Student Perceptions of the Effectiveness of Adaptive Courseware for Learning

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INTRODUCTION

In May 2016, the University of Mississippi (UM) received a grant from the Association of Public Land Grant Universities (APLU) to implement and scale the use of adaptive courseware in high-enrollment, general education, undergraduate classes. One of the goals of the Accelerating the Adoption of Adaptive Courseware Grant is to increase student learning so students may progress through their degree pathways. Faculty at UM and other grant cohort institutions are conducting research on the effectiveness of adaptive learning courseware through comparison studies with sections that do not use adaptive courseware. Similar studies have been reported by Mihalca et al. (2011), Freeman et al., Eddy (2014), Yarnall et al. (2016), Johanes and Lagerstrom, (2017), Liu, McKelroy et al. (2017), and Suna et al. (2017) among others. Studies reveal benefits of adaptive courseware in particular disciplines and with particular products (Nwaogu, 2012; Hinkle et al., 2018; Griff et al, 2013), but universal research on the benefits of adaptive courseware are less conclusive (Murray et al, 2015; Fontaine et al, 2017).

While these studies have measured student learning and outcomes through summative assessments, the purpose of our research is to explore student perceptions of the effectiveness of adaptive courseware for learning. We chose this topic because there are few published, peer-reviewed studies on adaptive courseware that address the student experience and student perceptions of adaptive courseware, although researchers at the University of Central Florida and Colorado Technical Institute have pioneered efforts in this area (Dziuban et al., 2016; Dziuban et al., 2017). These studies demonstrate student satisfaction with personalized learning in terms of self-pacing, learning guidance, ease of use of the platform, and increased engagement with the content. While these studies include a broad range of disciplines, the courses were online and delivered on a single adaptive platform.

Our study seeks to assess student perception of the effectiveness of adaptive learning platforms in courses delivered face-to-face and on a variety of adaptive platforms. Because the student experience is essential in assessing promising, but untested educational initiatives (Swing & Ross, 2016), we feel it is important to understand how students are experiencing adaptive courseware, and whether or not they find it adds value to their education.

As reported in the *2019 Educause Horizon Report*, "Adaptive learning has been a staple in the *Horizon Report* since 2015" (p.34), and was projected to have wide adoption in higher education by 2018. However, in the *2018 Horizon Report*, the timeline was pushed back 2-3 years. There are several reasons outlined in the *Horizon Report* for this change, including the amount of resources required to implement adaptive courseware, the cost of the adaptive courseware which is passed on to students, and the lack of universal evidence of adaptive courseware's efficacy following several years of hype by vendors, educators, and higher education support institutions. (Alexander et al., 2019) We find the student experience of adaptive courseware at the University of Mississippi aligns with the findings of the *2019 Educause Horizon Report* regarding cost and resources.

ADAPTIVE COURSEWARE AT THE UNIVERSITY OF MISSISSIPPI

INSTITUTIONAL CONTEXT

The University of Mississippi (UM) is an R1 research institution located in the city of Oxford, Mississippi, and surrounded by rural areas. Four regional campuses and a medical center in the capital city, Jackson, make UM a dominant presence in northern Mississippi. The undergraduate student population of 17,000 consists of mainly traditionally-aged students, 38% of whom are Pell-eligible and 22% who are first generation college students. The racially minoritized undergraduate student population at UM is currently 23% of the undergraduate population. This includes the following racial categories on which the institution collects data: African American, American Indian, Asian, Hispanic or Latino, Native Hawaiian or Pacific Islander, Two or More Races.

COURSES INVOLVED IN THE STUDY

UM began piloting adaptive courseware in Spring 2017, reaching scale in several courses by Fall 2018. The chart below lists the courses that adopted adaptive courseware during the grant period. The end-of-semester survey (provided as Appendix A titled) was sent to all students enrolled in these courses and to students enrolled in courses using adaptive courseware in the subsequent semesters discussed in this study. (See Appendix A for a copy of the end-of-semester survey administered in each case.)

