Achieving the Dream™

VALUE ADD: Integrating Adaptive Learning in Mathematics

A CASE STUDY OF ADAPTIVE LEARNING TECHNOLOGY IN MATHEMATICS

everylearner everywhere

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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

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OVERVIEW

Mathematics is a required component of many community college degree pathways, yet large numbers of students come to college needing additional support and struggle to complete gateway math courses—courses in which low-income and minority students are often overrepresented. All seven community colleges participating in the Every Learner Network implemented adaptive courseware to help students succeed in gateway math courses. Among their findings:

- Adaptive courseware provided needed corequisite and/or basic skills support, particularly at institutions which had eliminated developmental education courses as part of state-level or institutional reforms; some institutions also deployed the technology in higher-level math courses based on the experiences of students in introductory courses.
- Faculty leadership in identifying and deploying adaptive courseware was critical, particularly given the importance of ensuring that the courseware aligned with curricula and classroom lectures, activities, and assessments.
- Faculty and students stressed the importance of introducing students to courseware, regularly monitoring the student-performance data it generates to target class content and individual interventions, and aligning courseware with out-of-class supports such as tutoring or corequisite labs.
- Scaling the use of courseware varied from institution to institution, but efforts often focused on providing a consistent integrated experience across course sections taught by full-time and adjunct faculty.

SUPPORTING INSTITUTIONAL REFORM

The Every Learner initiative supports broader efforts to foster student learning with evidence-based practices, including supporting students in gateway courses in which low-income and minority students are often overrepresented. "Out of the gate, we were having more meaningful conversations about what students need," says Sarah Wyatt, associate professor of mathematics at Indian River State College. 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. 8.

COURSE AND COURSEWARE DATA SNAPHOT

INSTITUTION	COURSES	COURSEWARE
Broward College Fort Lauderdale, FL 38,976 students	Developmental Mathematics	ALEKS (McGraw-Hill)
Indian River State College Fort Pierce, Florida 16,686 students	Intermediate Algebra College Algebra Quantitative Reasoning	MyLab Math (Pearson) ALEKS (McGraw-Hill)
Miami Dade College Miami, FL 51,679 students	College Algebra	Integrated Review (Pearson)
Cuyahoga Community College Cleveland, OH 23,655 students	Basic Arithmetic /Pre-Algebra Beginning Algebra I	Knewton Alta (Wiley) MyLab Math (Pearson)
Lorain County Community College Elyria, OH 10,206 students	Statistics	WileyPlus Adaptive Practice
Amarillo College Amarillo, TX 9,739 students	College HSE Math STEM College Algebra College Algebra Business Math Contemporary Math	MyLab Math (Pearson)
Houston Community College Houston, TX 56,151 students	College Algebra Math for Business and Social Sciences	Knewton Alta (Wiley)

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

INTRODUCTION

Geolmary Suazo admits to being anxious before taking her first math class at Broward College in Florida.

"I was nervous because it was my first math class in another language," says Suazo, who immigrated from Nicaragua the year before enrolling at Broward. "I thought it was going to be very hard, and I remembered that I had a classmate tell me that it was the third time she was taking the course."

Suazo isn't alone. Gateway courses in math are mandatory for many community college students, regardless of intended major or program, and few begin their postsecondary studies prepared to excel. Efforts to reform developmental education by placing students into college-level courses regardless of ability level in some states have placed even greater emphasis on meeting students where they are and assisting them through these crucial introductory courses.

A cross-section of mathematics faculty across community colleges participating in the Every Learner Network grant suggests that adaptive courseware has benefits across the full spectrum of ability levels—from self-guided remediation and support for struggling students to helping reinforce skills for those who are ready for college-level content. A common strength is the technology's ability to provide guided practice outside of the classroom setting.

"They can keep working at it until they get it. They can get help. They can follow up," says Kati Dobeck, a mathematics professor at Lorain County Community College (LCCC) in Ohio. "They don't have to stop if they're not happy with a score they earned."

