TEACH TO LEARN: USING NEW TECHNOLOGIES TO SUPPORT AGRICULTURE UNDERGRADUATES IN BIOLOGY

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ABSTRACT
This study aimed to assess the perceptions of staff and students as to the type of support required to complete a technology-based assessment task effectively and whether students see the value to their own learning in the creation of videos to explain complex biological phenomona to their peers. The post-assessment survey responses revealed a level of satisfaction with the project, but it also revealed several shortcomings, particularly in communication, planning and implementation, and the design of the individual projects. This intervention is a good example of how using new technologies in teaching can lead to clear learning and teaching benefits such as increased student engagement and improved student understanding.

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INTRODUCTION
It is a truism to say that there is an increasing pervasiveness of Information Communication Technology (ICT) and other technologies in our lives. The expanding diversity of avenues for communicating information and ideas means that it is increasingly important to focus students not only on their capacity to communicate in text, but on their ICT skills so that they are encouraged to think laterally about how to best get their message across.

Another powerful motivating factor for inclusion of communication technology-enhanced student learning activities is the potential that it holds for improving the engagement of students in the core scientific ideas or phenomena. It has been shown that the inclusion of ICT can enhance student interest, effort and attention (Kubiatko & Haláková 2009; Uno 2009). It is critical, however, that we are mindful that the introduction of new technologies does not, in and of itself, result in more effective learning (Rifkin, Longnecker, Leach, Davis & Orthia 2009). As with any approach to teaching and learning, poor planning and implementation of ICT can result in students becoming less engaged and even disgruntled.

Rightly or wrongly, there has been a view that universities are resistant to the uptake of new technologies (Benson, 2009, Rifkin et al. 2009). In order to overcome this perception and build communication skills in Science Graduates, the Australian Learning and Teaching Commission (ALTC) funded a raft of ICT-focused projects including the “New Media for Science” project at http://newmediaforscience-research.wikispaces.com/ (Rifkin et al. 2009). The ‘new technologies’ project brought together and formalised a network of lecturers and other academics working to promote the use of new technologies as tools to be used for the tertiary education of science students. Whereas the program terminated in 2011, it and other initiatives have led to an increase in the number and scope of projects aimed at taking advantage of the possibilities made available by new communication technologies. The role of ICT in learning and teaching is now regularly championed at symposia and conferences and the information sharing that occurs at these events is important for the uptake of innovative methodologies.

The project described here was instigated by the creation of a new unit of study for first year agriculture students studying biology. The establishment of the unit provided an opportunity to use new technologies in a learning activity and to examine its value in student learning. Prior to implementation, some important aspects were considered including being clear as to the advantages of this revised assessment task using “new technologies” and focusing on team work, when compared to more traditional assessment tasks such online quizzes or laboratory reports Being able to communicate what has been learned is an important skill for all students. For teachers, the communication allows them to gain an appreciation of the students' understanding of the given phenomenon and whether it needs reinforcing or correcting.

The creation of any piece of work that will enter the public domain can be a daunting prospect for students and staff alike. Requiring students to come to a level of understanding of a scientific phenomenon whereby they feel confident to create and share a video that will eventually be published on a video sharing website may appear unreasonable for its complexity and for the large amount of effort on the part of the teaching staff and the students. However, if the objective of our teaching practices is to develop in students the capacity to take deep approaches to their learning then it could be seen as time well spent. Previous researchers have documented that the benefits of learning activities such as this are that students have little option but to process the information they have researched and that this leads to a deeper understanding (Ainsworth 1999). Creating multiple representations of explanatory information generates a richer, layered, understanding of the concept being examined. It also generates an appreciation of complexity allowing students to consider different aspects of the concept (Ainsworth 1999; Hoban, Nielsen & Carceller 2010; Hubber, Tytler & Haslam 2010; Lemke 1998; Prain & Waldrip 2006, Rifkin Longnecker, Leach & Davis 2011). The educational theory used by Hoban et al. (2010) to support slowmation learning was particularly helpful for understanding how this repetition deepens student understanding.