Table 1

Courses involved in Adaptive Courseware Grant

STEM	Humanities	Business	Social Sciences
Anatomy & Physiology	Health Ethics	Accountancy I & II	Microeconomics
Biological Sciences	First Year Writing I	Business Statistics	Intro to Sociology
Gen Biology I	European History	Mgmt Info Systems	College Success
Gen Biology II	Elementary Spanish		
Gen Chemistry	Intermediate Spanish		
Intro to Chemistry			
Organic Chemistry			
College Algebra			
Statistics			
Trigonometry			
Calculus I & II			
Quantitative Reasoning			
Gen Physics I & II			
Engineering Fluid Mechanics			

COURSEWARE

While there is currently no standard definition to assess which products can be categorized accurately as adaptive courseware and which cannot, per the terms of the Adaptive Courseware Grant, the University of Mississippi adheres to an approved vendor list compiled by the Bill & Melinda Gates Foundation under the advisement of the Courseware in Context Framework Primer developed by Tyton Partners, a consulting firm specializing in education, information, and media markets (Tyton Partners, 2016).

Digital courseware is instructional content that is scoped and sequenced to support delivery of an entire course through software built specifically for educational purposes. It includes assessment to inform personalization of instruction and is equipped for adoption across a range of institutional types and learning environments (Tyton Partners, 2016, p.3).

Additionally, the Courseware in Context Framework assesses courseware products according to six distinct levels of functionality highlighting adaptivity as a function of the learning tool rather than as a function of instructor or student behavior:

1. The courseware adapts the goals or standards for learner completion, based on more inputs than a single correct response to the previous item or activity.
2. The courseware adapts the presentation of content, based on learner-declared goals.
3. The courseware adapts the complexity or presentation of content, based on a learner pre-test.
4. The courseware adapts the complexity or presentation of content, based on a learner's affective state.
5. The courseware adapts the scope of instruction (breadth and depth of content), based on more inputs than a single correct response to the previous item or activity.
6. Educators or course designers can override or change the parameters of adaptive protocols.

Courseware assigned in UM courses includes Pearson's Mastering and MyLabs, McGraw Hill's LearnSmart and ALEKS, Cengage's MindTap and Open Now, Realizeit, Smart Sparrow, Wiley Plus with Orion, Lumen Waymaker, Hawkes Learning, and Macmillan's Learning Curves.

METHODOLOGY

FOCUS GROUPS

The methodology for analysis of focus group transcripts was a combination of sign-vehicle analysis and evaluation coding. Sign-vehicle analysis involves three measures: the frequency with which a symbol or idea appears, the relative balance of favorable and unfavorable attributions regarding a symbol or idea, and the kinds of qualifications and associations made with respect to a symbol or idea, (Krippendorf, 2004). In our analysis, we noted the frequency and intensity of student comments, and organized these comments into themes which were applied as codes to develop qualitative data in order to assess the focus groups' judgement of the features of adaptive learning (Rallis & Rossman, 2003).

Program evaluation is "the systematic collection of information about the activities, characteristics, and outcomes of programs to make judgments about the program, improve program effectiveness, and/or inform decisions about future programming. Policies, organizations, and personnel can also be evaluated" (Patton, 2002, p. 10). To Rallis and Rossman, evaluation data describe, compare, and predict. Description focuses on patterned observations or participant responses of attributes and on details that assess quality. Comparison explores how the program measures up to a standard or ideal. Prediction provides recommendations for change, if needed, and suggests how those changes might be implemented.

In our focus group sessions, we asked particular questions for the purpose of evaluation of courseware including how adaptive courseware was integrated in classes, what features of the courseware students found useful, and what user feedback students wanted communicated back to faculty.

Table 2

Academic status of students participating in focus groups

Academic Status	Round 1 Fall 2017	Round 2 Spring 2018	Round 3 Fall 2018	Round 4 Spring 2019	Sum	Percent of total
First Year		3	5	2	10	12%
Sophomore	15	4	7	7	33	39%
Junior	8	6	7	5	26	31%
Senior	7	4	3	1	15	18%

Table 3

Demographics of students participating in focus groups

	Round 1 Fall 2017	Round 2 Spring 2018	Round 3 Fall 2018	Round 4 Spring 2019	Sum	Percent of total
Asian	1	1	1	4	7	8.3%
Black	2	6	5	2	15	18%
Latinx	3				3	3.5%
white	25	10	15	9	59	70.2%
Female	24	13	20	11	68	81%
Male	7	4	1	4	16	19%

Our research subjects were undergraduates enrolled in face-to-face courses utilizing adaptive courseware. Students were recruited based on class enrollment and were contacted via email. Participation in the student survey was voluntary.

