



Achieving
the Dream™

A LEARNING EXPERIMENT: Developing Critical Thinking Skills with Adaptive Courseware



A CASE STUDY OF ADAPTIVE LEARNING TECHNOLOGY IN SCIENCE

everylearner
←————→
everywhere

OCTOBER 2021

ABOUT THIS CASE STUDY

Achieving the Dream (ATD) is one of 12 higher education and digital learning organizations that make up the Every Learner Everywhere (Every Learner) Network, whose mission is to help higher education institutions improve and ensure more equitable student outcomes through advances in digital learning, particularly among poverty-impacted, racially minoritized, and first-generation students. Every Learner partners are addressing high failure rates in foundational courses through the provision of scalable, high-quality support to colleges and universities seeking to implement adaptive courseware on their campuses. As part of its ongoing effort to help community colleges develop effective teaching and learning practices, ATD is working with seven community colleges in Florida, Ohio, and Texas on this initiative, providing coaching and direct support to the colleges, fostering collaboration within and among the participating institutions, and serving as a liaison to the Every Learner network.

The following case study is part of a series of studies conducted by ATD examining how adaptive courseware is implemented at those institutions as well as how courseware is used in particular disciplines to better serve students. Case studies are based on a series of interviews with college leaders, faculty, instructional designers, developers, technology specialists and students who were enrolled in classes using the courseware.

Acknowledgements

This case study and the underpinning work was made possible through the generous support and guidance of the Every Learner Everywhere Network. Achieving the Dream would like to thank the students, faculty, staff and administrators at Indian River State College, Cuyahoga Community College, and Amarillo College for their dedicated work on the Every Learner Everywhere initiative on adaptive courseware and for their time and participation in the focus groups that served as a basis for this case study.

We would also like to thank ATD Director of Program Development, Dr. Ruanda Garth-McCullough, for leading ATD's Every Learner Everywhere work with the support of ATD staff Susan Adams, Francesca Carpenter, Eric Fiero, Cheryl Fong, Jonathan Iuzzini, Sarah Kinnison, Dr. Richard Sebastian, Dr. Tanya Scott, Paula Talley and Dr. Monica Parrish Trent as well as former ATD staff members, Joanne Anderson, Shauna Davis and Shanah Taylor.

Finally, we would like to thank the staff at Communication**Works**, LLC for their editorial and design assistance in producing these case studies.

Sharing & Distribution

These case studies are protected under a Creative Commons: Attribution-NonCommercial 4.0 (CC BY-NC) license.

We encourage you to download, share, and adapt these resources with attribution to ATD. See suggested citation below.

Achieving the Dream. (2021). *A Learning Experiment: Developing Critical Thinking Skills with Adaptive Courseware — A Case Study of Adaptive Learning Technology in Science*

OVERVIEW

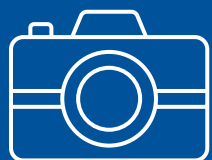
Gateway science courses for both STEM majors and those completing general degree requirements require students to master complex concepts. Always challenging, these courses have been made more difficult for many students by the transition to online learning during the pandemic. Colleges participating in the Every Learner Network found that adaptive courseware engaged students and supported their learning. Among their findings:

- The approach to guided review and assignments in adaptive courseware aligns with the discipline’s approach to conceptual and applied learning.
- Participating faculty reported that adaptive courseware increased engagement and, at times, academic success, among students who actively used it.
- As in other disciplines, faculty and students both stressed the importance of acclimating students to adaptive work, monitoring progress and intervening when individual students struggle, and ensuring that adaptive assignments align with course content and objectives.
- Students reported that courseware could be more challenging and time-consuming

than traditional assignments in science courses but acknowledged that adaptive activities helped them learn complex concepts.

SUPPORTING INSTITUTIONAL REFORM

The Every Learner initiative supports broader efforts to foster student learning with evidence-based practices, including supporting students with foundational skills for the gateway courses required for both STEM and general degree programs. “We need to teach students how to use the information they learn to solve a wide variety of problems,” says Amarillo College chemistry professor Jennifer Rabson. It also reflects the contexts in which broader institutional reform is taking place at community colleges throughout the ATD Network, including building a culture of excellence in teaching and learning and leveraging data and technology to support student success and equitable student outcomes. To learn more, see p. 7.