The literature suggests that there is considerable merit in using complex tasks to improve learning outcomes. Producing learning objects such as the video can take large amounts of time and effort and requires the development of a number of skills in addition to the main task of understanding scientific concepts. Constructivist activities like this carry the risk of causing the students to feel overburdened by what may seem to be excessive demands and as a result to become disengaged from the task (Porcaro 2010). It is particularly important that a sufficient amount of usable time inside of class hours is given to the project (Gaudet, Ramer, Nakonechny, Cragg & Ramer 2010), particularly if it is worth a considerable percentage of the total marks for the course. This assessment presented students with the opportunity to spend six hours of class time with a member of teaching staff working face-to-face discussing the science and working with the students ideas for presenting the material in the video. The class time also included basic instruction on the use of the camera hardware and the video editing software.

AIMS

This study aimed to assess the perceptions of staff and students as to the type of support required to complete a technology-based assessment task effectively and whether students see the value to their own learning of creating videos to explain complex biological phenomona to their peers.

DESCRIPTION OF INTERVENTION AND EVALUATION METHODOLOGY

Students were required to create a video containing time-lapse footage of a biological phenomenon, with an explanation of the mechanism and published theories behind the observed phenomenon. It was specified that this video needed to be scientifically accurate and interesting, keeping in mind that the level of complexity should suit an audience of their peers. In order to explain the current understanding of their chosen phenomenon, students were required to use a number of sources from the peer reviewed literature. Students were required to present an examinable script brief for the video before their final presentation and to meet with tutors to explain their understanding and approach and so were required to offer multiple representations of the phenomenon they are examining. The process therefore required them to shift between reading texts describing a phenomenon, synthesising the information in their script brief and translating that into their initial draft and final video. The iterative nature of the task allowed students to fix any elements that did not make sense or were inadequate representations of the process under investigation. After the assessment, videos that accurately and engagingly explained what occurs in the time lapse footage had the opportunity to be published on *YouTube*, *Vimeo* or similar network sharing sites. This had the goal of providing external motivation to create a quality product and to engender an appreciation of the public service nature of science. The content and presentation of the video, as well as the up-to-date work shown in the draft version of the videos were worth 30% of a student's final marks. A group question and answer session after the video presentation and a group member peer-review multiplier for the assessments had the benefit of encouraging consistency in the effort and time investment for each of the students within the group.

The unit of study within which the task was set catered to students completing a Bachelor of Environmental Systems or a Bachelor of Science in Agriculture. The class consisted of 54 students. The students were given access to the equipment necessary to conduct the experiment. The group nature of the assessment promoted the practice of communication and mediation between the students. The 54 students were divided into nine groups of six, with five groups completing the task in the first half of semester four in the second half. Each group was assigned one of the following experiments:

1. Gravitropisms (positive and negative) and their mechanisms
2. What can ethylene do (senescence and fruit ripening in the presence and absence of the chemical inhibitor 1-MCP)
3. Mycelium and mushroom growth (*Agaricus bisporus*)
4. Circadian rhythms and diurnal regulation
5. Phototropism and blue light responses
6. Microbe infection of plant material (bacteria soft rot, hypersensitive response)
7. Environmental influences on root architecture development (rhizotron studies)
8. Pig handling for stress minimization and yield maximization
9. The effects of increasing atmospheric CO_2 levels on plant growth.

The groups were given six weeks to capture good quality time lapse footage of their phenomenon, create a script brief of their theory explanation and integrate these into a video. The assessment was completed outside of normal lab sessions with an optional five hours of face-to-face with a member of teaching staff throughout the experiment and further contact with this member of teaching staff via email and *BlackBoard*. The level of face-to-face teaching support (described in Table 1) helped to provide the scaffolding necessary to better engage students in the translation process between each of the multiple representations of the mechanisms of each biological phenomenon.

