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Online Learning Objects with Embedded Self-Assessments as a Model for a Blended Student-Centered Approach in Introductory Biology

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Abstract

Blended learning classroom formats are becoming increasingly prevalent in large lecture undergraduate science courses. Integration of blended learning practices with online embedded student self-assessments provide flexibility during in-class time to extend conceptual understanding with student-centered approaches. We have developed web-based quiz questions with feedback that can be used in concert with online materials outside of class for introductory biology courses. The questions are in html5/Javascript format and can be accessed by most internet browsers and mobile devices. We specifically focused on difficult concepts in molecular biology such as DNA replication, transcription, and translation. Several question formats were used in concert with online materials to provide students with background material and opportunities for self-assessment. We compared in-class assessment results using a comparison group study approach that analyzed overall conceptual understanding in various classroom formats: a traditional large lecture with no student-centered learning, a large lecture with active learning and flipped components, a completely flipped student-centered format (Student-Centered Active Learning Environments with Upside-down Pedagogies – SCALE-UP), and a distance education section of the class.

Objectives

- To assess the effectiveness of online embedded student self-assessments through the use of a post-lesson in-class quiz.
- To compare student performance on an in-class assessment in order to compare various instructional methods.

Methods

- Target classes for this study included four sections of BIO 183 in Spring of 2014: a distance education section, a traditional lecture section, a modified lecture section, and a SCALE-UP section.
- A webquest (an online interactive guide to a topic) was developed to introduce introductory concepts of DNA replication, transcription, and translation and utilized in the DE, modified lecture, and SCALE-UP sections.
- Five online self-assessment exercises related to the webquest content were available to the students during the completion of the webquest.
- Following in-class activities or lecture on the topic of the webquest, students were given a free-response summative assessment written to target higher levels of Bloom's Taxonomy.
- Students in the modified lecture and SCALE-UP were also asked to anonymously indicate if they had completed the webquest and all online self-assessments after the completion of the in-class assessment.
- Two comparisons of student performance were made: one comparing overall student performance for the four sections, and one comparing performance for students who indicated they had completed the webquest with those that did not.
- Samples for assessments were simple random and independent. Sample size was based on 35% of total class size for overall averages and 50% of total class size for averages of students who did/did not complete the webquest for each section to ensure sample size and distribution equality for each section.
- All p-values were calculated using either a one-way ANOVA or a student t-test and evaluated at alpha = .05. Data was assessed assuming independent variables with unequal variances.

A group of students utilizing technology during class.

Results

- Class average for traditional students on the replication/translation/transcription assessment was significantly lower than SCALE-UP's and the modified lecture's class average.
- There were no significant differences found between modified lecture students' performance and SCALE-UP students' performance on the assessment.
- The average for students who did complete the webquest in both the SCALE-UP and Modified Lecture sections was significantly different from the average for students who did not complete the webquest in the SCALE-UP and Modified Lecture sections respectively.
- Data for the Distance Education section of introductory biology was not utilized in this analysis due to its preliminary status.

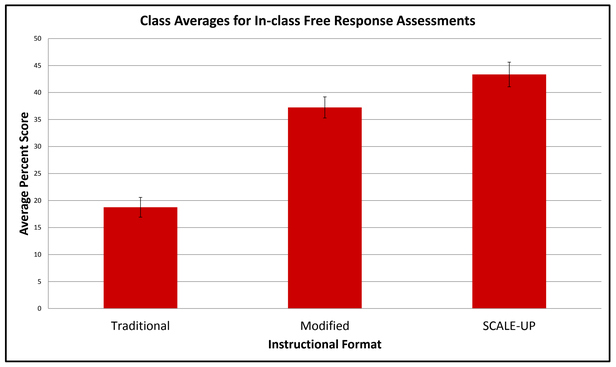

Figure 1: Class Averages for In-class Free Response Assessment with SE Bars

A one-way between subjects ANOVA was conducted to compare the effects of instructional methods on student performance. There was a significant effect of instructional method on student performance at p< .05 for the three methods. [F(2,144)=32.28, p=2.61E-12]

Post hoc comparisons using the Tukey HSD test indicated that the mean score for the traditional lecture (N=45, M=18.75% , SD=12.34) was significantly different from the modified lecture (N=71, M=37.24%, SD=16.51) and SCALE-UP (N=30 M=43.13% SD=12.86). However, there was no significant difference found between the modified lecture and SCALE-UP.

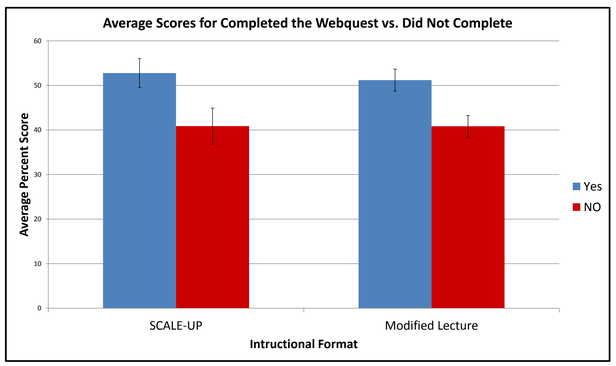

Figure 2: Average Scores for Completed the Webquest and Did Not Complete with SE Bars

A difference of means student t-test was conducted to compare the effects of the online self-assessment on student performance on an in-class free response assessment at the p<.05 significance level. There was a significant difference (p=.017) between SCALE-UP students who did complete (N=27, M=52.77% SD=16.81%) and SCALE-UP students who did not complete the webquest and online self-assessments (N=13, M=40.87% SD=14.56%) There was also a significant difference (p=.002) between modified lecture students who did complete (N=34, M=51.19% SD=14.38%) and modified lecture students who did not complete the webquest and online self-assessments (N=45, M=40.83% SD=16.19%)

A student using her computer outside of class.

Discussion and Conclusions

- Student centered learning strategies, in conjunction with a blended learning classroom format, encourage not only the creation of content specific knowledge, but also the development of skills necessary for developing critical thinking strategies, providing students with the opportunity to succeed in higher order conceptual learning resulting in higher student performance and overall learning gains.
- The use of online learning elements can improve student comprehension of course material even within classrooms that already employ student centered learning strategies.
- Students who make use of online learning opportunities prior to class arrive already prepared and with a basic understanding of the material to be covered.
- Online and interactive learning elements are more appealing to today's technologically focused students as opposed to traditional textbooks. The use of these elements in addition to other outside class assignments can increase the likelihood that students will come to class prepared and having completed all outside work.
- Similar performance between modified lecture students and SCALE-UP students suggests that incorporating at least some student centered learning strategies within large lecture hall settings can increase student performance to levels comparable to students in the preferred SCALE-UP format.
- Low performance overall on the free response in-class assessment may be attributed to student difficulty answering questions targeting higher levels of Bloom's Taxonomy. However, it should be noted that students in both SCALE-UP and the modified lecture significantly out performed traditional students suggesting these instructional models provide students with at least some opportunities to develop skills necessary for handling higher order questions.
- Future studies should be aimed at further determining how to optimize the modified lecture environment in conjunction with a blended learning approach to continue increasing student performance in large introductory courses where large numbers of students and limited resources constrain the number of SCALE-UP sections offered each semester. Focus should be placed on further quantifying the effects of online learning elements on student performance within various classroom settings.

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