COURSE AND COURSEWARE DATA SNAPSHOT

Three of the seven community colleges in the Every Learner Network piloted adaptive courseware in science courses, focused on gateway biology, chemistry and physics courses.

INSTITUTION	COURSES	COURSEWARE
Indian River State College Fort Pierce, Florida 16,686 students	Introduction to Chemistry	Inspark Smart Courses (Smart Sparrow)
Cuyahoga Community College Cleveland, OH 23,655 students	Introduction to Biological Chemistry Anatomy and Physiology Everyday Chemistry Introduction to Inorganic Chemistry General Chemistry I General Chemistry II College Physics I General Physics I	Mastering (Pearson) Cogbooks MyLab (Pearson) LearnSmart/Connect (McGraw-Hill Education) ALEKS (McGraw-Hill Education)
Amarillo College Amarillo, TX 9,739 students	Introductory Chemistry I Gen Organic & Biological Chem Principles of Chemistry I Principles of Chemistry II	Knewton Alta (Wiley)

For more detail on the pilot efforts at each college, see case studies for each institution.

INTRODUCTION

Jordan Kadas's experience in her introductory chemistry course at Cuyahoga Community College wasn't that different from many of her peers in community colleges across the country. "I was mixed in with people who hadn't gone to school for 10 years, while others had basic chemistry knowledge and there were some high school students in my class," says Kadas, who graduated from the Ohio college with an associate degree in 2019 and is now pursuing a nursing degree at a four-year institution. "There were really different knowledge levels, and it made each of our (course) experiences very different."

Those varied experiences are also what prompted chemistry professor Dr. Anne Distler to begin experimenting with different technologies to improve her online courses. "There's a lot of math and science phobia," says Distler, a faculty member at the Ohio college, known locally as Tri-C. "There's a lot of concern as students start launching into a class they're not comfortable with. I realized there needed to be a better way to reach students engaging on online platforms."

At Tri-C and other community college campuses participating in the Every Learner Initiative, faculty have explored ways in which adaptive courseware can help students in challenging STEM courses succeed. What they and students like Kadas have found is that while the technology can be challenging, and at times frustrating, it can be effective in helping students learn complex concepts.

Adaptive software, says Amarillo College chemistry professor Jennifer Rabson, "is especially good for science courses because we need to teach students how to use the information they learn to solve a wide variety of problems — to apply it outside the box."



'GO ON A LITTLE JOURNEY'

Dr. Heather Michaels likens chemistry lessons to a “journey” — and adaptive courseware to a productive way of retracing steps during that journey in the service of mastery.

“You’re learning the concepts, bringing in some guided reading, and there are places where students are asked if they remember the concepts,” says Michaels, a master instructor of physical sciences at Indian River State College in Florida. “If they say no, they have to go on a little journey to relearn it.”

Given the emphasis on translating complex concepts into real-world practice, science is an ideal discipline for adaptive courseware,

faculty members at institutions participating in the Every Learner initiative say. Rabson focuses on helping students “walk through the problem-solving process when they learn this material,” she says, with adaptive work reinforcing this overarching skill through guided review and practice.

“So much of science is just learning how to think and how to approach problems,” Rabson says. “I feel like when I was teaching more traditionally, I would try to help students by giving them examples of everything, and then they would echo and repeat my examples on the test, but they might not understand what they did.”

Distler agrees. “The questions I like to assign are very conceptual, sorting, or visual, and very similar to what I’d like to do in a class or lab,” she says.

“In science, you want to visualize the way putting concepts together works,” adds Tri-C physics professor Jonathan Williams. “Based on what product you use, the types of animations are better than what I could put on the board.”



BUILDING ON ATD'S CORNERSTONES OF EXCELLENCE

Like other community colleges participating in the Every Learner grant which are part of the ATD Network, the three institutions profiled in this case study have committed to engaging in bold, holistic, and sustainable institutional change across multiple institutional areas and priorities. Their efforts to implement adaptive courseware to support students in the gateway science courses required for both STEM and general degree programs reflect the importance of several key cornerstones of institutional change, including leveraging data and technology to support student success and equitable student outcomes and building a culture of excellence in teaching and learning.

