Assessing the impact of an "Echo360-Active Learning Platform"- enabled classroom in a large enrolment blended learning undergraduate course in Genetics

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In response to calls from the higher education science community to increase student engagement in learning, scientific teaching (reflecting the true nature of science by capturing the process of discovery in the classroom) and reflective teaching (or scholarly teaching), a genetics course was redesigned as a blended learning course. The new course model has provided several opportunities to engage students in the 5E learning cycle and to redefine the classroom experience. Despite the growing literature on effective design of blended courses, very little research has been conducted and very little is known about the impact of components of blended courses for large enrolment courses in relation to student learning outcomes. The goal of this investigation was to assess the impact of an Echo360-ALP enabled classroom on learning gains in a large enrolment blended learning course.

Keywords: Blended learning, Student response System, Learning analytics, Echo360-Active Learning Platform, Scientific teaching, pedagogy, learning outcomes, learning gains.

Introduction

The Introductory Genetics course at the University of Ottawa is a second-year large enrolment course offered by the Department of Biology. Though compulsory for students in the Biology, Biochemistry, Biomedical Sciences and Biopharmaceutical undergraduate degree programs, students from different faculties also take the course as an elective. Topics covered in this course include Mendel's laws of inheritance and application of Mendelian analysis to problems in genetics including gene mapping and linkage, molecular genetics, bioinformatics, and population genetics; with laboratory experiments to illustrate genetic principles. Initially taught using traditional teaching approaches (e.g. lectures), technology-enabled pedagogies have facilitated the transition of this course into an active learning zone combining online activities, face-to-face classes, and laboratory sessions to provide students with spaces to study, discuss, and apply within a collaborative environment the conceptual frameworks that serve as the foundation of genetics as a method of scientific discovery.

In 2013, the University of Ottawa Board of Governors approved an initiative for the implementation of large scale blended courses at the University to enrich the student learning experience while providing many benefits for both students and professors (Caulfield, 2011) by combining the best of online and face-to-face (F2F) teaching. The support provided by the blended initiative made possible the implementation of technology-enabled pedagogies in this course. In a broader context, it also gave opportunities to respond to calls from the higher education community to increase student engagement in learning (Bradforth and Miller, 2015), scientific teaching (reflecting the true nature of science by capturing the process of discovery in the classroom) and reflective teaching (or scholarly teaching) (Handelsman et al., 2004). The new course structure, designed to engage students in the 5E learning cycle (Piaget, 1950) – Engage, Explore, Explain, Extend, and Evaluate – aims to lead students in learning content outside of class time through assigned readings and online homework that include interactive exercises, quizzes, and metacognitive reflective activities. Class time, on the other hand, is used to study, discuss, and apply the conceptual frameworks of the discipline in a collaborative setting to scaffold learning of core disciplinary ideas such as applying the process of science, using models, reasoning analytically, developing arguments, creating narratives, and working cooperatively to actively construct knowledge. Inasmuch, taking advantage of pedagogical approaches associated with blended learning known to enhance the student learning experiences (Caulfield, 2011).

Using blended delivery, the new course model (figure 1) has provided several opportunities to redefine the classroom experience. The online environment offers students the convenience and flexibility to study and review materials at their own pace and time, enabling the instructor to use pedagogical strategies and activities for synchronous peer-to-peer and student-faculty conversations. Consequently, this allows students to receive immediate feedback and mentorship and to hone their critical and analytical thinking skills in support of independent learning (i.e online). Inasmuch, these opportunities also offer the instructor chances to gauge learning through routine formative and summative assessments. Indeed, classroom activities are now dominated by student-centred activities that rely on Just-in-Time teaching and learning approaches, problem-based learning, and clicker-case studies (e.g. interrupted cases) (Herreid 2006) to engage students, individually and in groups, in applying their learning and scientific knowledge to evaluate and solve issues contained within a story (Herreid 2006; Lundeber et al., 2011).