Table 1: Assistance offered to students during tutorial time for this assessment

Weeks into assessment	Face-to-Face time (h)	Purpose of tutorial time
1	2	· Teach students to use the cameras (Nikon D5200) · Discuss experiment with group, ensuring they understand the basis of the experiment · Set up experiment and camera · Give students an initial published research or review paper on the topic of their experiment and encourage deeper investigation of the scientific literature
2	1	· Review students experimental progress · Teach students to use Adobe video editing software · Turn initial time lapse footage into a video
3	1	· Check student progress in research · Support student software skills · Review progress of script brief process
4	1	· Handing in of draft version of video (detailed script brief as minimum requirement) · Peer assessment of group members effort · Review video draft · Correct student misunderstandings · Evaluate accuracy of student representation
5	1	· Final discussion of the scientific processes investigated in order to make sure that all members of the group understand the science, prior to the video presentation and question and answer session.

The peer assessment conducted in the second last tutorial before submission was used to gauge the effort of each group member up to that point and this was then used as a multiplier for the group mark. If a student was consistently marked down for contribution, for example if they have only put in half of the other group members effort, then that person's mark will be half that of the group mark, as is illustrated in Figure 1. This method of evaluating the time and effort investment of each student has been shown time to improve student attitudes as it provides a fairer mechanism for producing individual marks (Erez, Lepine & Elms 2002; Feichtener & Davis 1984; Loddington, Pond, Wilkinson & Willmot 2009; Pfeff & Huddleston, 2003).

$$S = C/100 \times G$$

Where S= Student Mark
C=student contribution percentage
G=group mark

Figure 1. Equation used to derive student marks

This group assessment formed 30% of the unit of study final mark. This substantial weighting reflects the effort expected to comprehend the science, master the technical aspects, and plan and produce the video to a standard that accurately portrayed and successfully transmitted their level of understanding of the science to viewers. The first third of the assessment was based on the presentation of a final script brief, with the remaining 2/3 being determined by a group presentation of the video, including a question and answer session in front of the whole class and academics in the final week of the semester.

The final week assessment was conducted by a panel of five academics, each with a marking rubric of assessment criteria. The rubric and instructions to the assessors stressed that the focus was on accuracy and clarity of the presentation of the biological phenomena, rather than on an assessment of the subjective appeal of the video presentation. After each video was presented, academics and fellow students were able to ask clarifying questions on the biological phenomena or theory presented and on the processes and choices made in the making of the video. The exemplar video (55 Mb) is available here: http://sdrv.ms/14KLU4Q

The research data used here was derived from Melissa Martin's undergraduate student project where students and teaching staff were invited to complete a voluntary online survey (via SurveyMonkey with participants being non-identifiable) comprised of open-ended response questions. Student were asked how many peer meetings they organised, how much face-to-face contact they had with staff, level of staff involvement in storyboarding and, for staff and students, their perceptions of the impact of using a technology-based innovation to improve understanding of biological phenomena. Open-ended response data were summarised and are presented below together with discussion on ways to improve implementation.

RESULTS AND DISCUSSION

All of the groups were able to complete the draft and final video tasks on time and to a satisfactory standard. An open-ended survey was conducted to gauge student and staff impressions and to gain information from which the process could be revised for the following year. Overall, the post-assessment survey responses (n = 5; 3 staff and 2 students) revealed a level of satisfaction with the project, but it also revealed several shortcomings, particularly in communication, planning and implementation, and the design of the individual projects.

The number of survey responses was low but from the responses submitted the students and teaching staff felt that the assessment task supported student learning. From responses to the question *"how comfortable did your group feel using the technology provided for the assessment"*, students enjoyed the process of using ICT in their learning, felt *"very comfortable"* with the tasks involved and that *"each member of the group was able to use the technology differently, which really helped".* From responses to the question *"Any other comments about this assessment",* Students felt the assessment as a whole was a *"reasonably enjoyable experience",* and a *"great way to learn a diverse range of topics".* Students were able to contact teaching staff outside of face-to-face hours with their questions or with dealing with problems encountered. However, for many of the groups, the diversity of skills within the group meant that they were confident in their own capabilities and so felt that the tutorial sessions were mainly useful as a means to validate that they were *“on the right track”*. Students were concerned about peer assessment. There was an increased confidence from several of the obviously committed students that their lead roles would be rewarded, whereas for others a concern for *“not getting marked down by the other group members”* was a motivating factor. Several of the group decided not to do the peer assessment since they all agreed that they put in the same quantum of effort, albeit it on different tasks.

