A Course Redesign Project: Adaptive Courseware in Biology

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Abstract

In the summer of 2019, a cooperative team of Biology faculty and a principal investigator worked to develop a solid set of aligned student learning outcomes across the sections of first semester (BIOL 1305) and second semester (BIOL 1306) of introductory Biology. Additionally, the group worked on course objectives alignment within the scope and sequence of the courses, as well as aligned syllabi. A full course redesign was initiated over the summer, where the goal was to align student learning outcomes (SLOs), assessments, and develop a shared set of syllabi for six sections across two courses of introductory biology.

At UTEP, the overall goal was to integrate adaptive courseware technology tools, open education resources (OER) and active learning strategies within a course redesign in our Learning Management System (LMS), Blackboard, for a number of sections in Biology 1305 and Biology 1306 beginning in the spring of 2020. This is challenging, as much of adaptive courseware technology is not as strong in content as the Biology faculty would like for these classes, although it can help to substantially reduce the costs for students. The information that follows defines the case study for integrating adaptive courseware within the course redesign process for a series of high enrollment introductory Biology courses

Key Words: Adaptive Courseware, Biology, General Education, Open Education Resources, Course Redesign

Introduction

In terms of the use of adaptive courseware at the University of Texas at El Paso (UTEP), the fundamental strategy is to provide better information in the classroom in order to improve student performance. This idea of asking, "What do students need to be more successful?" can come in many forms including homework, content, assessment and outcomes-based approaches. Current adaptive courseware options are most focused in the areas of general education (Gen Ed), and at UTEP, this translates into efforts associated with the "First 45", which may high volume include introductory courses in Psychology, Political Science, Biology, and Mathematics, among others. For UTEP, the basic problem is to increase the effectiveness of courses, while addressing issues associated with efficiency of course delivery. A secondary goal is to scale the efforts into a larger number of courses within a discipline as well as increase enrollment where appropriate.

A team at UTEP received a grant through the Association of Public and Land-grant Universities (APLU) to help with such a course redesign effort through the use of adaptive courseware in introductory Biology

courses. The goal was to integrate adaptive courseware technology tools, open education resources (OER) and active learning strategies within a course redesign for a number of sections in Biology 1305 and Biology 1306 for the spring and fall 2020 semesters. These courses are high enrollment sections of introductory Biology and have approximately 150 students per section. The Personalized Learning Consortium team from the APLU assisted UTEP to become an active member of their nationally networked community related to adaptive courseware solutions. APLU helped with the adoption of technology (information, research and contacts), recommended processes for course design/redesign and how best to use dashboard functions in adaptive courseware with specific interventions for students.

Any specific adaptive courseware at UTEP needed to be easily integrated into Blackboard, the institution's current Learning Management System (LMS). These features may be a new adaptive courseware solution or something that is in current use or an available feature that is somewhat underutilized in terms of its full impacts on teaching and learning. As stated in the APLU's *A Guide for Implementing Adaptive Courseware: From Planning Through Scaling*, "Adaptive courseware is a flexible tool that can be used in many different ways to support instruction in a variety of courses. Adaptive courseware is sometimes used as a component of a course—for example, as a homework tool, as a textbook replacement, or to deliver supplemental practice—but it can also deliver the content and assessment of a full course. Adaptive courseware is used across disciplines and in a variety of classroom environments—face-to-face, online, flipped, and blended courses."

As part of the pilot study, the curriculum development format for the selected Biology faculty was a seminar style approach in which the team worked both independently and collaboratively with regular meetings with the program Principal Investigator. This was done to ensure that consistent technology redesign goals would be met, along with pedagogical course enhancements designed to increase in class active learning (such as the use of interactive quizzes, think-pair-share strategies for large lectures with polling for class content and understanding). The requirements for this approach were as follows:

- Establishment of a UTEP community of practice around the use of adaptive courseware, Open Education Resources (OER) and enhanced use of Blackboard in course delivery.
- Successful completion of course redesigns for selected sections of Biology 1305 and Biology 1306 through a backward design curriculum development process.
- Increased active learning components in course design and classroom implementation.
- Establishment of benchmarks for course production and successful delivery of revised course in the spring and fall of 2020.