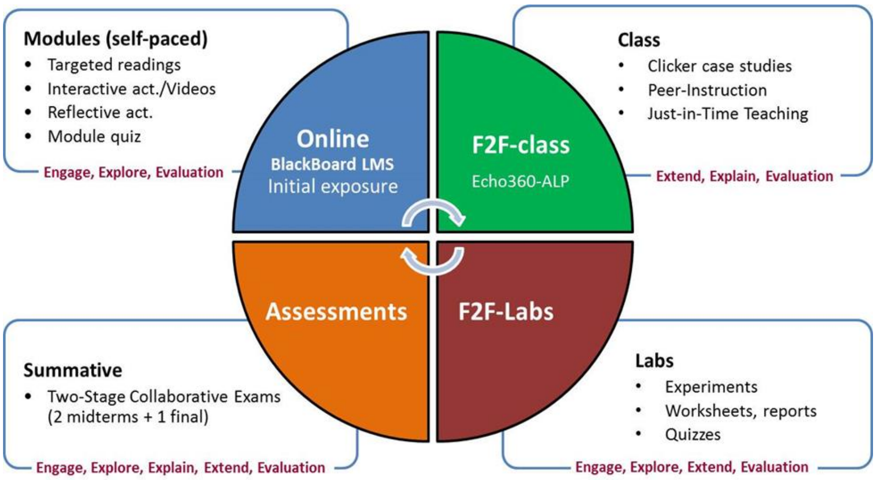

Figure 1. Structure of the BIO2133 Genetics Blended Course

The redesign of the course aims to combine online, F2F and lab activities that take advantage of the 5E learning cycle to engage students in independent, reflective, and collaborative learning activities.

Anderson (2003) defines 6 modes of interaction in distance education between student, teacher and content; from the students' perspective, these include student-student, student-teacher and student-content, while from the teacher's perspective, teacher-teacher, teacher-content and content-content interactions are considered. The Interaction Equivalency Theorem (Anderson, 2003) posits that while a high level of a single type of interaction between two components (student-teacher, student-content or teacher-content) can provide "deep and meaningful learning, high levels of more than one of these three modes will likely provide a more satisfying education experience". Though Anderson`s work has been largely dedicated to online teaching and learning, it is not unreasonable to extend his views to blended courses given their pedagogical and structural similarities.

The Echo360-Active Learning Platform (acronym ALP, a cloud-based student-response-system (SRS)) was chosen to engage a high number of students by harnessing large scale student ownership of laptops and mobile devices and to facilitate a community of learning fostering student-content, student-student, & student-professor interactions. Echo360-ALP features can facilitate the interaction between students and their professor; reciprocally, polls and quizzes allow professors to assess their student's grasp over content and intervene accordingly. Ability to write time-stamped notes alongside class videos (lecture captures) and playback recordings allows for a deeper student-content interaction. Students also have the ability to flag points of confusion and ask their professor questions through the platform without the fear of exposing themselves publicly. Finally, access to data on learning analytics and on viewing/reviewing of content by students allows teachers to identify student needs and customize content to improve classroom effectiveness.

Despite the growing literature on effective design of blended courses, very little research has been conducted and very little is known about effective design of blended courses for large enrolment courses in relation to student learning outcomes. Given that the Echo360-ALP provides tools with which to implement effective technology-enabled pedagogical approaches and to access learning analytics, the Echo360-ALP is well positioned to play a central role in providing deep and meaningful educational experiences in courses designed for blended learning in accordance with Anderson`s Interaction Equivalency Theorem (Anderson et al., 2003a). Knowing the nature and manner in which students engage with the Echo360-ALP system will enable instructors to develop informed strategies to improve the effectiveness of the course. The present study aims to assess Echo360-ALP's role in strengthening Anderson's 6 modes of interactions, and to investigate if student outcomes can be related to student engagement with the system.

Methodology

The study was carried out during the 2016 winter semester (January to April) in three separate sections (different times and days) of the course taught by the same professor, in an Echo360-ALP enabled auditorium (lecture capture software and camera) with a smart podium and WI-FI capabilities. Echo360-ALP learner metrics were collected each time students accessed the various features of the platform by logging-in to their personal accounts using a laptop computer or a mobile device connected to the internet prior, during, and after class. From this platform, students have the ability to navigate and annotate class notes to slides (in addition to accessing a PDF version of the slide deck) and flag content that confuses them to the professor. Moreover, students were also free to post questions/comments on a backchannel with the professor, teaching assistants, and other students able to respond to them. Every class, students submitted answers to "clicker-style" questions using their device and earned participation marks for submitting answers, regardless if they were correct or not. Following class, lecture captures were also available for viewing. Student usage of the various features of the Echo360-ALP was recorded by the system's "learner analytics". Eight variables (learner metrics) were collected from the learner analytics to conduct the analysis. These were Activity Participation: % answers submitted to the total of activity questions asked; Activity Score: % of correct answers to the total of activity attempts; Attendance: % of classes attended (and logged in to platform); Note Taking: total amount of words written in platform during the term; Presentation Views: total amount of times a presentation (slide decks) were viewed during the session; Presentation Views - % total viewed: average of the % of slides viewed; Video Views: total amount of times a lecture capture (video) was viewed; Video Views - %total viewed: average of % of length viewed of the lecture captures. Note, the "posting a question" feature was used by less than 5% of the students and thus not used in this analysis. Echo360-ALP learner metric data was collected from approximately 597 students.