Timing of the assessment. This assessment task was offered twice, once to half of the cohort at the start of semester and again, to the remaining students, half-way through the semester. Those students who undertook the assessment in the second half of the semester had other assignments due at the same time so these students perceived that they were able to spent less time on the assessment than the students who did the task first. The assessment was offered twice in order to minimize the requirement for equipment and tutorial assistants. To remedy this problem, in future all students will commence the assessment task at the beginning of the semester. Depending on the class size, more equipment will be available or the group size will increase. Alternatively, projects can be offered that require less sophisticated equipment. Many ‘Smart Phone’ mobile phones are able to take digital video and still images of sufficient quality that can be incorporated into a video presentation through the use of video editing software. Whereas mobile phone video data precludes time-lapse photography, biological phenomena such as anatomy or the effects on whole plant morphology of environmental variables can be used to complement a video-based (i.e. stop-motion drawing of a theoretical model) explanation of a phenomenon or theory. The final videos ranged between 5 to 12 minutes in length. Importantly, the time-lapse footage comprised on average only 6% of the length of the videos, with the remainder being explanatory pictorial and textual content and overlying narrative.

Requirement for explicit instructions. More explicit guidance and instructions in how to use the technology is required for both students and teaching staff. On reflection, the assessment did not explicitly identify that *stop motion* and *animation* were to be used to explain the biological phenomenon and so a few groups had a heavy reliance on narration with only basic image support and, here, there was insufficient focus on the cellular processes which underpin the phenomenon. Clearly, the instructions to both students and teaching staff need to be more explicit, particularly with respect to how to best use *stop motion*, *animation* and time-lapse to explain biology. Improvement here will better focus students on how to best represent their ideas and will reinforce the idea that it is better to create diagrams and images *de novo* rather than copying those from textbooks or journal articles; this is critical if students are to publish their work online via *Youtube* or similar. This issue will be addressed in the next iteration of the project through the integration of specialist instruction on media communication. A specialist tutor in media communications has been engaged from English Department at the University of Sydney. The tutor will conduct two X 1 hour tutorial sessions with each of the groups (included in the 6 hours of overall tutorial time) to review the script briefs and instruct the students on effective media communication skills. The remainder of the tutorial sessions will then be able to focus exclusively on establishing a thorough understanding of the scientific theory.

Range and diversity of topics. A few of the topics (biological phenomenon) available to students were identified by teaching staff as being too broad or the topic was too close to another topic e.g. the mechanisms that underpin ‘root architecture’ overlap with the topic ‘gravitropism in plants’. The ‘root architecture’ topic requires narrowing down into one or two aspects, since it can easily become too broad for students to cover in any meaningful way. The ‘plant defences’ topic was recognised by the teaching staff as being more complex than the other topics, and thus required more guidance to focus students on what they should be reading and how to interpret key data. This is not necessarily a bad thing, but could mean that simplification into a video for their peers will subsequently be a much more difficult task than those who have nominated other topics. It was acknowledged before the commencement of the projects that several of them were closely related. It was thought that this might make it easier for the instructors and would reinforce concepts for students at the final video presentations. The overlap was, however, confusing for the students because of the slightly different approaches that the groups took to explain the topics and so overlap will be avoided in the future. The plant defences topic was not perceived by the students as being inherently more complex than many of the other topics. The confusion was viewed more as the result of this project not having been worked through thoroughly before the projects commenced. It is critical that projects have been worked through before they are handed over to students for them to interpret and re-design.

Relevance of the draft. Few students understood the benefits or purpose of handing in their script draft of their project (a storyboard), this needed greater emphasis. The draft was an integral part of assessment scaffolding and the means by which to integrate multiple representations. Discussions around the storyboard brought to light any errors or misunderstandings the students made when interpreting theory as well as to ensure that there is clarity in the methods used to explain theory. The whole process will be more thoroughly explained to the students prior to the commencement of the projects to avoid misconceptions in the future. It is hoped that having an expert tutor in media communication will emphasise the importance of a script draft and why this should be assessed independently.