ATD's [Institutional Capacity Framework and Institutional Capacity Assessment Tool \(ICAT\)](#) outlines seven essential institutional capacities required to create a student-focused culture that promotes student success. One focuses specifically on teaching and learning and the commitment to engaging full-time and adjunct faculty in examinations of pedagogy, meaningful professional development, and a central role for faculty as change agents within the institution. Building capacity in this area is crucial because, as ATD President Dr. Karen A. Stout recently asserted, "focusing on teaching and learning is still not central to the field's overall theory of change. We still have much more to do to build a deep focus on pedagogy and to support our colleges in building a culture of teaching and learning excellence."

To foster this culture of teaching and learning excellence, [ATD's Teaching & Learning Toolkit: A Research-Based Guide to Building a Culture of Teaching & Learning Excellence](#) is centered on four cornerstones of excellence that provide a forward-looking vision that campuses can use to inform their work.



Initiatives such as Every Learner provide important resources and supports to community colleges and the time, space, support, and resources to explore innovative pedagogical approaches to improving student learning and outcomes. They also offer sustained opportunities to build on these cornerstones of excellence. At these three institutions, the grant provided

science faculty with the time and resources needed to evaluate, implement, and modify their use of adaptive courseware to best serve students.

Efforts to provide needed support and basic skills building for students exemplifies institutional efforts to empower faculty to consider, adapt, test, and refine new approaches to fit their campus context and the needs of their students. In science courses, this work often focused on identifying ways to strengthen math skills, with courseware playing a key role in getting students "prepared for the material that was going to come," says Tri-C chemistry professor Dr. Anne Distler. Adaptive course work also helped students master the highly conceptual content taught in science courses and "apply it outside the box," says Amarillo College chemistry professor Jennifer Rabson.

At some institutions, collaborative partnerships included adaptive courseware in efforts to support student success. For example, Tri-C's first-day access initiatives provided automatic access to courseware when students registered. "Taking one barrier out of that has made a huge difference for students," Distler says.

Faculty also worked to use data from adaptive courseware to monitor student progress and refocus supports and the content of their courses. "It really helped me see where they were," says Dr. Heather Michaels, a master instructor of physical sciences at Indian River State College.

TRIAL AND ERROR

“In routine courseware, you can skip a part and if it’s not on the exam, you can get away with it. With adaptive courseware, there’s no way to get away with it. I gained a more comprehensive understanding of things.”

— Sinem Balta Beylergil, Tri-C student

Participating faculty members say that adaptive courseware is particularly effective in helping students review concepts and prepare for class sessions. Nancy Doherty has students review concepts before twice-weekly synchronous meetings in her chemistry courses at Tri-C. “When you’re face to face, you want students to have some familiarity with the material,” she says.

Williams agrees, noting the time constraints of the compressed synchronous classes he teaches. “I don’t have time to go through every single concept, so I would have expected students to go through the adaptive assignments,” he says. “I asked students to read — they don’t always read. But doing the dynamic study module is a nice way to go through the entire content before coming into class.”

Many faculty members also use courseware to provide guided homework assignments. Since science questions tend to be complex and require students to work through multiple steps, adaptive courseware can provide support for “when I’m not able to be there to answer questions for them,” says Distler.

“I like how it would give you additional questions on your weak areas and immediate feedback,”

adds Williams. “If we didn’t have these tools, a student would submit an assignment on paper, and it would be a week before feedback is delivered to them. The adaptive piece is to have that immediate feedback without waiting for the professor to walk you through something.”

“I used two programs in two courses, and the differences between how the professors used them was huge. What I got out of the software depended on each professor.”

— Jordan Kadas, Tri-C student

As in other disciplines, science adaptive courseware allowed faculty to track student progress and identify those who needed additional support. “Students who were doing extra work generally accepted they needed the extra time and worked through it,” Rabson says. “The biggest problems are students who never warmed up to (the courseware) or decided they weren’t going to do homework. They may have never gotten fully committed to the class.”