Adaptive Courseware Background

There is ample research regarding adaptive courseware that examines the effectiveness of specific interactive and responsive systems. Koedinger and Aleven (2007) argue that adaptive tools must optimize student involvement in such a manner that provides tutorial interventions that inhibit student progress

through the over or under provision of help. This is a prime example of trying to provide a system that is dedicated "to balancing randomness and coherence" (Davis & Sumara, 2014, p. 135). Ghadirli and Rastgarpour (2012) argue that adaptive learning systems that integrate learning styles with an expert system is an inexpensive, fast, simple approach that improves learning.

Adaptive courseware systems also demonstrate a variety of levels of efficacy. Foshee, Elliott, and Atkinson (2016) found adaptive courseware systems were effective in teaching students' mathematical concepts. De Bra (2002) examined adaptive courseware in order to determine the use of hypermedia in developing e-textbooks that prohibit students from accessing links to material that is beyond their current ability level. These are examples of systems attempting to balance the inherent decentralized nature of adaptive courseware with student needs. In both cases, the systems are literally placing constraints on the student.

The organization of curriculum materials in relation to adaptive courseware is the focus of other researchers. Although Sosnovsky and Brusilovsky (2015) recommended the topic-based adaptive courseware approach based on current research, others have argued for alternative organizational schemes. Zhuge and Li (2006) found that materials can be more effectively used in a modular context in adaptive courseware when they are separated from the traditional concept-centered approach. This is an excellent example of trans-level learning, in that the developers are attempting to weaken the centralized nature of the concept-centered organizational approach. Other researchers have tackled resource organization as well. Ullrich and Melis (2010) examine a courseware generator system that generates a modular system that users found easy to navigate because it is user-centered.

Curriculum Alignment and Adaptive Courseware

For UTEP, the basic problem was to increase the effectiveness of courses, while addressing issues associated with efficiency of course delivery. A secondary goal was to scale the efforts into a larger number of courses within a discipline as well as increase enrollment where appropriate. A final challenge was related to the development of the redesign and the changes that it will require in terms of classroom pedagogy.

In the summer of 2019, the team worked to develop a solid set of aligned student learning outcomes across the sections of first semester (BIOL 1305) and second semester (BIOL 1306) of introductory Biology. Additionally, the group of six Biology faculty worked on course objectives alignment within the scope and sequence of the courses, as well as aligned syllabi. The team initiated a full course redesign over the summer, where they worked to align student learning outcomes (SLOs), assessments, and developed a shared set of syllabi for the 2 courses (BIOL 1305 and BIOL 1306) of introductory biology. The faculty also searched for partners in terms of textbooks and adaptive courseware solutions. A potential solution that meets the OER opportunity with adaptive courseware that was also supported by the faculty is through OpenStax combined with Cogbooks. The group had previously used a textbook from MacMillan with the

LearnSmart platform, and it was suggested at the on-campus meeting with APLU that the team start there and then look to move to another option once the adaptive options were integrated into the courses.

In the fall of 2019, the team explored the uses of adaptive courseware, as well as reviewed 5 possible textbooks and adaptive courseware solutions. The faculty decided late in 2019 to utilize materials from MacMillan in Biology, and 2 professors implemented it in their classes in the Spring of 2020. The goal again was to integrate adaptive courseware technology tools, open education resources (OER) and active learning strategies within a course redesign in our Learning Management System (LMS), Blackboard, for a number of sections in Biology 1305 and Biology 1306 in 2020. This was challenging, as much of OER is not as strong in content as the Biology faculty would like for these classes, although it can help to substantially reduce the costs for students. For established vendor solutions, the integration of adaptive courseware into the course is less a challenge, and became our starting point, although this was not without its limits as well.

The main challenges to this point were to define the exact adaptive courseware to be utilized by the group. The team did have a visit from member of the APLU in August of 2019, in which the group went through an extensive overview of adaptive courseware in Biology, as well as the ways in which we could practically implement it in the introductory sections. The faculty then went through an extensive vetting and research process in examining 5 potential textbooks and connected adaptive courseware functions, including vendors (MacMillan, Pearson, McGraw-Hill) and open source (OpenStax/Cogbooks). The main challenge was in getting a viable solution identified, which did take a long time during the course of the fall 2019 semester. In the end, the group went with MacMillan and LearnSmart (not an OER, but a vendor solution) for the spring 2020 semester, due primarily to student cost and the fact that the Hillis textbook was already being used in the current introductory Biology sections, which also reduced the number of sections for spring.

