The approaches refined our first year courses will be employed across courses in biological sciences. We intend to implement successful strategies for engaging students in biology to increase student satisfaction (CATEI feedback) and retain students in upper year biology courses, and increase student number in first year courses. These are priority areas (at least for the school of BEES), and building on the outcomes of this project is an important long-term learning and teaching strategy within the school.

8. Evaluation of Outcomes

Our proposal to simultaneously address our objectives on two large first year courses in two separate schools was highly ambitious. Schools, and large courses within schools, have potentially conflicting goals and needs, and these can lead to difficulties in running the project. The co-director of the project (Dr Anne Galea) left the project on maternity leave for a year six months into the project. After this time, the school of BABS had a much reduced contribution to the project. While members from the school of BABS made important decisions on such things as the platforms for videos, interactive apps, and the hardware to be used (the Microsoft surface pro tablets), the consultation between the groups was quite poor.

Conflicts between the needs of the two separate schools led to problems in the nature of student encouragement into course programs. I believe that many of these issues have been sorted out between the schools. However, conflicts between the schools caused problems in implementing the objective of establishing intellectual links between the courses and demonstrating the commonality between cell and molecular biology, and organismal biology.

We spend a great deal of effort in the first year of the project working to have the new online content (videos, apps, games) accessible from Moodle. This was a very difficult process and was eventually abandoned (following the decisions made by one of the schools – see our comments on difficulties in school co-operation raised above). We should have kept things as simple as possible – links to external web sites and platforms that could be posted through moodle work quite effectively for us, fit with student expectations, and are easy for students to access and use.

Recommendations:

- *Be inspiring but keep it simple*. Our overall goal was to teach and inspire students. In our proposal, we had a number of ideas that were based on technical advances (virtual labs, videos and apps on moodle). However, students are not particularly inspired by the technology they use; they are more inspired by the content, and how they can explore biological concepts.

- *Students demand on-line course material but need face to face interactions.* Updating and modernising the course material has had a positive effect on student experiences in biological science. Much of this can be seen in the positive experiences students have in the labs, and in the open lab / tutorial sessions. Student hunger for face to face interactions with their lecturers sets a difficult problem for the university, as clearly students are engaging poorly with lectures (lecture attendance is quite poor as many students simply acquire the material online) but online only courses will probably not be satisfying for students. We are currently trying to develop a way to present more tutorial style interactions with students in a large class format – this has been challenging so far.

- *Try a range of approaches*. We outlined a number of lab exercises in this final report that seem to work very well to in inspiring and teaching students. However, other things did not work as well. We attempt to be flexible in the presentation of these courses, continually trying new things and keeping things that work. Simply introducing technology to the course (e.g. a video on youtube) is not necessarily inspiring to students – these technologies are not new to them. Students engage with concepts, not technologies.

- *Change in courses is a continuous process*. Our ability to make these course changes sustainable (e.g. through staff committed to continually changing and updating course material) was one of the big positive outcomes of this process. The 1.5 years of the project was a chance for us to see what works in course changes, and establish links with other staff and academics capable of enacting these changes. We now have a framework for implementing course changes that we have expanded to some of our other courses (e.g. BIOS 1301 – Ecology and Sustainability).

9. Financial statement acquittal of funds

All expenditure should be reported in whole dollars.

	Budget $	Expenditure Actual $	Expenditure Committed[1] $	Balance $
PERSONNEL				
Technical assistant, admin relief	153,292	162,795		-9,503
Subtotal				
PROJECT SUPPORT				
Tablet computers, stands, docking stations, security cables	7,790	39,643		-31,853
Consumables		912		
Repairs and maintenance		47		
Subtotal				
PROJECT ACTIVITIES				
Interactive models	1,600			1,600
Video and virtual lab development	42,450			42,450
Vitual microscopy	1,250			1,250
Subtotal				
TOTAL STAGE 1				3,944

[1] Committed expenditure represents funds for purchases or personnel costs that have already occurred and are awaiting invoices/payments