

Learning through Video Production - an Instructional Strategy for Promoting Active Learning in a Biology Course

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Videos are widely used in education but the pedagogical potential afforded by student's video productions is largely unexplored. This pilot study used video production as an instructional strategy for promoting active learning in a biology course. Students were instructed to build a 3D model and create a video to explain cell structure and function. They then summarized their project proposal, goal, scientific content and innovation in a report. They were suggested to form teams comprising students from different disciplinary areas, and to incorporate interdisciplinary knowledge into their videos. During the project, three psychological needs including autonomy, competence, and relatedness were supported based on self-determination theory in order to enhance intrinsic motivation. Analysis of the data from student feedback, submissions (models, videos and reports) and final examination revealed enhanced active learning and improved understanding of biological concepts. The results also suggest a need for fostering integrative thinking across disciplines.

Keywords: active learning, cross-disciplinary learning, intrinsic motivation, videos

Background

Recent advance in the digital video technology has enabled non-specialists to produce and distribute videos easily. Videos have been widely used as a powerful teaching and learning tool that enhances information acquisition via both visual and auditory channels. According to a recent survey, 93% of educators and students think it is important to raise the levels of digital and video literacy, and 98% of respondents think the knowledge of video tools and technology is an important part of digital literacy (Kaltura report, 2015). A separate survey shows that 68% of students watch educational video during class and 79% of students watch video to enhance their understanding of a topic (SAGE White Paper 2015). However, although video production and consumption rates are exploding, and students enjoy learning experience via watching videos, it is not necessarily equated with that fact that it is the most effective didactic format. The perceptions of students claiming improved learning should be carefully examined (Kirschner & van Merriënboer, 2013)

In order for video to serve as a productive part of a learning experience, instructors are advised to consider three elements in their video design and implementation: cognitive load, engagement and active learning (Brame 2015). Besides, there are arguments that students might not become critical consumers of mass media unless they experience the media production process themselves (Norton & Hathaway, 2010; Hung et al. 2004). Compared to the wealth of information on how instructors could make and use videos, the pedagogical possibilities in higher education afforded by student's video productions are still largely unrealized.

During years of teaching an elective module, General Biology in the National University of Singapore (NUS), I observed there is low engagement in watching videos related to lectures unless an assessment or assignment task is linked to the videos. Therefore, this study aims to explore a potential instructional strategy using video production for promoting active learning and integrative thinking cross-disciplines. The preliminary data on student engagements, challenges, and learning outcomes through the video production are presented in this report.

Methods

Module information

This study involved an elective module General Biology (LSM1301) in NUS. The module was offered to all university students and comprised of 12 topics taught over 48 contact hours in one semester. Class sizes varied between 300~450 students depending on semesters. The topics included in the video production were cell structure, function and reproduction.

Video production

The video production project included three components: building cell models, creating videos and writing reports. Students used an online forum to form teams, each with 3-4 members. During the project, they were asked to move beyond the biological contents and integrate knowledge from other disciplines. Hence, they were suggested to form teams with members from different faculties. The team will then decide on presentation content and style.

Students were given autonomy to choose the target, either a particular part of cell or an entire cell, to build their cell models. They then used the model with other materials to explain structural and functional contents, record and edit the presentation into a video file no longer than 5 min duration. Finally, they had to write a two-page report to explain the rationale and scientific content of their projects. All videos and reports were uploaded onto The Integrated Virtual Learning Environment (IVLE) for assessment by the module teaching assistants and instructors based on rubrics provided in Table 1.

The teams were given access to technical support and consultations to meet the three psychological needs of autonomy, competence, and relatedness based on self-determination theory (Ryan & Deci 2000) in order to enhance their intrinsic motivation to complete the project.