Teaching staff training. Teaching staff needed to be better utilized and a training step needed to be incorporated in the instructions. Teaching staff were given a table detailing the week-by-week face-time aims of the activity students were to undertake (Table 1) but in the end many of the teaching staff were not required for all six hours. Some of the student groups tended to minimise their contact to just essential needs and students thought of the tutorials as an optional support. The need to scaffold as students move between different representations (e.g., between the written text and their script brief and again between their script brief and their initial draft video) was not clear. As this was the first instance of this type of assessment being offered, the level of support students needed was less than clear and so it was left to students to decide when they needed help and to seek it accordingly. Similarly, teaching staff were not made aware of the importance of their role in scaffolding student processes and learning and thus they seemed quite content to allow students to act more or less completely independently. Although the standard of the scientific explanations in the videos made it clear that almost all of the groups had understood the science to a high level, it was assumed that they could be encouraged to deeper or broader understanding of a topic if they were required to attend the tutorial sessions in future, rather the session being perceived as optional.

Organising the students into effective groups. The size of each group was controlled to maximise effectiveness, however, the composition of the groups was largely by student self-selection. For most groups this was unproblematic, however, two groups, which were formed by students who lacked motivation and this impacted on their final product to some degree. This sort of peer-group selection has been identified in research as one of the worst methods of selection, since students often choose people from their social network of friends without any regard for the work styles or skill base their peers have (Levine & Moreland 1990). Instructor assigned groups have been shown to yield positive student attitudes and a higher level of intergroup stability which enhance a team’s ability to perform effectively (Hernandez 2002, Koppenhauer & Shrader 2003). Recognising that the students in this particular degree are generally quick to build a network of relationships and are keen to share their work with one another, a more effective way to form groups is to utilises these existing friendships; Mahenthiran & Rouse (2000) assert that the best possible method of group selection is to pair friends, and then allow an instructor to combine these pairs to form appropriate sized groups and this approach will be trialled next year.

Copyright Issues For first year students, issues surrounding copyright are usually focused on appropriately attributing the published work of others and while this is the case here, instilling awareness of copyright extends to the student’s own work. Most students were careful to attribute the journal articles, textbooks and CDs from which they sourced diagrams and sounds. There was some concern that students were embedding music and images they have sourced online without asking for copyright clearance from the owner of these media. Copyright and use of videos on YouTube and other New Media to support learning in a university setting has been discussed in previous research by Rifkin et al. (2011) and Micolich (2008) and engaging students as to the implications of breaching copyright remains a challenge. The University of Sydney provides general information that we shared with students (http://sydney.edu.au/copyright/), assuming that the students would make informed decisions before using the work of others to create their videos. In future, to assist students further in complying with copyright, the instructions for this task will include a summary of the copyright laws relevant to online publication of student work and include copies of the University of Sydney letters that can be used to contact creators of material that students wish to add to their video.

We encourage students to publish their videos online and as students hold the copyright of the work they create and publish (including online publishing) they need to be made aware of how to protect their own work from misuse. For group work, the copyright is held by the group and all group members need to agree to have the work published prior to proceeding to publication. It is possible to apply different levels of *creative commons* licensing, so that these videos can be used for further educational purposes (http://creativecommons.org.au/learn/fact-sheets/attribution/). It would not be ethical for us to demand students adopt particular terms, however, providing them with a summary and making recommendations will allow them to better understand what the applicable terms mean and promote an informed group decision.

CONCLUSIONS

This intervention provides a good example of how using new technologies in teaching can lead to clear learning and teaching benefits. Benefits include increased student engagement and improved student understanding of complex scientific topics. The level of engagement in the topics was clearly high e.g. *"..great way to learn".* The students understood that having this assessment format meant more was required from them than might be the case for a more traditional text-based report. From their comments, they perceived the task to be intrinsically interesting and useful. The involvement of multiple academic staff had the benefit of delivering many ideas for improvements to the project and these ideas have been wholly taken on board for the next class in the hope that the potential benefits will be fully realised.

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REFERENCES

Ainsworth, S. (1999). The functions of multiple representations. *Computers and Education, 33*, 22.

