FLORIDA INTERNATIONAL UNIVERSITY:

Adaptive Courseware for Early Success Case Study

Association of Public & Land-Grant Universities

FIU Florida International University

everylearner everywhere

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The 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. The association's membership consists of more than 250 public research universities, land-grant institutions, state university systems, and affiliated organizations. APLU works with members to expand access and improve student success to deliver the innovative workforce of tomorrow; advance and promote research and discovery to improve society, foster economic growth, and address global challenges; and build healthy, prosperous, equitable, and vibrant communities locally and globally. The association's work is furthered by an active and effective advocacy arm that works with Congress and the administration as well as the media to advance federal policies that strengthen public universities and benefit the students they serve.

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 **everylearnereverywhere.org.**

Association of Public & Land-grant Universities

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Seeking to address student costs, preparedness, and high attrition rates for those taking Calculus for Engineering, Florida International University established a highly collaborative, uniquely skilled, cross-functional team to create an effective adaptive tool that was free in cost to students and that could serve as a model for scaling into other courses and programs.

ADAPTIVE COURSEWARE FOR EARLY SUCCESS INITIATIVE

The Adaptive Courseware for Early Success (ACES) Initiative was a grant-funded initiative supported through the Every Learner Everywhere network and funded by the Bill and Melinda Gates Foundation. In total, thirteen colleges and universities from Ohio, Texas, and Florida participated in this initiative from 2019 through 2021. Six 4-year universities, which are members of the Association of Public Land-grant Universities (APLU) received direct guidance and support from the Personalized Learning Consortium (PLC), located in the Office of Digital Transformation for Student Success (DTSS). The ACES Initiative centered around two primary goals:

- **To redesign critical gateway courses taught by faculty committed to integrating equity-centered, evidence-based teaching practices that are enhanced by adaptive courseware**
- **To create more equitable student outcomes by improving learning and educational experiences for poverty-impacted students, racially minoritized students, and first-generation students**

Over the course of two and a half years, the PLC provided intensive coaching, peer-mentorship, collaborative learning and networking opportunities, and educational resources and training to cross-functional, institutional teams at select institutions. These institutions received further support and benefits from the Every Learner network partners, including Achieving the Dream and Digital Promise who offered collaborative learning with participating two-year institutions and program evaluation support, respectively.

Note. It is critical to acknowledge that this initiative took place at the onset and height of the COVID-19 global pandemic crisis. The COVID pandemic dramatically altered the higher education landscape in 2020, requiring colleges and universities to rapidly transition to remote instruction and to reprioritize the allocation of their resources and institutional capacities to appropriately respond to the crisis. Despite facing these challenges, each of the participating institutions carried on their work, adapting in real-time and focusing on how to best leverage newly adopted technologies and supporting students with quality teaching practices. For more information on the impact of COVID on these grantees and other institutions, please see our network partner Digital Promise's report, *Suddenly Online: A National Survey of Undergraduates During the COVID-19 Pandemic.*

Florida International University Demographics

46,400 undergraduate students and **10,200 graduate** students

4-year public research institution in **Miami, Florida**

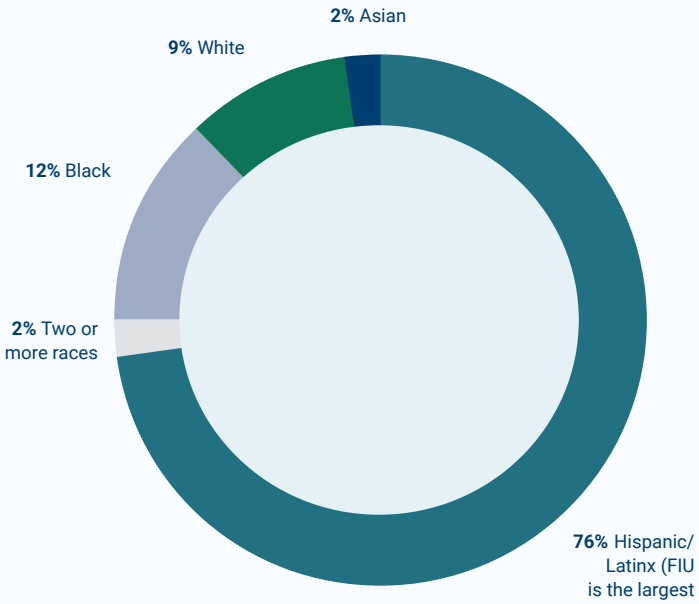
96% of all students are in-state residents and **seven percent of students identify as a non-U.S. citizen.**

