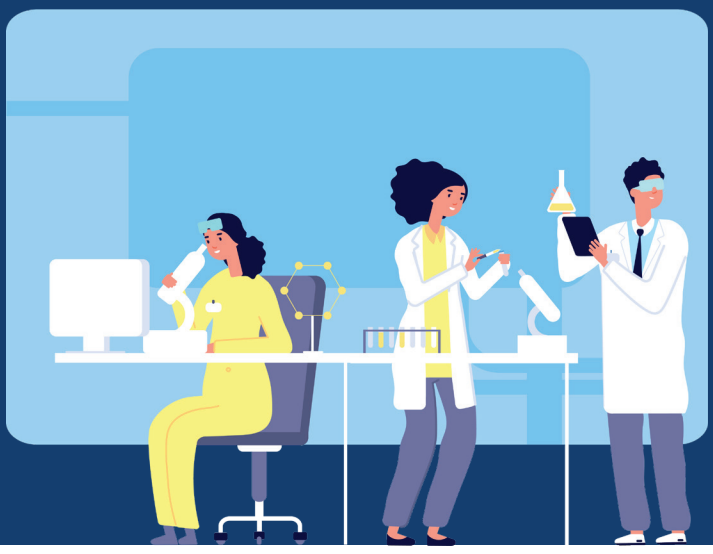
Adaptive Courseware in Biology



everylearner everywhere

Association of Public & Land-grant Universities

Contents

Citing this Resource:

To reference this work, please cite:

Vignare, K., Lammers Cole, E., Araya-Anchetta, A., and Goulet, T. (2019, July 28) Adaptive Courseware in Biology. Association of Public & Land-grant Universities and Every Learner Everywhere.

Authors

Karen Vignare, Ph.D.
Vice President, Digital Transformation for Student Success & Executive Director, Personalized Learning Consortium at the Association of Public and Land-grant Universities;

Emily Lammers Cole
Education Consultant

Ana Araya-Anchetta
Lecturer in the Department of Biological Sciences at Northern Arizona University

Tamar Liberman Goulet
Professor in the Department of Biology at the University of Mississippi

About the Supporting Organizations

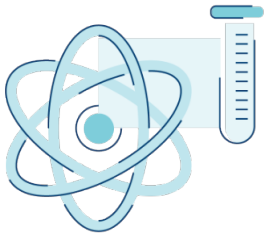
Every Learner Everywhere is a network of twelve partner organizations with expertise in evaluating, implementing, scaling, and measuring the efficacy of education technologies, curriculum and course design strategies, teaching practices, and support services that personalize instruction for students in blended and online learning environments. Our mission is to help institutions use new technology to innovate teaching and learning, with the ultimate goal of improving learning outcomes for Black, Latinx, and Indigenous students, poverty-affected students, and first-generation students. Our collaborative work aims to advance equity in higher education centers on the transformation of postsecondary teaching and learning. We build capacity in colleges and universities to improve student outcomes with digital learning through direct technical assistance, timely resources and toolkits, and ongoing analysis of institution practices and market trends. For more information about Every Learner Everywhere and its collaborative approach to equitize higher education through digital learning, visit www.everylearnereverywhere.org.

Association of Public and Land-grant Universities (APLU) is a research, policy, and advocacy organization dedicated to strengthening and advancing the work of public universities in the U.S., Canada, and Mexico. With a membership of 244 public research universities, land-grant institutions, state university systems, and affiliated organizations, APLU's agenda is built on the three pillars of increasing degree completion and academic success, advancing scientific research, and expanding engagement. Annually, member campuses enroll 5 million undergraduates and 1.3 million graduate students, award 1.3 million degrees, employ 1.3 million faculty and staff, and conduct $49.2 billion in university-based research.

Adaptive Courseware in Biology

Background

Adaptive courseware is a digital instruction tool that provides a personalized learning experience for each student.



It includes instructional content and assessment that is scoped and sequenced to support an entire course. Adaptive courseware analyzes student data and can adapt elements of the instructional content, activities, and assessments based on the student's performance. As a result, each student takes a customized path through the course material based on how he or she is interacting with the software (e.g., answers/inputs, time spent on tasks, assessment results). The individual student data allows faculty to also customize pedagogy and interventions used during remaining course time (Vignare et al., 2018). In this brief, we provide an overview of the current research on the effectiveness of adaptive courseware broadly and in the discipline of Biology. We also provide a list of suggested resources where you can learn ore about adaptive courseware, its efficacy, and best practices.