CREATING ALIGNED SUPPORTS

Supporting students in gateway courses is particularly important at institutions in states where legislation or policy changes have prompted changes in developmental education. At Miami Dade College, for example, adaptive software was intended to support skill building in students following legislation passed in 2013 that effectively eliminated developmental education math courses. "It was intended to take care of students on the back end so they could catch up and (be) all the same in the classroom," says Nicholas Schur, math department chair at Miami Dade College's (MDC) Kendall Campus.

> "(The technology) provided activities in the questions that you can click on and break down the problem in a way that you didn't look at it before. With the online abilities and tools that were provided, I didn't have to feel uncomfortable about not getting it right away."
>
> Jennine Wilson, Indian River State College student

Beyond support for skill building, faculty found that adaptive courseware also benefitted students unfamiliar with the workload and expectations of college work. At LCCC, for example, Dobeck uses adaptive courseware for college-level statistics courses—the college's largest enrollment math course—but not for corequisite support, which is provided by a paired developmental course focused on small-group instruction. Instead, adaptive courseware was intended to help students build the kind of study skills required to be successful in college-level math courses. "So many students can get by (in high school) without doing any studying," she says. "If you don't get it yet, you're not proficient yet. There's more work you can do. It's interesting how many ways it can be used."

However, math faculty stressed that adaptive software is not a set-and-forget add-on to curriculum. They emphasized the importance of aligning courseware to curriculum and the content of in-class lectures. "We ensure the materials we choose are covered within our outlines," says Jasmine Vazquez, an assistant professor of mathematics at Broward College.

Faculty also stressed the importance of introducing students to courseware and explaining the rationale behind it at the beginning of courses, as well as regularly monitoring student performance and intervening as needed. A common strategy involved adjusting grading thresholds and other components to ensure that students didn't become frustrated by a lack of progress within the courseware, which typically requires set pass levels before students can move on to graded assessments or the next unit of the course.

"It was challenging to develop how we were going to use it," says Christine McDonald, a master instructor in mathematics at Indian River State College (IRSC) in Florida. "We fumbled around for a couple of semesters figuring out what to use that wouldn't overburden students but be enough."

> "When you first log into courseware, you see you have 30 assignments. I think 10 a month, that's not too bad. But I can understand if you wait a month to do everything how it can be overwhelming."
>
> Brandon Rios, Miami Dade College student

Some institutions also made efforts to align out-of-class supports, including faculty and peer tutoring, to support students by working directly within the courseware. MDC, for example, is adding a lab for college algebra students built around the same adaptive courseware platform. "Whatever the courseware is telling them to work on, they can get help in the lab," Schur says.

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 seven institutions profiled in this case study have committed to engaging in bold, holistic, and sustainable institutional change across multiple institutional areas and priorities. Efforts to implement adaptive courseware support students in the gateway math courses in which poverty-impacted and racially minoritized students are often underrepresented at many of these institutions. They also 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. In this case, the grant provided faculty at participating institutions with the time and resources needed to evaluate, implement, and modify their use of adaptive courseware to best serve students.

Efforts to provide needed corequisite support and basic skills building for students exemplifies the importance of 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 this case, these efforts focused on ensuring more equitable outcomes for students struggling to succeed in gateway courses, particularly at those institutions which had eliminated developmental education courses as part of state-level or institutional reforms. "It was intended to take care of students on the back end so they could catch up and (be) all the same in the classroom," says Nicholas Schur, math department chair at Miami Dade College's (MDC) Kendall Campus.

Faculty- led efforts to identify evidence-based instructional practices that fostered student learning were centered in efforts to align courseware to curriculum and out-of-class supports such as peer tutoring, as well as ongoing attempts to adjust grading thresholds and other components to ensure that students didn't become frustrated by a lack of progress within the courseware. "It was challenging to develop how we were going to use it (in ways) … that wouldn't overburden students but be enough," says Christine McDonald, a master instructor in mathematics at Indian River State College (IRSC) in Florida.

Faculty also worked to use data from adaptive courseware to monitor student progress and refocus supports and the content of their courses. "You need to use the data not to target students, but to coach or mentor them," says Sarah Wyatt, associate professor of mathematics at Indian River State College. "You need the instructor there coaching the students through the course for it to be effective."