Understanding of genetics concepts was assessed using a validated genetic assessment test (Smith et al., 2008), which comprises a set of 25 multiple choice questions designed to measure conceptual understanding of content aligned to course learning outcomes. The test was administered at the beginning of the course and prior to instruction (pre-assessment) to get a baseline level of student understanding and again at the end of the course (post-assessment). Learning gains were measured using the following equation: LG= [(Postscore – Prescore)/(100%-Prescore)]. A total of 434 students completed both the pre- and post-assessments.

Correlations and linear regressions were used to assess the impact of Echo360-ALP learner metrics on student learning gains. Correlation was first used to assess the link between each metric and student performance on exams and learning gains, respectively, as well as between each metric, individually. Stepwise backward multiple linear regression with AIC criterion for deletion was used to test interactions between Echo360-ALP learner metrics and learning gains. Finally, logistic regression was used to further break down the analysis and evaluate how the effect of metric usage varies for different levels student learning. Students were divided into quartile groups: 0-25%, 26-50%, 51-75%, 76-100% for this analysis. All statistical analyses were performed using version 3.3.0 of the R software (R Core Team, 2016).

Results/Discussion

The Echo360-ALP was introduced to the students during the first class and 99% of the students were signed on to the platform by the second class. Prior to class meetings, slides prepared in PowerPoint were uploaded in the platform. On a per class basis, 5-7 "clicker-style" questions were asked to engage students in peer-instruction activities. Students submitted answers to a mix of multiple-choice questions, short answer questions, ordering list questions, image hot-spot quizzes, or numerical questions, using their laptop computers or mobile devices logged in to the course Echo360-ALP account.

All features of the Echo360-ALP were used during and/or following class. Echo360-ALP learner metrics show that students attended class on average 89% (with a median 89%) of the time and, when present in class, submitted answers to activity questions 99% of the time. On questions seeking a correct answer, students were successful approximately 50% (median 52%) of the time. In terms of note taking, students wrote on average 2245 words (median 1350). 91% of students took notes in the platform during at least one lecture. Overall, students averaged approximately 200 words per class meeting. Students viewed the slide deck in the platform on average 125 times (median 114) during the term. 100% of the students viewed a slide deck at least once during this time. Furthermore, an average of 90% of students viewed the slide decks associated with each class meeting. Students viewed on average 60% (median 62%) of the length of the slide decks associated with each class time. Following class meetings, number of lecture captures viewed by students varied between 0 and 24 times for an average of 13.8. Students viewed on average 34% (median 30%) of the length of each lecture capture. Each student viewed at least 5% of one lecture during the term.

Based on classroom observations and student comments, students greatly appreciated the implementation and use of this tool during class meetings. Factors that contributed to this appreciation include low cost (no cost to the student; cost covered by the institution), low-stakes participation (students earn participation marks, no grade associated with correctness of answers), anonymity of revealed answers, and the ability to communicate with the professor (and other students) in private during class without exposing themselves publicly. Students felt that the instructor was listening to them during lectures and that the professor was able to provide prompt feedback (e.g. address confusions and/or common questions/comments on the "ask your prof" feature, or share thoughts on student answers to "clicker questions") in a more synchronous fashion. Students felt that the platform helped make classes more game-like. The opportunity to combine peer-instruction approaches with the various ways to ask questions made class fun, interactive, collaborative, and intellectually challenging, and made class time go by more quickly. Others indicated that the classroom approaches helped transform class time into a "study-zone". Some students even expressed a wish for longer class sessions! A large proportion of the students appreciated the ability to take and keep notes within the platform, and then access them wherever they went. Finally, students also liked being engaged with their own devices as they could consult the Internet at the ready during classroom activities

While the Echo360-ALP supported the implementation of strategies that reinforce the 7 principles of good teaching (Gamson and Gamson, 1987), notably activities encouraging student to student interactions, interactions between the students and the professor, and student interaction with the content (among others), the aim of this project was to investigate if student outcomes can be related to student engagement with the system. Because exam questions and difficulty may differ from year to year along with group abilities, and despite all the good intentions to formulate thoughtful and useful questions to assess student learning, final exam scores may not necessarily serve as good indicators of class success. An alternative way to assess classroom performance is through the use of concept inventories. Concept inventories are tools designed to help educators evaluate students' understanding of a specific set of concepts and identify misconceptions. Unlike typical MCQ tests, both questions and response choices are the subject of extensive research designed to determine both what a range of people think a particular question is asking and what the most common answers are. In its final form, the concept questions present both correct answers as well as distractors, which are incorrect answers based on actual commonly held misconceptions. Questions used in this test were aligned with the learning objectives of the course.