The purpose of the survey was to scale and quantify feedback from the student focus groups, which averaged 3-5 students from each course. By offering a survey to all students using adaptive courseware at UM, we have been able to obtain feedback from hundreds of students in a short span of time. This immediacy of feedback stands in contrast to focus group feedback, which involved far fewer students, and took much longer to obtain, organize, and analyze.

RESULTS

During the final two weeks of the Fall 2017, Spring 2018, Fall 2018, and Spring 2019 semesters, we deployed a 20-question survey to all students enrolled in sections of courses using adaptive courseware. (See Appendix A.) The response rate for the first three surveys averaged 14%, but in the case of the fourth survey, the response rate dropped significantly to 4.7%.

While the demographic make-up of survey respondents generally reflects that of the university, in the cases of the Fall 2017 and Spring 2018 surveys, the ratio of minoritized student respondents to white student respondents was slightly higher than the overall university population.

Table 4

Ratio of minoritized and white student survey respondents AY 2017/2018

Survey respondents by semester year	Ratio of minoritized to white students
Fall 2017 survey respondents	25:74
Spring 2018 survey respondents	26:74
Academic year 2017/2018 population	23:77

The ratio of minoritized student respondents to white student respondents fell below the ratio of the university population for the Fall 2018 and Spring 2019 surveys.

Table 5

Ratio of minoritized and white student survey respondents AY 2018/2019

Survey respondents by semester year	Ratio of minoritized to white students
Fall 2018 survey respondents	23:77
Spring 2019 respondents	19:81
Academic year 2018/2019 population	24:76

Student respondents also over-represent both the Pell-eligible population at UM and the national average of first-generation students at 4-year institutions.

Table 6

Percent of Pell-eligible survey respondents in the UM population

Pell-eligible respondents	Survey	UM population
Fall 2017	43%	26%
Spring 2018	44%	26%
Fall 2018	39%	24%
Spring 2019	39%	24%

Table 7

Percent of first-generation survey respondents in the UM population

First-generation respondents	Survey	Nat avg. at 4-year inst.
Fall 2017	23%	20%
Spring 2018	26%	20%
Fall 2018	23%	20%
Spring 2019	23%	20%

Across all four surveys, respondents consistently ranked the following as the most highly useful features of courseware: supporting multiple attempts at taking quizzes, homework practice, instant feedback, and viewing solutions to problem sets. Also highly ranked as useful features were lesson progress meters, and 'chunked' content, a term describing the strategy of breaking up content into shorter, bite-size pieces that are more manageable and easier to remember (Miller, 1956).

In all four end-of-semester surveys, respondents identified "more flexibility in submitting homework and quizzes" as the number one way in which the courseware changed how they learned, and "more flexibility for learning and practicing course concepts" as the second most effective way the courseware changed how they learned. Flexibility in both cases can be defined as having choices in terms of *when* to learn and take assessments, and more choices in terms of modalities for content delivery and practice, the *how* of learning.

In the first year the survey was administered, just over 43% of responding students reported the courseware contributed to their grade being higher than it would have been without the courseware. In the second year, that percentage increased to 49.7% (Fall 2018) and 48.7% (Spring 2019). The percentage of students who felt their grade was about the same with or without courseware remained steady between 39.74% - 42.66%. Each semester of the survey, the percentage of respondents who felt their grade was worse due to the courseware decreased from 14.27% (Fall 2017), 12.79% (Spring 2018), 10.56% (Fall 2018), to 9.13% (Spring 2019).

Another consistent report concerned how faculty were implementing courseware. In all four surveys, students reported faculty were using courseware as a homework and quizzing platform and as a textbook replacement. Even so, over 50% of students in AY 2017/2018 reported being directed to purchase a physical textbook to supplement the ebook. This percentage dropped to just over 40% in the following academic year, showing that faculty were responding to student concerns about the additional cost of physical textbooks. Unfortunately, the cost of courseware, with or without a physical textbook, remains high. According to a 2016 survey reported by SRI, after the first year of implementation, "adaptive courseware was associated with lower ongoing costs" (Yarnall et al, 2016. pg. iii). However, that study measured several cost factors including faculty training and technological support costs. Our cost measurements single out the actual price students paid for access to adaptive learning products. Across all four surveys, an average of 73% of students reported paying $75.00 or more for courseware access, and 53% of students reported paying more than $150.00 for courseware access.