THE IMPACT

“ Courseware brings some system to the learning. If there’s nothing to follow and it’s just a textbook and exams to be taken down the line, I feel a little lost. It gives me some sort of schedule and more frequent deadlines. Rewards, reminders — that kind of feedback is really helpful.”

— Sinem Balta Beylergil, Tri-C student

Across participating institutions, faculty members said that students are more engaged and successful when they work with adaptive courseware. At Amarillo College, students benefitted from more hands-on lab activities in class because “faculty saw what they needed to spend time on” through data generated by the courseware and could focus their lectures, says instructional designer Dr. Lori Petty. At Tri-C, faculty said that adaptive courseware helped students stay on track. “In particular, students completed more assignments in adaptive courseware”, says Williams.

“I see a huge correlation between the students who do the electronic homework and those who don’t and how they do in class,” agrees Doherty.

Tri-C biology assistant professor Dr. Prabhat Sharma agrees. “Adaptive (courseware) gave students three chances,” he says. “In their first attempt, they were not getting good (scores), but they knew what they had to work on and had more

chances to work on weaknesses and deficiencies, and grades went up.”

Students generally found adaptive courseware challenging but ultimately beneficial. For example, nondegree student Sinem Balta Beylergil took different chemistry courses with and without adaptive courseware at Tri-C. “I felt there was too much work and I ended up spending more time compared to the other course without courseware,” she says. Even so, “a month later, you remembered what you had trouble with... It makes you learn — that’s the pain associated with it.”

At Tri-C, including science courses with adaptive courseware in first-day access initiatives, which automatically include access to courseware when students register for class, has also boosted engagement. “I had a hard time getting students to get the books,” says Distler. “In the last two semesters, I have had a majority of students log in and complete assignments in the first two days, which I’d never seen before.”

What Worked Well:

Remediation: Faculty found adaptive assignments based on prerequisite knowledge particularly helpful. “I found a lot of students were not ready for the course. They needed a lot of math intervention,” says Tri-C chemistry professor Dr. Anne Distler. She found that adaptive questions from an introductory chemistry class for non-science majors helped prepare students in gateway classes for chemistry majors who needed intervention on prerequisite concepts. The assignments “got them situated and prepared for the material that was going to come,” she says. Amarillo College chemistry professor Jennifer Rabson says the variety of questions and topics within adaptive courseware is also a benefit. “It is advantageous to have a wider variety of questions to force students to start thinking through what they’re doing and how they would solve different types of problems,” she says. “If a student is having trouble with a certain type of question, the more it will try to lead them to the things that will help them to figure out that concept.”

Adaptive tools that support complex science problems. Faculty members said adaptive products include built-in tools to enter and structure complex math equations and for measuring and drawing that allow for more sophisticated homework problems.

Detailed feedback and guidance. Some — but not all — adaptive products provided feedback and links to reinforce key concepts through each part of complex, multistep questions, faculty members said. “The (questions) that step them through and grade each step — those are phenomenal,” Tri-C chemistry professor Nancy Doherty says. “If they’re drawing an organic structure and have the wrong number of bonds to a carbon, it’ll guide them. In class, I’d draw it very similarly.”

Even in graded assignments, courseware could generate a similar practice question and walk students through the steps to solve it so they “don’t waste the attempt,” Distler says. “I have

had students asked for nongraded assignments that have that practice, and I’ve done that to help them.”

Guided review. Faculty found adaptive products provided a comprehensive review of course objectives. “I like it because it asks questions on all topics, but if you know it, it gives you fewer questions,” Doherty says. “It does some adaptive work for the students, but it also gives them the chance to look at all the materials.”

Enabling targeted support for students. Faculty said they monitor student progress in courseware to determine where to intervene. “If someone’s doing it on the first attempt and someone’s taking five or six times, it helps me identify the ones I need to reach out to,” Distler says. “It helps me get to the heart of what’s going on with the individual student that I couldn’t if I didn’t have that data.”