75% of first-year students live off-campus or commute.

50% of undergraduate students are eligible for a Pell Grant.

As of fall 2020,

85% of undergraduate students were enrolled in at least one online course, with **34% enrolled exclusively online.**



Student Demographics

Institutional Background

FIU published their *BeyondPossible2020* strategic plan, which discussed strategies to increase the institution's student retention rate by expanding the Center for the Advancement of Teaching (CAT) and redesigning gateway courses. It was specifically noted that "math course design, discipline-based teams and support from CAT have already resulted in significant gains in Algebra. The university will follow a similar approach to develop the optimum course redesign for all math gateway courses" (Florida International University, 2020, p. 23).

FIU has multiple offices dedicated to advancing the teaching practices of mathematics. The Center for the Advancement of Teaching works with faculty members to identify evidence-based, inclusive pedagogy that promotes student success in the classrooms. For students taking math courses such as College Algebra, there is an associated lab requirement, called The Mastery Math Labs, to provide additional content support. The Center for the Transformation of Teaching Mathematics supports first-year mathematics courses with assessment and activities meant to advance student learning. FIU also houses a STEM Transformation Institute, which collaborates with multiple STEM (science, technology, engineering, mathematics) majors to promote active learning and develop future professionals in these disciplines.

This infrastructure shows a dedication to teaching and student success in mathematics across the university. Since 2011, face-to-face College Algebra courses have seen an increase in pass rates from 33 percent to nearly 64 percent, and online algebra courses have increased their pass rates from 10 percent to 65 percent (Florida International University, 2020). The integration of adaptive courseware into redesigned gateway algebra courses helped to support the institution in its efforts to improve student learning and course completion, as well as shorten the path to graduation.

The institution also recognized that engineering students were struggling with algebra and calculus. Students entering engineering courses do so with varying competency levels in mathematics–skills that are critical to student success and program completion in the college's Engineering program. The Calculus for Engineers course was developed to provide engineering students with calculus-specific math problems that were applicable to the discipline. Participating in the ACES Initiative enabled FIU to expand the resources and support provided to students taking the Calculus for Engineers course.

Goals of Grant Participation

FIU's goals for participating in the grant included reducing attrition rates of engineering majors, helping students become better equipped to use prerequisite algebra content in the Calculus for Engineering course, and promoting an engineering identity for students, especially those from underserved backgrounds in the discipline. Students, especially those from underrepresented populations, are more likely to leave a STEM field if they do not identify with it (Oseguera, et al., 2019). The university ultimately hoped to create a multi-tiered support program for the course by using adaptive learning and prioritizing student cost and access to course materials. They also planned to pilot an optional six-week extended semester with adaptive courseware for students struggling with the math topics.

Course Implementation

Because FIU was looking to integrate an adaptive product into a unique course on calculus tailored to engineering majors, there were limited commercial options that met their needs. Given the existing resources, expertise, and institutional support at FIU, the implementation team decided to develop their own customized product for the Calculus for Engineers course. The team was also interested in finding ways to support students' access to high-quality content with low or no cost materials. The free, open-source mathematics assessment system, IMathAS, was chosen for this purpose (Table 1). Custom-built platforms come with several benefits such as allowing for the integration of original, commercial, and open education resources; however, development and sustainability require unique skills and access to long-term resources and maintenance that many institutions lack (Vignare et al., 2018). Whereas creating and maintaining a custom-built course made sense for FIU, as they had the internal expertise and capacity to effectively do so, many early adopters choose an "off-the-shelf" platform that has already been designed and extensively vetted.