Pilot Study with Transition to Remote Learning due to COVID-19

In the spring of 2020, two faculty members began to offer adaptive learning courseware from MacMillan with the LearnSmart platform integrated into their sections of BIOL 1305 and the other three active faculty members continued to plan the ways in which to integrate adaptive courseware in their courses for the fall 2020 semester. Additionally, the team continued to work on course objectives alignment within the scope and sequence of the courses, as well as having aligned syllabi.

Additionally, efforts were made to continue to search for partners in terms of textbooks and adaptive courseware solutions. The faculty had to switch their courses officially following the week of spring break (March 16-20, 2020), although there was a strong indication that we would be moving in this direction in the week prior to spring break. For the Biology classes participating as part of the pilot study, they were given an extra week following spring break (as were most UG classes at UTEP) to make any

additional adjustments to ensure that the switch to remote learning was complete. Once this switch was made, there were still 7 weeks of classes left in the semester.

At this point, it was important to keep the cohort intact and to make the transition to a single platform for adaptive courseware by the fall of 2020. The group also lost 2 of our original members, one who left the Biology department to become a Chair in another College and one who left the Biology Department to become a University Botanist. The remaining 4 professors continued to make great strides and achievements using adaptive courseware integrated into their classes, which are all now fully online for fall 2020. Largely, the list of implementations and next steps remained the same after the switch to remote learning. One topic reported consistently across the Biology faculty was that both the instructors and the students were more prepared for the lockdown based on what had already been implemented.

Generally, the courses did seem to change in several major ways. First, the lectures went entirely online to a video format. There was not an attempt to do live meetings with the classes, which in effect, moved to an asynchronous format for the remainder of the spring semester. As a result, more time was spent developing and deploying substantial amounts of video content, some of which will surely be used in future semesters.

Understanding Impacts with Adaptive Courseware

An important initial part of the project at UTEP was to be able to integrate adaptive courseware technology tools, along with open education resources (OER) and active learning strategies within a course redesign for a number of sections in Biology 1305 and Biology 1306. As a result, the group has continued to search for partners in terms of textbooks and adaptive courseware solutions. This is a most important point, as the team made the transition for the Fall 2020 to use OpenStax as a textbook and CogBooks as the adaptive courseware provider, which also produced a cost savings for students, moving from $120 per student in fall 2019, $90 per student in spring 2020 to approximately $40 per student for fall 2020. This represents not only growth in functionality in the use of adaptive courseware across the cohort, but it also brings a savings of approximately $80 per student. In terms of the sections and the approximately 500 students involved in this pilot project, this potentially could produce upwards of $40,000 in cost savings for these students, while increasing the use of adaptive courseware technology both in terms of use and academic rigor.

The most significant barriers continue to do with adaptive courseware implementation across the cohort. This is being managed by having a strong award winning professor lead the group implementation in the spring of 2020, with the goal of integrating other members of the team in the fall of 2020. The team agreed to use CogBooks as the adaptive courseware technology for fall 2020, with the textbook being from OpenStax. There is also a need to work on making the adaptive functions into more interactive components, and would have made for a better online educational experience. This has the potential to bring a new level of adaptive features integrated inot the courses in addition to the progress the faculty have made this semester.

Three of our group members also participated in the Faculty Guild, which was a professional development effort headed by APLU that did prove quite useful in its interactions with other faculty within the Biology discipline. One aspect that did prove fruitful were interactions with Biology faculty at Arizona State University about their biospine program and how it is integrated within their curriculum. Once the team started to interact more with CogBooks in the spring of 2020, they were given the opportunity to actually enroll in one of the introductory Biology courses, which proved to be quite beneficial for the team in terms of selecting a final adaptive courseware platform, which has been the factor that has been harder to drive to consensus across the group.

Pedagogical Innovations with Adaptive Courseware

The collective research and experiences in this effort reinforce the idea that "adaptive courseware" varies in terms of definition and function from different vendors. In the platform used in Spring 2020, the faculty had a sense that the platform would allow students to have more in depth interaction with the material, and possibly the faculty with a mechanism for switching to a more 'flipped' classroom initially. As a group, the team felt that this approach was going to be much more meaningful for the students in comparison to in-house or self-made Blackboard quizzes. Rather than just forcing the students to peruse the material before a class session, they would instead monitor their own understanding through adaptive courseware. How much time they spent reviewing the material ahead of time or how much they already understood of the material would be reflected in how many questions the students would need to answer correct to obtain the threshold number of points set by the system.