Customizability. Rabson says the ability to customize adaptive courseware is critical. “You can pick and choose assignments and then objectives depending on exactly what you want your students to learn, or if you know your students have limited time, what you want them to focus on,” she says.

Cost and access. At around \$40 per semester, adaptive products are significantly cheaper than used textbooks and homework packets, which begin at \$125 or more. At Amarillo College, the goal is “trying not to add to students’ financial burden,” says Rabson. “It’s greatly improved things.” In similar fashion, Tri-C’s first-day access program helped improve access to materials. “Students always had the ability to sign up for a free trial, but taking one barrier out of that has made a huge difference for students,” Distler says.

Ongoing Challenges:

Technology overload. Students in science courses often are provided with a wide range of online materials and resources, including lab materials, textbooks, and other digital tools,

and adaptive courseware can seem like yet another disconnected option. “There’s always a new tool for them,” says Doherty. “When I’m teaching face to face, they wonder why they have to do online homework. I try to make them understand they’d be doing it on paper if they weren’t doing it online.”

Managing workload and settings. As in other disciplines, faculty said students often found it difficult to progress in some courseware assignments when they struggled with concepts. Doherty found “a lot of hard questions and not enough easy ones” in courseware for her entry-level introductory courses. While faculty members may not always be aware of how to adjust assignments, others said that some products don’t allow them to override key adaptive settings. “I had a student who had a nervous breakdown in my office because she got into a loop and there was no way for me to get her out because I couldn’t circumvent the structure of the tool,” Distler says. “There was no control for me to say ‘we’re going to skip that question.’”

Tri-C biology assistant professor Dr. Prabhat Sharma adds that it’s not always clear what problems students are receiving in some adaptive products. “I don’t know if they’re getting the right level of questions,” he says. “I should be able to see what they’re getting.”

At the same time, Doherty says some adaptive homework was “gameable,” meaning students could progress without demonstrating mastery of the concepts. “You can push buttons often enough to get the right answers without doing any thinking,” she says.

Onboarding. Students said that learning how to use the software could be difficult. “I was overwhelmed,” says Tri-C student Jordan Kadas. “I figured it out, but I would have loved a tutorial to begin with.” Another Tri-C student, Sinem Balta Beylergil, agrees. “I work with computers and online programming, but it just didn’t feel intuitive at all,” she says.

Faculty members have responded with introductory videos and assignments to familiarize students with courseware, but some say that

onboarding has become more challenging since the rapid pivot to online courses in Spring 2020. “Students would be more comfortable if we had some type of in-person contact,” says Tri-C physics professor Jonathan Williams. “Right now, students are having problems familiarizing themselves with the software. If we were meeting once a week, I would be able to (better) help them.”

Lack of feedback through multiple steps of complex questions. While some adaptive products earned high marks for providing feedback and guidance through complex, multi-step problems, faculty members said that other courseware was less effective at providing step-throughs. “It gives you a right or wrong answer, but it doesn’t walk you through the calculations,” says Williams. “One thing students said they’d like to see better is not just being told the answer is wrong and what it is, but walking them through it.”

Dr. Heather Michaels, a master instructor of physical sciences at Indian River State College, agrees. “Other products were more like homework systems where it was like ‘here’s a question, answer the question,’” she says. “It didn’t feel as much as a teaching tool as a testing tool.”

Other faculty members said that different courseware provided step-through support for some — but not all — adaptive questions, and some said they preferred less adaptive products that provided more comprehensive feedback and support for students.

Learning curve for faculty members. More than in other disciplines, science faculty said it was difficult to learn how to use adaptive courseware — and particularly how to craft assignments at the appropriate level of difficulty for students. “It’s a really steep learning curve for faculty and so different from other courseware,” Doherty says.

Siloed questions. Faculty which experimented with multiple courses or products found that questions are “often siloed by textbook,” Doherty says. “They have a huge database of questions you could use, but you can only access the ones (associated with the textbook) you use. It seems like a waste.”