Table 1: Rubrics for video production project

Scores	Model (4 marks)	Video (4 marks)	Report (4 marks)
3-4	<ul style="list-style-type: none">The target selected with high educational value and strong rationaleThe feature of structures and/or dynamics clearly and correctly shownModels built up with (cross disciplinary) creativities/novelties	<ul style="list-style-type: none">Clearly focused, engaging and strong awareness of audience throughout the presentationArticulating clearly with good rhythmThe model is fully used and well integrated with images/scripts/other materials	<ul style="list-style-type: none">Explained well why the target is selected and model is built (purpose and rationale)Compelling and concise use of words to make the content clear and correctEvidence of integrative thinking across disciplines.
2-3	<ul style="list-style-type: none">The target well selectedThe feature of structures and/or dynamics clearly shownModels built up nicely	<ul style="list-style-type: none">The purpose established early on and the presentation maintained on the topics.Voice is clear and explanation goes smoothThe model is used for the purpose	<ul style="list-style-type: none">The purpose and rationale is explained to some extent.Relevant biological contents are included and correctly stated.There are some ideas, information from other disciplines
1-2	<ul style="list-style-type: none">The target selected without strong rationaleThe feature of structures and/or dynamics can be observed with minor defects	<ul style="list-style-type: none">A few lapses in focus, but the purpose is fairly clear.Explanation is understandableThe model is used at some points, but not really useful.	<ul style="list-style-type: none">The purpose and rationale is explained but not convincingKey points are included but sometimes meanders and confusingNo evidence of cross disciplinary creativities
0-1	<ul style="list-style-type: none">The model has obvious wrong structures or does not fit the conceptThe model is not built up by the groupNo model is built	<ul style="list-style-type: none">Difficult to figure out the purpose of the presentation.Difficult to catch what is said (voice is low or background noise is high)The model is not helpful for elaborating contents (or no model)	<ul style="list-style-type: none">Lack of explanation of rationale or purposeDifficult to understand and follow the ideaInformation is incomplete, irrelevant, or incorrect.Does not show any cross-readings

Investigation of student's learning activities and outcomes

Survey and data collection

Students were invited to provide feedback on the project via an anonymous and optional survey. The questionnaire included 12 questions focusing on the costs (labour and financial) of the video production, team collaboration, self-reported learning activities and outcomes as well as their reflections on the project. The respondents answered the questions using a 5-point Likert scale.

Analysis of student work

Each team's work included a model, a video file and a report. The scores of each component were statistically analysed using GraphPad Prism. This analysis helped instructors to understand challenges, learning activities and efficiency during the project. It also served to identify creativities, cross-disciplinary learning, thinking beyond the biology content and access accuracy of understanding,

Analysis of examination results

The video production project was carried out in the Semester II of AY1415 (Academic Year 2014-2015) but not in the Semester II of AY1516, so that the final examination results from the two semesters could be compared in order to provide another layer of evidence of learning outcomes. The two semesters in comparison have exactly the same module synopsis, and the same lecturers carried out the lectures. The enrolment sizes were 383 in AY1415 and 305 in AY1516. The multiple choice questions used for the final exams were set based on Bloom's Taxonomy with similar cognitive levels at our best effort in the two semesters. There were 10 and 8 questions related to the cell topics in AY1415 and AY1516, respectively. The frequencies of correct answers for each question was calculated and compared. $P < 0.05$ was considered as significant difference by two tailed test.

Results

Student's participation and project completion

There were 383 students from 11 faculties enrolled in the class in AY1415. Although 95.8% of students worked in teams, 86% of teams were made up of members from the same faculty even though they were encouraged to seek team members from different faculties. Three groups submitted their project reports late and were penalized with a 50% deduction of the marks earned. Four students did not participate the project work. The completed projects were uploaded onto IVLE before the deadline.

The financial cost for the project was low and did not hinder the completion of the project (data not shown), while time cost on the project was heavy. The Figures 1 and 2 show the time needed to complete the project. The X-axis represents the number of students, while the information on the Y-axis shows the 5-point Likert scales. The number on the bar is the student number for the particular option. Since this survey was not mandatory for students to complete, the total number of students counted may differ in different questions.

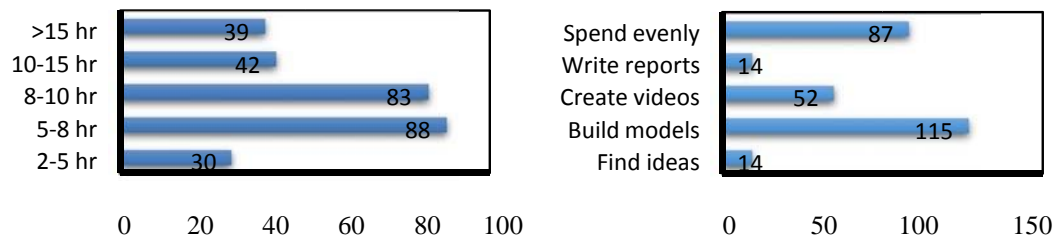


Fig. 1 Hours spent on the project per student Fig. 2 The section taking most of time to complete

Student's perception and self-reported learning outcomes

Marking rubrics (Table 1) were explained to students before the start of the project. The students were informed that there has to be a strong rationale (education value) for the model built, and it should facilitate the presentation. In order to achieve a high score, most students were motivated to read broadly (Fig 3). The student's perception of their own understanding on cellular structure and function suggests that they might have read carefully to achieve the accuracy, which enhanced their understanding in depth (Fig 4). These data also support that students were engaged in active learning.