Filtering the surveys for minoritized students did not reveal significant differences in responses. Moreover, the category of minoritized students is not mutually exclusive from the two other filtered categories, first-generation respondents and Pell-eligible respondents.[1] That said, treated as a discrete category, minoritized students were far more likely to report their grade was higher

[1] See Appendix C for percentages of survey respondents who were categorized in overlapping categories involving two or more of the following categories: Minoritized students; First-generation students; Pell-eligible students.

because of the courseware than the unfiltered student population. In addition, while minoritized students similarly rated flexibility in submitting homework and quizzing as a feature that changed the way they learned, minoritized students noted as helpful for their learning the ability to complete coursework on a mobile device and the opportunity to practice concepts the courseware identified to them as areas in which their mastery was weak.

First generation responding students were aligned with the unfiltered survey respondent population in terms of the two of the top three most useful features of courseware first generation survey responders identified: being able to take quizzes more than once and homework practice. However, unlike the unfiltered population, first generation students consistently ranked the progress bar as either the second or third most useful feature of courseware. Among the top three ways the courseware changed the way they learned, first generation respondents listed a. flexibility in submission dates for homework and quizzes, and b. flexibility in learning course concepts and in practicing those course concepts. However, they differed from the minoritized population by listing c. 'revising lessons for a higher grade' as a way the courseware changed the way they learned.

First generation respondents aligned with the unfiltered population in reporting their grades as positively affected *by* courseware each consecutive semester. However, they did not report a steady improvement in their grades *due to* the courseware. Those in spring semesters reported a more positive effect on their grades due to the courseware than those in the fall semesters. As we explain below, students differentiate grade gains made from increased learning from grade gains obtained through increased opportunities to earn additional points on assessed work.

Pell-eligible responding students found homework practice and the ability to take quizzes more than once to have been useful features of courseware. However, they also found the progress bar and solution sets useful features. As with the other groups, Pell-eligible respondents found the flexibility of submission dates and multi-modal ways to learn content changed the way they learned. They also identified revising lessons for a higher grade and accessing alternate learning materials as important to their learning.

Pell-eligible students reported a steady increase in the positive effects of the courseware on their grades. After a spike of 16.67% reporting in spring 2018 that courseware negatively affected their grades, that percentage dropped to 12.29% in fall 2018 and to 10.87%in spring 2019.

During each of the four semesters of the study, we conducted four student focus groups, with each group focused on a particular course. (See Appendix B). Conducting student focus groups allowed us to drill down into the data provided in the end-of-semester surveys, while also allowing us to identify student concerns specific to particular courses and courseware. Each focus group was audio recorded, and the audio files transcribed. Individually, and then collectively, members of the research team determined major themes in student feedback based on the number of times students spoke about an issue and the intensity with which they made such utterances.

Table 8

Top concerns of the student focus groups by semester

Semester	Courses	Top Concerns Ranked
Fall 2017	Trigonometry General Biology I General Chemistry Anatomy & Physiology	1. Cost and value of the courseware 2. User experience 3. Alignment of courseware with course content 4. Instructor use of courseware
Spring 2018	College Algebra Intermediate Spanish Intro to Chemistry Business Statistics	1. Cost and value of the courseware 2. User experience 3. Alignment of courseware and course content
Fall 2018	Intro to Statistics Microeconomics Organic Chemistry First Year Writing	1. Cost and value of the courseware 2. User experience **3.** Alignment of courseware with course content
Spring 2019	Accounting II Biological Sciences II Intro to Sociology Fluid mechanics	1. Alignment of courseware with course content 2. Cost and value of the courseware 3. Instructor use of courseware 4. User experience

Cost and value of the courseware

Because digital learning platforms are classified at UM as course materials, the decision to adopt a particular product is made primarily by course instructors and course directors. As a consequence, negotiations with vendors regarding cost and point-of-sale tend not to be made at the institutional or department level. Courseware costs can vary considerably based on where a student purchases the courseware and how course materials are bundled.

Students who purchase courseware access either directly through the vendor or from a third-party online retailer tend to get the best price and the most flexibility for access codes. In large part, this is due to two factors: courseware being sold separately from a print textbook and the variety of choices students have to purchase variable durations of access to a resource: Durations of access to courseware tend to vary between 6 months and 24 months.

Some departments have instituted a course fee to cover the cost of digital learning platforms, thus allowing students to pay for course fees as a component of tuition rather than as an out-of-pocket expense. The course fee model does not allow students choice in terms of which course materials they prefer (digital or print) or allow students to choose length of access to the courseware, but the course fee model often saves students money since departments negotiate course fees with vendors.