FIU felt that IMathAS allowed faculty to be more in control of the adaptive content presented to students compared to using adaptive courseware products being offered in calculus courses at the time of the project. IMathAS supported the faculty in curating the delivery of assignments, exams, and diagnostics, while providing immediate feedback to students. With reducing student cost as a priority, the zero cost of IMathAS was a major consideration for choosing the product.

FIU expanded its use of IMathAS in the course over time. In fall 2020, a team of four faculty and the project lead created an operational plan to develop IMathAS weekly prerequisite modules, each of which contained around ten initial questions per module. Students needed to answer all the prerequisite questions correctly to open the week's pre-class assignments. If a student answered a question incorrectly, they were directed to answer another question that addressed the same topic with supporting materials like solved problems, explanations, and videos. As students completed these prerequisite knowledge assessments, faculty were able to evaluate student learning and provide "just-in-time" instruction to support students' ongoing learning. In their research on evidence-based teaching practices being employed by faculty participating in the ACES Initiative, Digital Promise (2021) found that, of the adaptive features available, faculty were most likely to leverage system-generated feedback on student responses (96%) and dashboard analytics on student progress (91%).

Table 1.

Course Implementation of Adaptive Products at FIU

Discipline	Course Name	Adaptive Product	Students	Faculty
Mathematics	Calculus for Engineers	IMathAS	139	2
Totals	**1**	**1**	**139**	**2**

Note: *Final data as reported by the university in spring 2020, summer 2020, fall 2020, and spring 2021.*

Overcoming Implementation Challenges

COVID-19 Pandemic.

In February 2020, the project lead, Leanne Wells, was assigned to help lead an institution-wide Academic Continuity Team, which reduced her time to prioritize this project. While involved faculty members continued to develop the integration of adaptive learning, they had less oversight. FIU identified solutions to this issue by appointing their Program Director of the Mastery Math Lab, Roneet Merkin, as a project co-lead and by organizing times for course assessment. Informed by its work on an array of student success and institutional transformation initiatives, leadership from APLU recommends that, from the start, institutions build knowledge and capacity across their teams, with integrated and collaborative support woven into the design and implementation of projects to ensure success (Vignare et al., 2023). By tapping an experienced and fully integrated faculty lead to transition into the role of project lead, FIU was able to carry the project forward as planned.

Additionally, FIU continued to work on expanding their use of adaptive learning to other departments and mathematics sections in 2020, even while managing the pandemic.

> ***"We have already begun work on expanding to a differential equations class and a physical chemistry class because those faculty heard of this project either from a colleague (differential equations) or from a site visit meeting (physical chemistry). Additionally, after the December site visit, the chair of Mathematics & Statistics indicated that she was interested in having statistics faculty adopt IMathAS modules and course design. A meeting is scheduled for the first week in January to discuss this with her."***

Addressing Student Buy-In with Faculty Buy-In.

Student buy-in was a challenge that FIU acknowledged throughout the implementation process. Some faculty were concerned with the additional work for students who are already struggling with course concepts. One instructor "*was worried that students were getting overloaded with the work,*" noted co-lead Roneet Merkin. She explained that many FIU students are full-time commuters who work part-time or full-time jobs but added that "*this does not mean it shouldn't be done. It's not unreasonable to expect a student to spend a few hours outside of class time preparing for class.*" The faculty members also noted how some students were frustrated with the need to review math concepts that they studied in high school.