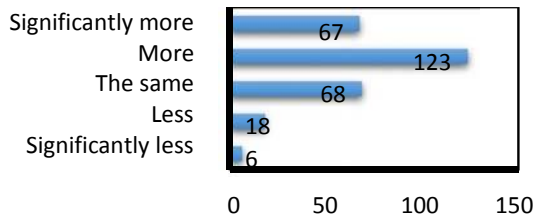


Fig. 3 Reading on the topics of cells compared with reading on other topics in this module

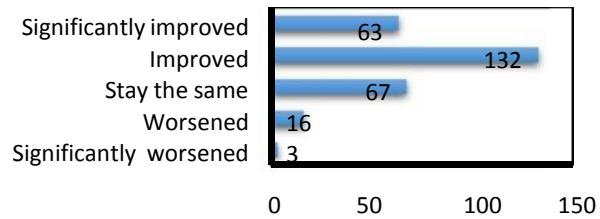


Fig. 4 Learning on the topics of cells compared with learning on the other topics

However, there was tepid support that this project should replace conventional assignments (such as essay writing) for future cohorts (Fig 5 and 6) even though the current cohort reported improved active learning and learning outcomes (Fig 3 and 4). Through informal conversation with students after the project and analysis of module feedback at the end of semester (data not shown here), some students complained of long hours spent and fierce peer competition, which contributed in part to the dilemma faced by students.

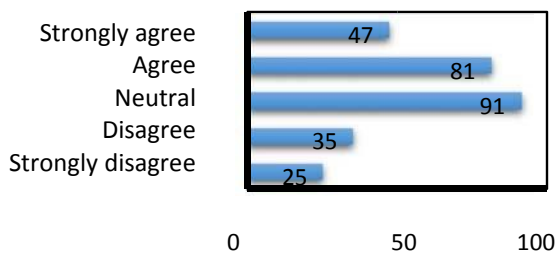


Fig. 5 I prefer this project to the conventional assignment such as a short essay question.

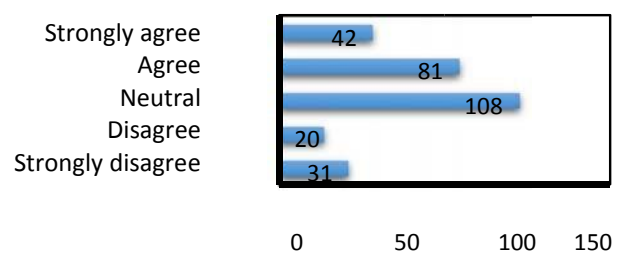


Fig. 6 I am supportive to keep this project for teaching General Bio in future.

Analysis of student work

Each of the three components, i.e. models, videos and reports was graded separately, and each had a maximum score of 4. The average score of entire class (red line) shows the lowest for model building and the highest for report writing. When considered with the survey data (Fig 3), the data suggests that students as a whole encountered difficulties or were not creative enough in model construction.

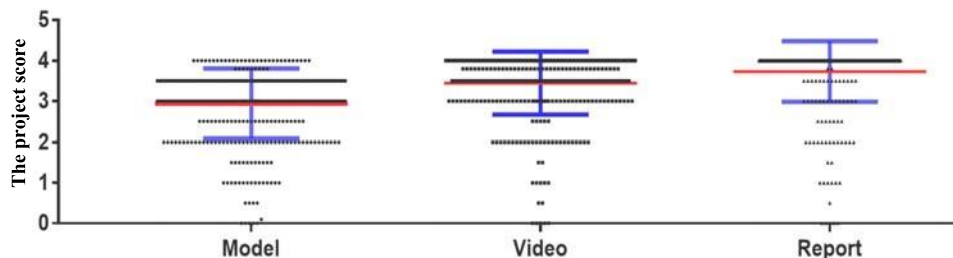


Fig. 7 The distribution of student project scores. Each black dot represents a score from one team; the red line represents average score with standard deviation (blue line)

Analysis of the results of final examination

The two exam results from AY1415 and AY1516 were compared. The overall percentages of correct answers in AY1415 during which the project work was carried out were higher than they in the AY1516 when the project work was not implemented (Fig 8). This result is consistent with the data of student self-reported learning outcomes (Fig 4); they reported better learning outcomes when doing the project. The exam result on all other topics was shown here as negative control (Fig 9). Learning on cell topics is significantly improved when doing the project.