LESSONS LEARNED

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

- **Consider how implementation fits in with other institutional initiatives.** Since math is the focus of many initiatives, including but not limited to developmental education reforms, it's vital to understand where adaptive software fits in—and where it doesn't.

  "Initiative fatigue was a constant point of conversation, especially with math," says Nathan Smith, a faculty member and grant manager at Houston Community College in Texas, where faculty avoided using adaptive courseware in introductory-level courses to avoid conflicts with other reform initiatives. "To be successful, pilots need to be intentionally integrated into a department's priorities… if it isn't, it's hard to maintain focus and enthusiasm." Amarillo College was in a similar redesign of developmental math and subsequently stepped back from using adaptive tools in those courses for that reason.

- **Adaptive courseware isn't a replacement for effective instruction.** In math more than other subjects, even students who gave the technology high marks stressed the importance of the instructor; many said in interviews that the quality of the instructor was more important than the presence of adaptive tools. "I don't think the courseware can do it by itself," says Miami Dade College student Emily Gonzalez.

> "My (first teacher's class) correlated directly with the (adaptive) homework. The teacher I have right now is a good teacher, but if what he's teaching is not aligned with the homework he's giving, is it really working?"
>
> Brandon Rios, Miami Dade College student

- **Faculty leadership is critical in ensuring effective implementation.** Faculty must map their curriculum to ensure that courseware mirrors the desired units and objectives, advises Sarah Wyatt, associate professor of mathematics at Indian River State College (IRSC): "Go through the curriculum step by step… to make sure it's in line with what the department wants," she says.

What Worked Well:

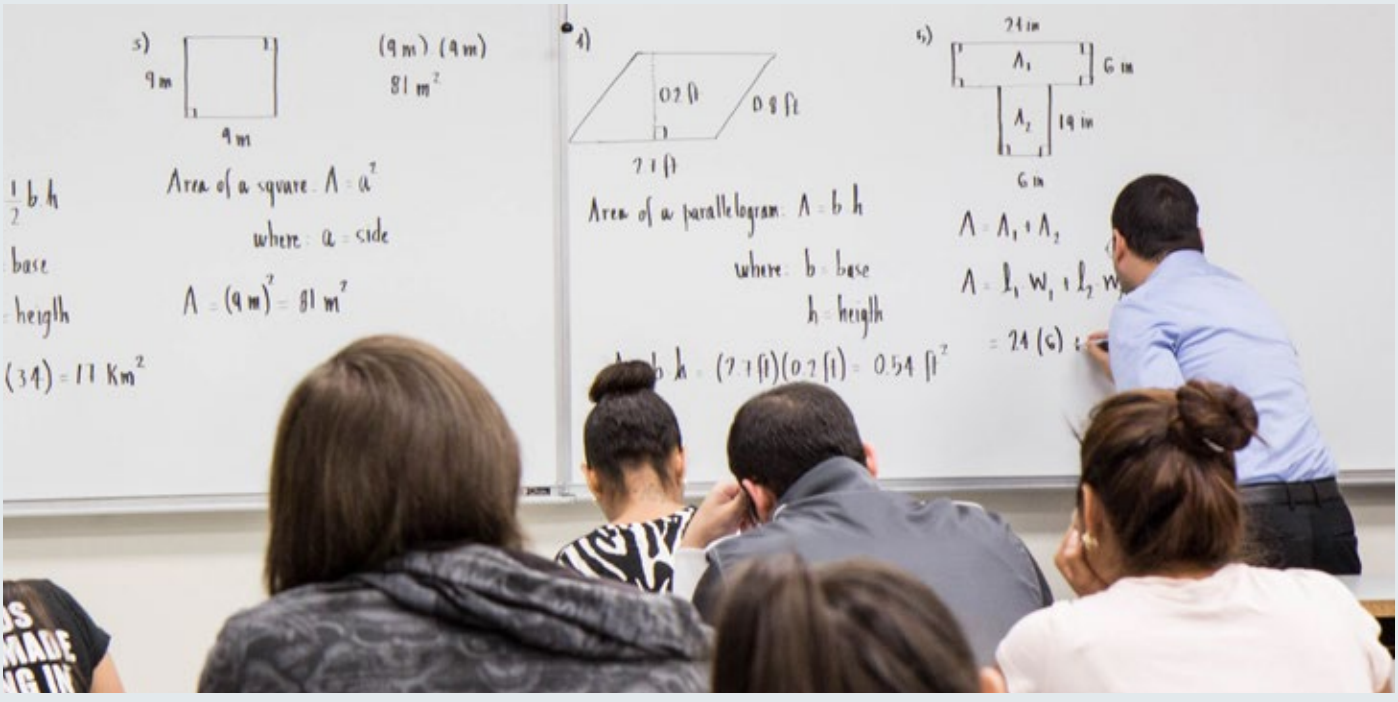
Differentiation. Particularly on campuses which have eliminated developmental education, adaptive courseware helped students build prerequisite skills outside of class. "It targets what they need to practice," says Christine McDonald, a master instructor in mathematics at Indian River State College (IRSC) in Florida. "It helps direct where they need to put their attention to be successful on coming tests." Conversely, the people who "already know the material and have a decent math background get through the assignments quickly," she adds.