The FIU team explicitly spoke to faculty about communicating to students about the purpose of the prerequisite assignments and how adaptive courseware offered more time for in-class instruction. Co-lead Merkin said "*faculty understand what [adaptive courseware] is and how it helps them. They think it makes perfect sense to not keep teaching their students the same thing over and over again [in class*]." Merkin stated the importance of refreshing students on their algebra skills, which faculty also recognized:

> ***[Students] don't remember [algebra], so it serves a real function… I think for the majority of students that is likely the case. Yes, they took algebra in high school and they took college algebra, and you would think they retain it, but some don't."***

Impact

The FIU team compared the pass rates of the Calculus for Engineers courses taught with and without adaptive courseware in spring 2020, summer 2020, and fall 2020. Students taking the on-campus course with adaptive courseware had a pass rate of 87 percent in spring 2020 and 77 percent in summer 2021 compared to students taking the online course who had a pass rate of 71 percent in spring 2020 and 72 percent in summer 2020. The implementation of these efforts took place during the height of COVID-19 pandemic, which likely affected the results. It is also possible that the instructional delivery impacted the results, as the adaptive courses were taught on campus and remotely, while the non-adaptive course was taught only remotely. Research has shown that students taking fully online courses have historically had lower academic outcomes than in-person or hybrid modalities (Alpert et al., 2016; Kofoed et al., 2021).

A fall 2020 institutional survey on students' perception of teaching showed students who took the sections with adaptive courseware were more satisfied (n=4.48) compared to students in sections without the courseware (n=4.09). The FIU team leveraged institutional resources and built relationships across the mathematics and engineering departments to develop an adaptive tool specific to supporting students in a unique course. By developing quality content that supported student learning, the team created a replicable implementation model for supporting math students at FIU that can be adopted across other future courses.

Takeaways and Next Steps

Florida International University's key takeaways focused on the importance of involving the right institutional stakeholders within their cross-functional team, which enabled their customized adaptive program to be realized. They recommend the following:

1. **Include faculty who teach the course as early as possible. Faculty must have a large role in shaping the development, planning, and implementation of teaching and learning projects.**
   - **For the FIU team, faculty involvement in the design of the modules was crucial for buy-in for other faculty, including those in other academic departments.**
2. **A highly-skilled, technical expert (faculty or non-faculty) is an integral addition and critical to designing a customized adaptive program of curated content and course modules.**
   - **Institutions should further consider how they will sustain and maintain custom programs over time, as it will require continued resourcing and refinement.**
3. **Key elements of design should be limited to a small team to avoid duplicate work.**
4. **Include a highly effective departmental administrator on the team who can build relationships and secure critical resources for the cross-functional team.**
5. **Prioritize backwards course design, an essential process that promotes intentionality during instructioal planning and a focus of student learning (Wiggins & McTighe, 2005).**

The FIU team was intentional about bringing faculty in mathematics and engineering together to collaboratively address attrition rates by identifying which concepts to cover in the Calculus for Engineers course. They also benefited from having a diverse group of internal constituents including faculty members, an instructional designer, and directors from multiple offices on campus dedicated to supporting mathematics instruction. This provided the team with instructional expertise and institutional leadership to facilitate the course redesign process through challenges that came up like the change in team leadership and the COVID-19 pandemic. This also provided faculty with the ongoing campus support to increase student buy-in and handle the transition of teaching a redesigned course.

This robust institutional support and collaboration allowed FIU to build their own adaptive product that was free to students. Customized platforms require a lot of time and energy to create content on the front end. The team had the technical skills and time necessary to create a program from scratch. These efforts allowed for the creation of an adaptive program that catered to the specific needs of the Calculus for Engineers course, offered more control for faculty members teaching the sections, and reduced the cost of materials for students.

Moving forward, FIU intends to scale successful models from the Calculus for Engineering course into their regular calculus courses. They are building prerequisite modules with adaptive courseware for their Physical Chemistry courses and looking to expand to General Chemistry as well. They plan to submit multiple grant proposals to further their implementation of adaptive courseware to support their strategic plan to improve course completion in gateway courses.

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