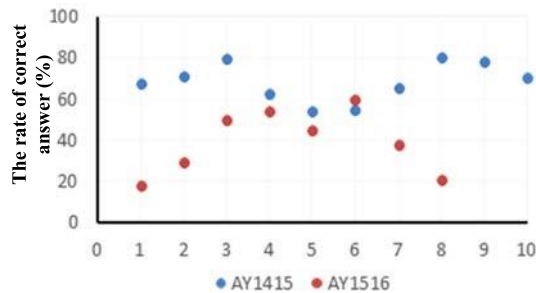


Fig. 8 The frequencies of correct answer (%) of each examination question on the topics of cell in the two semesters with (AY1415) and without (AY1516) the video production project work. There are 10 and 8 MCQs in AY1415 and AY1516, respectively. These questions are arranged randomly in sequences and are independent from each other.

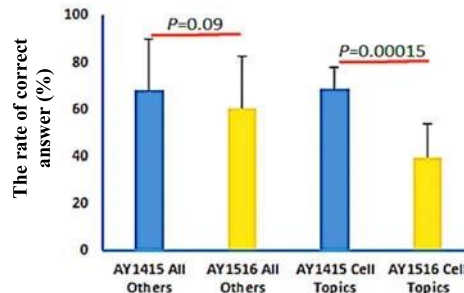


Fig. 9 The average frequencies (%) of correct answer in the final examination in the two semesters with (AY1415) and without (AY1516) the video production project work. It shows no significant difference among all other topics except for the topics about the cell.

Summary

This pilot study explored how video production could promote active learning. An integration of three components, *i.e.* model building, video taking and report writing, and with supports for the three psychological needs makes this project differ from other video projects.

Students were required to select a reasonable target for model construction; and the rationale for the selection had to be addressed in the report. This requires students to read widely, which may have broadened their knowledge. Teams comprising members from different disciplines may also have benefited from cross-disciplinary thinking. Model construction requires students to apply and synthesize knowledge of cellular components and the dynamics of cellular process to create the model in 3-D arrangement. A majority of teams spent their time heavily on this part (Fig 2) when compared to the other two (creating video and writing report). Overall, the video production project is much more time consuming than a conventional assignment. It is worth noting that this trade-off is sometimes ignored when discussing the use of video in learning environments. Future examination of the efficiency of learning through video product should take the time cost into consideration.

Cross-disciplinary work is observed. Some had used their domain-specific knowledge and skills to design and print a 3D cell membrane model and some to show dynamic change using magnetic force. A number of great models was collected and preserved for the future use. Students were happy to know their models become valuable educational assets. The overall quality of videos was higher than expected. Students collaborated in filming and editing of videos and were very satisfied with their team members (survey data not shown). The evidence of strong team spirit and peer learning can also be observed from videos. There was variety in presentation styles; some created songs, some adopted a classroom teaching style, while others presented their models, which they had constructed from food ingredients, on a dinner table. The overall high quality of videos also reflects the inherent competency of college students in digital video technology. The reports consist of the rationale for model construction, scientific contents and self-statements on their creativity across disciplines. Writing provides training on logical thinking, and also opportunities for students to express their idea precisely in words. In addition, the reports also allow examiners to adjust their marking on the models and videos after they read student's statements in the reports.

In brief, the video production project promotes active learning, evidenced by actively looking for references and the improved examination results. Our data may indicate students' weak hand-on ability and creativity to meet the requirement of model building because they spent most of efforts on it but still got the lowest scores among the three components. So long as the three psychological needs are supported, a vast majority of them could collaborate well and complete high quality project work. Future work may focus on how to boost the cross disciplinary talk among students and how to evaluate a work with cross-disciplinary creativity.

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