Ensuring students maintain an appropriate cadence. Requiring students to reach a set proficiency level before progressing to tests or moving forward helped students keep up with course requirements. Kati Dobeck, a mathematics professor at Lorain County Community College (LCCC) in Ohio, acknowledges that students found the unit-level assignments stressful, but added that previously "students were really stressed when it came to exam time, because they hadn't had the chance to synthesize things yet. That's where I like to shift the stressful experience, so when they get to the exam, they're like, 'that's not so bad'," she says.

Understanding student needs. Faculty who reviewed the data on student performance generated by adaptive products found that it helped them pinpoint support to individual students and shape in-class instruction to address the topics where the largest numbers of students struggled. "Out of the gate, we were having more meaningful conversations about what students need," says Sarah Wyatt, associate professor of mathematics at IRSC.

Cost savings. Faculty across campuses pointed to adaptive courseware's low cost compared to textbooks, although some who had previously used non-adaptive versions of the same courseware reported little or no change in costs, which were around $40 to $70 per student on many campuses.

Accountability. Faculty said that the variability of questions delivered by adaptive courseware helped ensure that students did assigned work and were prepared for exams. "The bank has 400 questions. It holds students accountable," Dobeck says.



Ongoing Challenges:

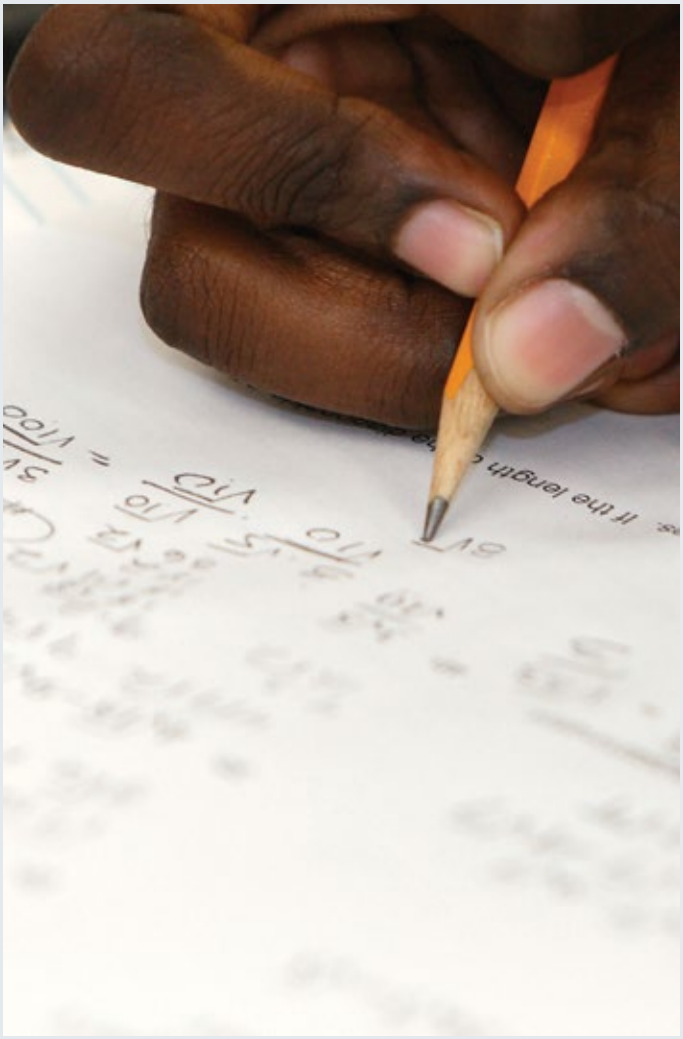
Addressing student frustration. Faculty frequently reported students being overwhelmed by the number of skills they had to master and how related assignments and tasks were presented by courseware. "It was structured in ways that students could throw their hands up in the air and say they can't do the class," says Nicholas Schur, math department chair at Miami Dade College's (MDC) Kendall Campus. For example, some courseware highlights the full list of quizzes students will have to take throughout the semester after completing an initial diagnostic test. "Some (quizzes) just have seven questions, but it does look overwhelming when you see this humongous list," McDonald says.