Among the students who completed both the pre- and post- assessment, normalized learning gains were normally distributed with a class average of 50%. Correlations and linear regressions were then used to assess whether student gains on the concept assessment test could be associated with student engagement within the Echo360-ALP system. Correlation was first used to assess the link between each learner metric, and between learner metrics and normalized gains on the concept assessment test. Correlation tests revealed very little links or no links between the Echo360-ALP learner metrics and normalized gains on the assessment. Stepwise backward linear regression was then performed to test for higher order interactions between learner metrics that may lead to differences in assessment gains. The generated predictor model accounted for 60% of the variance in normalized gains (p-value = 0.09), where very few interactions were deleted from the full model. Overall, these observations suggest significant and complex interactions between the Echo360-ALP learner metrics and associated gains on the concept assessment.

Using this model, the impact of the Echo360-ALP features on student outcomes was assessed by calculating the effect size of each of these features on the predicted assessment gains. The results demonstrate that while high attendance, the % of presentations viewed, # of video views, and the activity score positively impacted gains on the assessment, note taking within the platform and the length of video views may be negatively associated with these gains. Thus, attending class, participating in activities, and engaging in independent study appear to positively contribute to student gains on the concept assessment test.

The effect of feature usage on the probability of falling within a gains (on the assessment test) quartile was assessed by logistic regression. The results show that while the higher level activity participation and activity score increased the chances of students to fall within the 1st, 2nd and 3rd gains quartile, low participation and activity scores increased chances of students obtaining lower gains score, therefore falling in the 4th learning gains quartile. Finally, while attendance, note taking, presentation views (# viewed and length viewed) and video views (# viewed and length viewed) appear to have had very little to no impact on the probability of falling within the 1st and 2nd gains quartile, they seemingly had effects on those students falling in the 3rd and 4th gains quartiles. For example, higher note taking, and longer length of presentations and videos viewed increased the probability of obtaining lower learning gains. Predictively, the manner in which these students are using these features for studying purposes is impacting their conceptual understanding of the subject matter.

Conclusion

Historically the course has been regarded by students and instructors as one of the most difficult 1st and 2nd year undergraduate science courses and has typically had high failure rates. As in other higher education institutions, instructors attribute this reputation to a number of factors: little or no opportunities for the development in numeracy and thinking skill in the curricula; ineffective study habits (e.g. rote vs higher cognitive levels); larger focus on content coverage than student-centred outcomes; lack of familiarity with assessment strategies (e.g. assessment of conceptual understanding); and few opportunities to interact with genetics as a research model. The inclusion of the Echo360Active Learning Platform into the class component of the course has provided opportunities to redefine the classroom learning experience to one that is aligned with a student-centred classroom consistent with the institution's teaching and learning philosophy for blended learning courses, scientific teaching, and scholarly teaching. Does student engagement in the classroom in a blended learning course translate into successful learning? The Echo360-ALP facilitates active learning and formative assessment opportunities to improve student performance by offering a diversity of approaches to setup instruction and reflections on prior knowledge (to provoke thinking, stimulate discussions and induce cognitive conflicts); to develop knowledge (tackle misconceptions, exercise skills, and conceptual understanding, judging etc.); communicate (asking and answering questions); and assess learning (exit polls, probe limits of understanding, demonstrate success, and review). The platform also offers educators endless ways to engage student intellectual and affective domains and metacognition, while offering students the means to express themselves (even in a large group setting). The results of this study suggest that the level of students' engagement with the Echo360-ALP system can have impacts on their performance in the course. The degree to which students use features of the Echo360-ALP in and out of the classroom and the manner in which these contribute successfully (or unsuccessfully) to their conceptual understanding remains unknown and will be the focus of future studies. Engagement with the Echo360-ALP features and strategic use of each of these features in concert with one another could predictively play a significant role in learning outcomes. In these regards, it is therefore of essence for instructors to scaffold student use of the Echo360-ALP to ensure effective studying practices in and out of the classroom. To further help in these endeavours, the goal of future studies will be to dissect how the tool is used by the students and to formulate best practises for usage by students and instructors.

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