Adaptive Courseware Efficacy

Because adaptive courseware is relatively new, published research on its efficacy and even more so, best practices regarding implementation, is limited. Controlled studies and other research suggest that using adaptive courseware benefits both students and instructors. An extensive report, Next Generation Courseware Challenge Evaluation by House et al. (2018), found that across multiple tools, in different disciplines, and at different institutions of higher education, overall adaptive courseware technology increased student success. The variation in success at institutions often using similar tools ranges from positive to negative, supporting the need for even more understanding about implementation and whether faculty use the data to adjust other instructional practices. The slightly positive findings build on a previous grant funded two-year evaluation, where data from over 19,500 students in classes taught by more than 280 instructors, which also showed that adaptive courseware holds promise for improving student outcomes (Yarnall, 2016).

Adaptive Courseware in Biology

Adaptive learning can be effective in aiding students entering courses with less prior knowledge. van Seters, Wellink, Tramper, Goedhart, and Ossevoort (2012) see potential in helping reduce the "pipeline problem", as less than 40% of US students who pursue STEM education and disproportionality only 20% of underrepresented minority students graduate with a STEM degree (Freeman, McDonough, Smith, Okoroafor, Jordt, & Wenderoth 2014). Kim, Prevost and Lemons (2015) argue a lack of research into biology courses using web-based teaching technology is due "partly because biology education research is an emerging field (Dirks, 2011; National Research Council, 2012)" (Kim et al, 2015, p. 363). In developing their own non-adaptive web-based program, students improved problem solving and reacted positively to prompts/immediate feedback. However, the web-based services lack of adaptive capabilities led to a negative experience from students in the inability of the technology to be flexible to different student needs.

Adaptive E-learning was highlighted by van Seters et al, based on previous studies (Bransford, Brown & Cocking, 2000 ; Brusilovsky & Peylo, 2003), as an effective way to present exercises at different levels. The researchers focused on a specific area of biology and created a web-based adaptive tutor to teach PCR primer design. By testing pre and post knowledge, researchers concluded the adaptive system was effective at teaching PCR primer design to students of differing prior knowledge and students reacted positively in a post interview to the personalized instruction.

What tools are being used

The Associaton of PUblic & Land-grant Universities (APLU) grant recipients implemented adaptive courseway in 14 biology courses across six institutions including:

- **Arizona State University**
- **Colorado State University**
- **Northern Arizona University**
- **Portland State University**
- **University of Louisville**
- **University of MIssissippi**
- Reaching over 8,000 students, those implementations include the following courseware products:
- **Cogbooks**
- **McGraw-Hill LearnSmart**
- **Macmillan Learning Curves**
- **Pearson MyLab & Mastering**

Adaptive courseware has become increasingly popular and effective in adaptive quizzing. Phelan and Phelan (2011) tested the Prep-U online quizzing tool for the mastery of biology course material in an introductory course at a major US university. The tool tests students for practice, retrieval and learning, with questions adapted by student input and feedback for both students and faculty on performance. The study compared students with and without access to Prep-U, concluding that students with access used the tool voluntarily when given the opportunity and performance was significantly improved, which also correlated with usage. Additionally, the highest performers on the course had access to Prep-U earlier on in the course, suggesting early adoption increased mastery throughout the semester.

Application of Adaptive Courseware in Biology

Adaptive learning technologies engage directly with students 'core learning activity' through active and personalized materials. Plass (2016) argues that adaptive learning systems engage students through a variety of adaptive methods. From the type of interaction, mode of representation, progression of difficulty and scaffolds of learning. These feed into the overall taxonomy of adaptive learning, progressing from learning environment, learning performance, diagnostic assessments and adaptivity. This acts as a feedback loop back to the learning environment and the system learns from the student to continuously personalize. At its core, adaptive learning supports the implementation of 'active learning' through interactive and engaging web-based materials (Plass, 2016).

This is supported by Freeman et al. (2014), who argue that the predominant teaching method of 'teaching by telling' is shown to not be the most effective approach/method/strategy. In a meta-analysis of 225 studies containing data on exam scores or failure rates in undergraduate STEM courses, the researchers compared traditional lectures versus 'active learning'. The results showed that students in traditional lectures were 1.5 times more likely to fail than were students in active learning classes. Mean failure rates were 21.8% in active learning, compared with 33.8% for traditional lecturing, representing a 55% increase in success rates.

