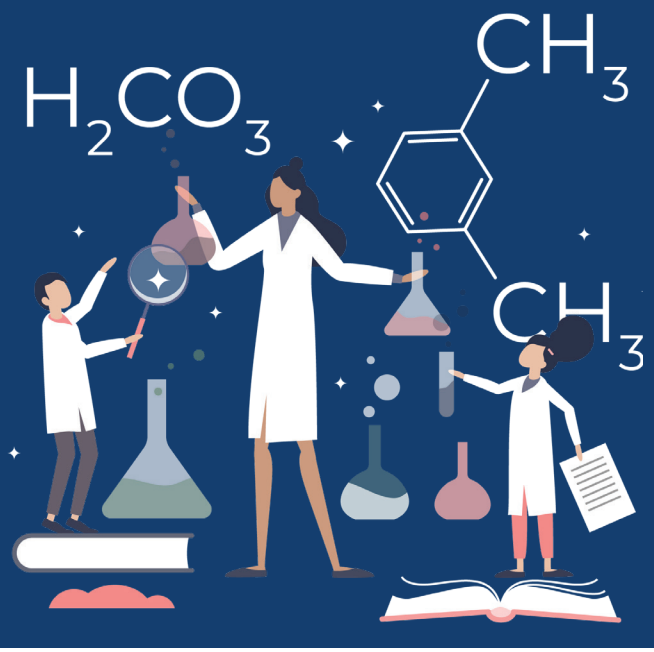
Adaptive Courseware in Chemistry



everylearner everywhere

Association of Public & Land-grant Universities

Contents

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About the Contributors

Authors

Megan Tesene, PhD
Director of the Personalized Learning Consortium at the Association of Public and Land-grant Universities

Emily Lammers Cole
Education ConsultantConsortium at the Association of Public and Land-grant Universities

Farai C. Gombedza
Assistant Professor of Biochemistry at Purdue University Northwest

Kerry MacFarland
Assistant Teaching Professor, Department of Chemistry at Colorado State University

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 Chemistry

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 Chemistry. We also provide a list of suggested resources where you can learn more 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 Evaluationby 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 Chemistry

Adaptive learning has been shown by Liu, McKelroy, Corliss and Carrigan (2017) to be effective in reducing the knowledge gap of students entering chemistry related professional degrees. Haak, Pitre & Freeman (2011, p. 1213) contend that in the past decade, STEM disciplines have been "charged with improving the performance and retention of students from diverse backgrounds." van Seters, Wellink, Tramper, Goedhart, and Ossevoort (2012) note the potential of adaptive technologies to help reduce the "pipeline problem." Indeed, less than 40% of US students and only 20% of underrepresented minority students who pursue STEM education graduate with a STEM degree (Freeman, et al., 2014). Liu et al. (2017) examined how adaptive learning was used to intervene in remedial modules for four disciplines, finding that chemistry students significantly increased knowledge of remedial chemistry content. With over half of all students indicating improved knowledge needed for professional school and the technology facilitating effective learning, adaptive learning was shown to provide a positive learning experience for students (Lui, et al., 2017).

Problem-solving practice is essential for learning chemistry. Online homework systems (OHS), including traditional, rich feedback responsive types and adaptive courseware OHS, have been found to improve student engagement, study habits, and success rates in undergraduate chemistry courses. Eichler and Peeples (2013) investigated the efficacy of adaptive compared to traditional-responsive OHS in general chemistry courses. Student performance significantly improved with adaptive software final exam scores increased eight points on average compared with nonparticipants and most notably over thirteen points for those who completed a pre-course assignment on the adaptive homework system. Richards-Babb, Curtis, Ratcliff, Roy, and Mikalik (2018) found similarly higher final letter grades across average, below average, and failing students who used an adaptive-responsive OHS. The study also found students were less favorable of the adaptive OHS since it required more time and overall effort.

What tools are being used

The Association of Public & Land-grant Universities (APLU) grant recipients implemented adaptive courseware in 16 Chemistry courses across five institutions including:

- **Colorado State University**
- **Oregon State University**
- **Portland State University**
- **University of Louisville**
- **The University of MIssissippi**

The number of students enrolled at these institutions is over 5,600 students. Those implementatons very in reported imporvements in studen success. The faculty at each of the institutions have used.

- **Knewton**
- **McGraw-Hill ALEKS**
- **McGraw-Hill LearnSmart**
- **Person MyLab & Mastering**
- **WileyPlus with Snapwiz**

Application of Adaptive Courseware in Chemistry

Colorado State University (CSU) uses McGraw-Hill ALEKS in general chemistry courses, with assignments due 2-3 times per week, and knowledge checks every three weeks. CSU also requires students to complete an adaptive math review on ALEKS before registering for general chemistry. Impacts reported from the adoption include:

1. ALEKS appears to improve student learning as indicated by higher exam scores.

2. Faculty report seeing some correlation between exam scores and the percentage of the ALEKS topics students have mastered at the time of the exam (following a knowledge check and time to relearn topics the knowledge check indicated students had not mastered.)

3. In informal surveys, students report that ALEKS helps them learn. Students think ALEKS is more helpful for their learning than a traditional-responsive online homework system that is also used in general chemistry courses at CSU.

4. The prerequisite math review using ALEKS appears to be helping students enter the course better prepared for chemistry problem-solving.

Practical Advice For Using Adaptive Courseware in Chemistry

From Colorado State University:

- Assignments due three-times each week encourages spaced practice and helps deter students from falling behind.
- Assigning knowledge checks several days before each exam shows students which topics they have not mastered and helps focus work and study time on those topics. The spaced-practice and testing help students prepare for exams.
- Attributing a portion of the course grade to overall topic mastery (percentage of topics complete at the end of the semester) encourages students to work on topics that they failed to complete before the due date or that they hadn't fully mastered.
- Faculty review incoming data analytics to highlight concepts that students are finding difficult, so additional class time can be spent on those topics.

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 conside locating 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

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