To address issues with students becoming frustrated by their lack of progress, Schur ultimately overruled some of the courseware's efforts to force constant retakes. The goal, he says, is to strike a balance between remediation while "at the same time pushing forward."

Even students who understood the value of retakes said that at times the courseware would slow progress for minor, sometimes mechanical, mistakes. "If you get a math question wrong, you should redo and redo it," says Broward College student Valeska De Lang. "But if you accidentally put the wrong parentheses (and it counts it as wrong)? It's great in the long run because it teaches you to look over things, but when you have a lot of assignments and have to do other things, in the moment it is frustrating."

Lack of higher-level materials. While adaptive courseware is effective at helping students reinforce and master core skills, faculty said it may not be ready for the more conceptual work required in higher-level courses like calculus. "I wish adaptive had more conceptual questions, or asked (questions like) what is the first step to solve the equation?" Wyatt says.

Onboarding. Some students—even recent high school graduates accustomed to online



classes—found working in adaptive courseware unfamiliar. "I wasn't used to doing that kind of thing for homework," says Ivan Ondoa, a student at Houston Community College. Faculty stressed the need to explain the purpose of adaptive exercises to students. "They're used to (standardized) assignments," Wyatt says. "We went on for a very long time explaining what they needed to do and the connection to the grade."

Challenges with planning. While traditional courseware often describes how long assignments should take students, adaptive assignments defy easy estimates. "With regular homework, I assigned 15 questions and can estimate how long it will take," Wyatt says. "With adaptive, one student has 20 questions, another has 10. Some students are very low-skill, and it's not going to take them a minute per question."

> “At first it might be a little more difficult because you’re learning to navigate the courseware as well as the class itself. Once you get a handle on that, maybe if you struggle with math it would be more beneficial.”
>
> Sydney Wade, Lorain County Community College student

Students also stress that alignment is critical in ensuring that courseware is effective. “It works really well as long as what the professor is teaching and what’s in the software is properly aligned,” says Gonzalez. “Otherwise, you don’t know what way you should be solving problems.”

Amarillo College instructor of mathematics, science, and engineering Gale Brewer saw this firsthand after making mid-course adjustments. “Students did (adaptive work) but didn’t see it as beneficial until I tweaked it so it matched what I was doing in college algebra,” she says. And Christine McDonald, a master instructor in mathematics at IRSC, says that the Florida college had better results in courses where students had experience with college-level math than the introductory course, despite adaptive courseware’s promise to support students with lower skill levels. “It could be we didn’t find the right way to use it in (that course),” she says.