Haak, Pitre & Freeman (2011, p. 1213) are conscious that in the past decade, STEM disciplines have been "charged with improving the performance and retention of students from diverse backgrounds". The researchers looked at a large undergraduate Biology 180 class at University of Washington's Educational Opportunity Program (EOP), for students who are educationally or economically disadvantaged. By looking at historical records of the class between 2003 and 2008, they found the mean failure rate for EOP students was 21.9%, compared to 10.1% for non-EOP students. To improve performance of underprivileged undergraduate students in STEM, the researchers argue courses must "address what Benjamin Bloom called the '2 Sigma Problem': the need to create teaching-learning conditions under large group instruction that allow students to achieve at the level they would under individual instruction by a skilled tutor" (Haak et al., 2011, p. 1214).

As Plass (2016) argues, this is where adaptive learning technologies have the potential to make sizable impacts in supporting active learning. From the student perspective, active courses would increase examination scores on average by 6% and with 29,300 students from 67 lectures used in the study, Haak et al (2011) argue 3,516 fewer students would have failed by taking the raw failure rate under active learning. Additionally, researchers estimate conservatively this would equate to US$3,500,000 saved in tuition fees.

Practical Advice For Using Adaptive Courseware in Biology

From University of Mississippi:

- Reward usage of the adaptive courseware with points towards the final grade. Students are more apt to utilize adaptive courseware when they are rewarded for doing so, as such, instructors should consider allocating points that contribute to course grades to students' use of the adaptive courseware.
- Early intervention for students who are not doing all or many of the adaptive courseware assignments. Dashboards provided by the courseware often allow instructors to see who is not completing assignments or struggling with assignments. The courseware may also provide an easy mechanism to email or send a message to those students to offer help or prompt action. Contacting students early on in the semester may improve the students' overall performance in the semester.
- Be clear and upfront with students about what the adaptive courseware does and does not do. Many courseware products help with content delivery so that students are familiarized with the content required for class. However, this doesn't necessarily mean that students know how to apply the knowledge they are gaining through the courseware. Being clear with students early about what the courseware can and cannot do, and how they should supplement their courseware practice to meet course objectives is key.

Find more resources at everylearnereverywhere.org

For questions, contact resources@everylearner.org

References

Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). How people learn (Vol. 11). Washington, DC: National academy press.

Brusilovsky, P. (1999). Adaptive and intelligent technologies for web-based education. Ki, 13(4), 19-25.

Dirks, C. (2011). The current status and future direction of biology education research. In Second Committee Meeting on the Status, Contributions, and Future Directions of Discipline-Based Education Research. Available: http://www7. national academies. org/bose/DBER_Dirks_October_ Paper. pdf.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410-8415.

Haak, D. C., HilleRisLambers, J., Pitre, E., & Freeman, S. (2011). Increased structure and active learning reduce the achievement gap in introductory biology. Science, 332(6034), 1213-1216.

House, A., Means, B., Peters Hinton, V., Boyce, J., Wetzel, T., & Wang, S. (2018). Next Generation Courseware Challenge Evaluation. Final Report. Menlo Park, CA: SRI International.

Kim, H. S., L. Prevost, and P. P. Lemons. "Students' usability evaluation of a Web-based tutorial program for college biology problem solving." Journal of Computer Assisted Learning 31.4 (2015): 362-377.

National Research Council. (2012). “Discipline-based education research: Understanding and improving learning in undergraduate science and engineering”. Washington, DC: National Academies of Science Press. 978-0-309-25411-3.

Phelan, Jay, and J. Phelan. "Improving biology mastery through online adaptive quizzing: An efficacy study." toward formative assessments supporting learning: Design, validation, and mediating factor: The annual meeting of the American Educational Research Association. 2011.

Plass, J. L. (2016). Adaptive Learning. Retrieved July 11, 2019, from http://janplass.com/index. php/2016/07/07/adaptive-learning/

Riffell, Samuel, and Duncan Sibley. "Using web-based instruction to improve large undergraduate biology courses: An evaluation of a hybrid course format." Computers & education 44.3 (2005): 217-235.

Schaffhauser, Dian. “The Next Frontier of Adaptive Learning.” Campus Technology, 2018, www.campustechnology.com/articles/2018/11/14/the-next-frontier-of-adaptive-learning.aspx.

van Seters, J. R., Wellink, J., Tramper, J., Goedhart, M. J., & Ossevoort, M. A. (2012). A web-based adaptive tutor to teach PCR primer design. Biochemistry and Molecular Biology Education, 40(1), 8-13.

Yarnall, L. (2016). Can Adaptive Courseware Technology Positively Impact Student Learning Outcomes? Retrieved July 12, 2019, from https://www.sri.com/blog/can-adaptive-courseware-technology-positively-impact-student-learning-outcomes.