Regardless of how many questions the students answered, once they reached the threshold number of points, they received full credit for the pre-class quiz. In terms of the adaptive courseware adaptive courseware, it essentially consisted of a large database of questions and using an algorithm, the system would present the next question to a student based on previous answers thus moving students along quicker if they were on target with their responses and other students who were answering incorrectly, would receive additional questions on the topics they were not getting. Ultimately, working students through more questions if they needed more assistance, as well as directing them to the reading sections of the material they needed to re-assess.

For example, the spring 2020 adaptive courseware pre-class quizzes were worth 20% of the student's overall grade for the semester. Both faculty used this approach to offer a total of 25 pre-class quizzes throughout the semester, essentially 1 quiz for every topic (the way it was divided it up on the syllabus and from the curriculum alignment) and then they would only use the top 20 scores towards the grade. Thus, quite a bit different in delivery and required student engagement. Originally, this was the only aspect of Adaptive courseware that was going to be used, and one professor decided on incorporating a second element into her course. The faculty member substituted the IF-AT cards with an online quiz through Launchpad, requiring students to take the review quiz as individuals rather than as a team. To create these "review" quizzes on Adaptive courseware, the professor was able to choose questions that were provided

in the pre-class assessment (through Launchpad) and was also able to add her own questions. The faculty member felt this provided students with a better link to what they saw prior to the introduction of the material and to possible questions they would see on the exam (provide for a bit more continuity). In this class, the Exam Review Quizzes were worth 10% of the student's overall grade for the semester.

Another technique of an active learning approach used was to employ a team-based review quiz prior to each exam through the use of IF-AT cards (Immediate Feedback – Assessment Technique". These are scratch off cards, much like lotto cards. A master key is provided and the professor created quizzes in which the answers match up the key. When students scratch off a possible answer, if a star is located under the scratch, they've answered the question correctly. If they do not see the star, they can make a second or third attempt until they find the star. The amount of points they receive for each question depends on how many scratches it takes to 'find' the star. The professor had the students conduct these quizzes as teams and noted that they got pretty excited (motivated and engaged) when the choose the correct answer. The faculty member also provided the quiz questions as a hard copy so students can use them as a study guide, with questions varying in in levels of Higher Order Thinking (HOT) from 1-4.

Scaling Adaptive Courseware Purposefully

Biology faculty participating in this effort overall were particularly excited about implementing an adaptive courseware solution into the course structure. It provided them with a new element for the course to expand on student engagement, wherein students engaged themselves. Within the adaptive courseware structure, regardless of platform, the faculty created a series of pre-class quizzes/assessments and incorporated them into the course design primarily as a just-in-time teaching tool. However, how effective these created questions were in really ascertaining student's understanding of concepts was unclear. Overall, the faculty had gotten fairly comfortable with structuring the class sessions both in person and online using active learning approaches and staying on track with the course material through the use of the adaptive courseware.

To leverage this as a systemic solution, the support needs to come from both the bottom up (faculty) and top-down (administration, including Provost's Office, Dean's Office and Chair of Department). It would be pivotal to have the Chair of the Department be a co-PI (or PI) on future grants, as this would help to ensure that the course schedules would be predictable and maintainable, as well as that the faculty in the project would be to provide dedicated schedules that would leverage the grant efforts and funds. This would also help the faculty to produce not only changes in their pedagogy and the use of technology in their teaching, but would help to disseminate these efforts across an entire department, and in such a supported way, this could more easily translate to impacting teaching practices and costs for students. Finally, having specific and identifiable steps – Identifying a project leader, securing funding, identifying a program and take a grassroots approach working with faculty to define goals and objectives with an aligned curriculum has great merit for replicability.

Conclusion

The use of adaptive courseware offers great promise in allowing students to self-regulate their learning in large enrollment Biology classes. The use of this technology also allows faculty to focus on pedagogical innovations and group interactions, while keeping track of student progress. It also can be seen as a mechanism to increase student interest and motivation in Biology. Additionally, through this pilot study, the cost of the textbook and adaptive courseware solution was reduced substantially, which has a direct economic benefit for students enrolled in these courses. Overall, the use of adaptive courseware, combined with textbooks that are Open Education Resources, offers opportunities to increase student success in gateway courses, as well as to increase access to higher education by reducing costs overall.

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