- **Prepare students to use adaptive software.** Wyatt began her in-person classes in the computer lab to ensure students log into the courseware and understand how to use it. “The software is designed to help them, but what gets in the way is that they get so overwhelmed from the get-go. You have to coach them to stick with and get through the adaptive (elements),” she says. In similar fashion, HCCS developed a student onboarding module which was added to its learning management system to guide students and faculty.
- **Monitoring student progress is critical.** “You need to use the data not to target students, but to coach or mentor them,” Wyatt says. “You need the instructor there coaching the students through the course for it to be effective.” Kati Dobeck, a mathematics professor at Lorain County Community College (LCCC), for example, monitors students’ most-missed questions in the courseware to plan the focus of her synchronous sessions in an online math course.

Along with identifying which students are struggling, McDonald says it's also important to monitor how students are using the courseware. "Pointing to the example of a student who kept unsuccessfully retaking a quiz instead of going back to do practice problems, she says, "It's our responsibility to show them what they need to do to be successful… instead of doing the inefficient thing over and over again."

Dobeck agrees, saying that she reaches out to students who are spending large amounts of time on a specific assignment to guide them to other options. "It's not my intention for it to take five hours—maybe go talk to a tutor and it would take less time," she says.

- **Using the courseware in class.** Despite its primary use case as guided homework and practice, faculty and students stressed the value of having some class time dedicated to working in the courseware. Wyatt held classes in the computer lab regularly to watch students work. "It was helpful for me to see who was struggling and making progress in the courseware," she says.

- **Ensure that faculty use the courseware themselves.** Many students stressed the importance of having instructors try the software themselves so they understand the range of questions included in adaptive exercises and create alignment between those exercises and their other class activities. Dobeck agrees. Pointing to her own attempt at taking the start-of-course diagnostic test, she says, "I got an 87 percent, and I know the stuff." More to the point, it made her realize that the default passing threshold of 80 percent wasn't appropriate, resulting in her changing grading standards for the course in ways that more students progressed through the courseware in a timely fashion. "You'd be surprised at how tricky the questions were," Dobeck says.

> "I don't know if professors see everything we have to do (in the courseware). Last week, we had to turn in two assignments—one with eight questions and another with 17. The same week we did a practice test, which helps us for the test, but it was 35 questions. Everyone said there were (types of) questions we didn't see in class that were in the pretest."
>
> Geolmary Suazo, Broward College student

CONCLUSION

Faculty at participating institutions said that the Every Learner grant support provided them with the time and resources needed to evaluate and implement adaptive courseware.

While the coronavirus pandemic limited their ability to fully measure its impact, anecdotal evidence suggests the technology was beneficial. Preliminary data suggests that adaptive courseware helped bring students up to college-level math in introductory classes at MDC, says Schur. At Indian River State College, one math instructor saw pass rates jump from 40 percent to 60 percent after making adaptive study a prerequisite for taking graded quizzes. Faculty members across participating sites reported that overall grades improved, while some said that more students completed homework, with the technology helping focus their attention on the areas they needed most.

"The beauty of adaptive is that it's laser focused on what you need to know for the semester to be successful—it eliminates busywork," says Sarah Wyatt, associate professor of mathematics at IRSC. "I wouldn't say engagement is more or less, but it makes the focus better."

Experiences scaling adaptive courseware varied from campus to campus. Some institutions scaled back the use of adaptive courseware in developmental math courses because of conflicts with ongoing redesign efforts. At others, math faculty made deliberate efforts to ensure that college algebra sections taught by adjunct faculty were aligned with adaptive courseware by creating

> "When you think back to using textbooks, there's so much information in your face. (With courseware), you have just one question presented to you, and then you go on to the next one. You're not bombarded with all these problems."
>
> Emily Gonzalez, Miami Dade College student

master course shells and/or daily lecture notes to ensure consistency across sections taught by full-time and adjunct faculty. "The idea was that the platform would make their lives easier," MDC's Schur says. "We wanted a turnkey approach." At other colleges, implementation was less consistent, depending on individual adjunct faculty members' willingness to experiment with new technology or definitions of academic freedom.

Now a second-year student at Broward, Suazo credits the efforts her professor made to introduce her class to the courseware to her success in the initial math class she took. "She explained it the first time and explained it well," she says. "She gave me the vibe that I'd understand everything."

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