LESSONS LEARNED

Keys to the successful implementation of adaptive courseware in science courses across Every Learner sites:

- **Identifying specific adaptive components to meet course needs.**

Given that many participating faculty members tried more than one adaptive product, they stressed the importance of selecting products that align with their classes. “You try to choose a textbook that best fits your learning style and meets the objective of the class, and you choose software that complements your teaching — the ones that have the same types of questions, the same graphs and figures that complement your in-person teaching,” says Tri-C physics professor Jonathan Williams.

That goal is made easier by the fact that faculty can select which components of courseware they use. “A lot of the publishers have an adaptive piece, a homework piece, and other pieces you can use,” says Tri-C chemistry professor Nancy Doherty.

- **Aligning courseware with course objectives.**

As in other disciplines, students at times reported that adaptive work didn’t match up with course lectures or tests. “I felt like I was taking two different classes — the one the professor was teaching, and what I was learning from (the courseware),” says Tri-C student Jordan Kadas.

To address these concerns, Amarillo College chemistry professor Jennifer Rabson deliberately maps out adaptive assignments and readings before each semester and details them in the course syllabus and on Blackboard so students have a clear roadmap to follow. “It works well if you spell it out exactly and make sure the content matches,” she says. “You just have to have a plan for what you can realistically accomplish with everything else students have going on in their lives.”

- **The importance of onboarding.**

“It’s critical to have a strategy that acknowledges that students are going to have a learning curve and build that into the course during the first couple of weeks,” Distler says. For example, both Tri-C chemistry professor Dr. Anne Distler and Doherty structure activities around familiarizing

“What I was getting from the courseware was more complex and involved more work and critical thinking than I was anticipating for an entry-level course. I wouldn’t say it prepared me for my tests because it was so beyond what I needed to know.”

— Jordan Kadas, Tri-C student

students with the courseware in the first few class sessions, including a syllabus quiz and introductory assignments focused on “concepts they already know so they can get used to the tools,” Doherty says. Throughout the course, Doherty solves a problem in adaptive courseware in each class, “showing them what it’s like for me to do it online.”

- **Tracking student progress.**

Faculty members stressed the importance of monitoring student progress and referring students who are struggling to tutoring or one-on-one support. “There’s a tendency to believe adaptive means you don’t have to do anything in the course,” Distler says. “It’s not on autopilot — you need to interact and intervene with your students and use the data tools to give the student the best experience.”

Faculty said adaptive products offered differing levels of insight into student progress. Dr. Heather Michaels, a master instructor of physical sciences at Indian River State College, began taking students into the computer lab to monitor their progress in courseware and identify which ones were having trouble using it. “It really helped me see where they were,” she says.

- **Consistency.** To avoid the often-heard challenge of students allowing adaptive assignments to pile up over weeks or months, Doherty stresses the importance



of building a consistent schedule of assignments in which students are working in the courseware every few days. “I am lenient with extensions, but that forces students to think they need to work on this every few days or they won’t be able to keep up,” she says.

Michaels agrees. “I had students who would not spend much time with the software — it was really disheartening,” she says. “Weekly objectives helped.”

As a student who took consecutive chemistry courses, Kadas suggested an additional approach to consistency: using common courseware across course sequences. “I think it would be really beneficial and allow students to get ahead,” she says.

CONCLUSION

More than their peers in other disciplines, participating faculty members said the transition to online courses in Spring 2020 was challenging for students in science classes, which often include hands-on and small-group activities that help support students and keep them engaged. “In the current environment, students aren’t excited about learning online but doing it out of necessity,” Distler says. Adaptive courseware has provided important support for these students, she adds: “Since I’m not seeing them face to face, it’s guiding them in a way I can’t do one on one” during online courses. “There are still a lot of students struggling in this current environment, but I think they’re getting there.”

While Kadas found the level of work within adaptive courseware too difficult for her introductory chemistry class, she said it was “invaluable” during a subsequent higher-level course. “It helped me understand some bigger concepts,” she says. “(Adaptive) is definitely a challenge, but I would absolutely take any other course with it. I got so much out of it.”





Achieving the Dream™

LEARN MORE ABOUT ACHIEVING THE DREAM, INC.

Visit www.AchievingtheDream.org

or contact us at info@AchievingtheDream.org or call (240) 450-0075

Follow us on Twitter @AchieveTheDream