Students who purchase courseware access through the University bookstore often pay the most because course materials packages are often bundled to include a physical textbook with the courseware access code. In addition, the University bookstore markup on course materials tends to result in higher costs than course materials purchased online or at local, competing bookstores.

Every focus group mentioned the high cost of courseware access codes; for members of 14 of the 16 focus groups, cost and value was participants' top concern regarding adaptive courseware. Over the two-year period of our study, access codes sold through the university bookstore averaged $151.00 for each code. This price average did not account for codes granting access to courseware across semesters. Students informed us that two-semester access did not benefit them when they were unable to register for part II of a year-long course due to scheduling conflicts, or due to not having earned a high enough grade in part I of the course to be allowed to register for part II. For these reasons, multi-semester pricing deals do not necessarily mitigate students' overall cost of courseware access.

Another cost issue is bundled course materials. While some bookstores market first day course materials packages to students as a convenience, students noted how these bundled packages included physical textbooks they did not want but had to purchase because it was the only way to obtain the access code for required courseware.

A related theme of frustration students expressed during the focus groups involved a perceived lack of guidance from advisors, faculty, and bookstore staff regarding which course materials significantly contributed to course success and which did not. Like any savvy consumers, students do not want to purchase items they do not perceive as adding value to their endeavors. First year students, transfer students, and first-generation students are particularly vulnerable to over-purchasing and overpaying for course materials because they do not yet have the university connections to guide them in bypassing bookstore bundles for more economically practical purchasing options.

Across focus groups, students made economic calculations based on the price of courseware and the value of courseware in determining their final grade. In particular, students were frustrated by high-cost access codes for courseware that did not significantly contribute to their final grade in a course. For example, members of one biology focus group expressed their frustration at having paid $200.00 for courseware that only accounted for 10% of their final grade. However, students in College Algebra characterized the courseware as adding value to their learning. Although they mentioned that the courseware was still expensive at $92.85, they thought the value the courseware brought to their learning experience was significant. For these algebra students, support tools included in the courseware (diagnostic tests, identifying content with which students struggled, and practice exercises) and the courseware's alignment with high stakes exams in the course increased the courseware's value and justified the high price.

Similar to members of the college algebra focus group, members of both the engineering focus group and the accounting focus group thought the price of their courseware was reasonable. Engineering focus group members did not pay anything for their courseware, whereas members of the accounting focus group had paid over $100 for 12 months of access to the courseware. Overall, students in professional programs expressed less frustration with the cost of access codes than students taking general education or elective classes. For example, students in Biology I, which is a class for non-STEM majors, felt that paying over $100.00 for the courseware access code was excessive.

Most focus group participants agreed that $100.00 is a fair price for access codes for ebooks and courseware in STEM classes, but also stated they wished faculty would try harder to find less expensive course materials. When pressed for a fair price point for non-STEM courseware, students agreed $50.00 is the high end of what a single text or homework platform should cost.

Some students believed cost of courseware was too high because they believed use of the courseware had not been integrated well into primary course content, and/or felt that faculty members had not utilizing courseware features beyond the rudimentary capability to grade assessments automatically. Students felt

it was wrong to be asked to pay for courseware that was only utilized as a homework platform. For other students, the problem of integration lay with the courseware's misalignment with the content assessed on high-stakes exams. We will expand more on this topic below. A third source of economic frustration identified by focus group participants had to do with faculty members who required the purchase of courseware systems that were not used consistently in a course, or who did not include the evaluation of student work performed within the courseware system in the calculation of the students' final grades. Additionally, students did not find the price of courseware corresponded with its value or effectiveness. Specifically, higher pricing did not mean the courseware was more beneficial in learning or course success. In fact, students in the engineering focus group who paid nothing for the courseware they used seemed to have the most positive experience with the use of courseware.

User Experience

Students in most focus groups found courseware easy to navigate and noted they did not need to view tutorials before using it. The focus of discussion for user experience tended to fall into three categories: grading, personalization, and workload.

In both the student surveys and focus groups, students overwhelmingly expressed not knowing how much their performance in adaptive courseware counted toward their final grade. While this lack of knowledge could be a matter of students not reading what is clearly stated in the course syllabus, we also heard from students in focus groups that instructors sometimes added or eliminated courseware assignments during the semester, making it difficult for them to assess the value that would be assigned to courseware use in the calculation of their final grade.