Benson, R. (2009). Issues in Peer Assessment and E-Learning. In T. S. Roberts (Ed.), *Self, peer and group assessment in e-learning* (pp. 117-131). Hershey, PA: Information Science.

Erez, A., Lepine, J. A., & Elms, H. (2002). Effects of rotated leadership and peer evaluation on the functioning and effectiveness of self-managed teams- a quasi-experiment. *Personnel Psychology, 55*, 929-948.

Ellem, G. (2007) Group work: Horses for courses in first year biology. First year Experience Forum Presentation, *UniServe Science*, The University of Sydney 126-131

Feitchner, S. B., & Davis, E. A. (1984). Why some groups fail: A survey of students' experiences with learning groups. *Organizational Behaviour Teaching Review, 9*(75-88).

Gaudet A.D., Ramer L.M., Nakonechny J., Cragg J.J. & Ramer M.S. (2010) Small-Group Learning in an Upper- Level University Biology Class Enhances Academic Performance and Student Attitudes Toward Group Work. *PLoS ONE* 1-10

Hernandez, S. A. (2002). Team learning in a marketing principles course: Cooperative structures that facilitate active learning and higher level thinking. *Journal of Marketing Education, 24*, 73-85.

Hoban, G., Nielsen W. & Carceller C. (2010) Articulating constructionism: Learning science through design and making "slowmations" (student-generating animations). In C.H. Steel, M.J. Keppell, P. Gerbic & S. Housego (Eds.), Curriculum, technology & transformation for an unknown future. *Proceedings ascilite Sydney* 2010 433-443

Hubber, P., Tytler, R. & Haslam, F. (2010). Teaching and learning about force with a representational focus: Pedagogy and Teacher Change. *Research in Science Education, 40*(1), 24.

Kubiatko, M. & Haláková Z. (2009) Slovak high school students' attitudes to ICT using in biology lesson. Computers in Human Behaviour 743–748

Lemke, J. (1998). Multiplying Meaning: Visual and verbal semiotics in scientific text. In J. R. M. R. Veel (Ed.), *Reading Science:Critical and functional perspectives on discourses of science* (pp. 87-113). New York: Routledge.

Levine, J. M., & Moreland, R. L. (1990). Progress in small group research. *Annual Review of Psychology, 41*(1), 50.

Loddington, S., Pond, K., Wilkinson, N. & Willmot, P. (2009). A case study of the development of WebPA: An online peer-moderated marking tool. *British Journal of Educational Technology, 40*(2), 13.

Mahenthiran, S. & Rouse, P. (2000). The impact of group selection on student performance and satisfaction. *International Journal of Education Management, 14*(6), 11.

Micolich, A. (2008) The latent potential of YouTube – Will it become the 21st century lecturer's film archive? *CAL-laborate International* 12–19

Pfaff, E., & Huddleston, P. (2003). Does it matter if I hate teamwork? What impacts student attitudes toward teamwork. *Journal of Marketing Education, 25*, 37-45.

Porcaro, D. (2011). Applying constructivism in instructivist learning cultures. *Multicultural Education & Technology Journal, 5*(1), 16.

Prain, V., & Waldrip, B. (2006). An exploratory study of teachers' and students' use of multi-modal representations of concepts in primary science. *International Journal of Science Education, 28*(15), 24.

Rifkin W, Longnecker N, Leach J, Davis L, Righetti J, Stewart C. New Media for Science project 2010. Retrieved June 9, 2014, from: http://newmediaforscience-research.wikispaces.com/Project+information.

Rifkin W., Longnecker N, Leach J. & Davis L. (2011) Worried about engagement? Have students create 'New Media'. *Australian Conference on Science and Mathematics Education Proceedings,* University of Melbourne 211-219

Rifkin W., Longnecker N, Leach J., Davis L. & Orthia L. (2009) Motivate students by having them publish in new media: An invitation to science lecturers to share and test. *Motivating Science Undergraduates: Ideas and Interventions,* UniServe Science, The University of Sydney 105-111

Uno, G. E. (2009). Botanical literacy: How and what students should learn about plants. *American Journal of Botany, 96*, 1753-1759.