When we reported this student confusion to faculty members, they lamented how students only seemed to want to perform schoolwork with a grade attached to it. However, when we shared that faculty sentiment back to students, they replied that they have to make careful choices about how to spend their time. In particular, students who work, who have family responsibilities, or who are heavily involved in school organizations must make careful choices regarding the activities they invest time to accomplish. If there is little or no direct value tied to time spent on a learning task, or if the value is unclear, students will choose not to spend their time on that task.

While it was hard for students to assess accurately the impact of the courseware on their final grades, they expressed concerns regarding the impact of performance in the courseware on their overall grade. Some students completed the homework in the courseware to ensure that their work would raise their grade,

but did not view courseware as a study tool or a means to improve learning; they commented that the courseware "functioned more as a grade booster than a learning system." However, other students commended the courseware's quick grading turnaround.

Generally speaking, students had a positive reaction to the adaptive features of courseware if those features were present and conspicuous. Participant of the college algebra focus group reported finding the adaptive resources in ALEKS to be mostly helpful. Students liked the way the system focused on the content with which they struggled and they liked being able to prove mastery and skip over content they already knew. Students also liked being able to practice similar examples of difficult content and being able to choose a less difficult level of problem when the current one was too complex. Students using ALEKS liked the agency the system provided. They were able to choose where to go next versus being forced to follow a particular, system-generated pathway. Students liked the step-by-step instructions for solving problems. On the other hand, students reported feeling frustrated if a courseware system did not seem to provide guidance when they were stuck. Students also lamented courseware systems that require very specific answers (for example, to a decimal place) and systems that are not "smart" in terms of misspellings or other minor errors. Some students who did not like the user experience of the courseware reported using outside aids such as Khan Academy to learn confusing concepts.

Other focus groups perceived the personalized aspect of the courseware as limited. For example, the Intro to Chemistry focus group members reported little variety in the questions the courseware posed. Members of other focus groups also reported frustration when the system did not provide useful feedback for understanding how to model a problem or did not demonstrate how to solve a problem with which they were struggling. Students expressed a desire for a step-by-step demonstration of how to solve a problem they repeatedly got wrong. Other focus groups also expressed a desire for additional, non-adaptive features in the courseware such as video tutorials and low-stakes practice for high-stakes exams.

Some students reported feeling overwhelmed by the number of courseware assignments. They noted that even though they tried to maintain focus on the assignments, as one student put it, the number of assignments caused them to "feel burned out." Some students proposed that having fewer assignments due each night would allow them to work through the assignments more deeply and methodically. It should be noted that some of these comments came from a six credit-hour class in which students may have been struggling with the workload regardless of the courseware.

Conversely, students did not feel burdened by the workload if they perceived the direct benefit of the courseware to their understanding of course concepts and their performance on assessments. For example, the College Algebra focus group did not feel the amount of time spent in their courseware, ALEKS, was excessive and mentioned the usefulness of the courseware in preparing them for high-stakes exams.

Several focus group participants mentioned how they were required to use multiple platforms each semester, and how switching between systems and remembering all of the passwords created an additional intellectual burden. A few students expressed frustration with online course materials, saying they preferred physical textbooks to online systems because there are too many distractions working online. These students also mentioned screen fatigue, unreliable WiFi in their off-campus accommodations, and computers freezing in the campus testing lab, causing them to lose time during a quiz or to forfeit a quiz attempt.

Some students from the Economics focus group said the courseware was too easy, and that they were able to get high scores without experiencing deep learning. One student from that focus group said she learned more effectively when she wrote her responses on paper versus typing them into a computer. Several students reported frustration that instructors assume that their students are far more tech savvy than those students actually are. The fact that students are comfortable with entertainment and social media technology does not necessarily mean those students are comfortable with educational technology. In fact, the high stakes use of educational technology is stressful for students, especially early in a semester when students lack familiarity with a system at time when they are submitting weighty assessments.

However, some students had a more positive view of the courseware, stating that it was good for accountability in that it forced them to space out learning and prevented them from procrastinating. Students in the First Year Writing focus group spoke positively about the usefulness of the courseware, and reported using adaptive modules for homework and for grammar checks for their writing assignments.

Personalization of the courseware and adaptivity were also frequently mentioned by students in the focus groups. In the Statistics focus group, students had the impression that the instructors checked their progress in the courseware only infrequently because grades were infrequently transferred to the LMS, because instructors did not mention how much time students were spending on the platform, and because instructors infrequently mentioned student performance in the courseware. In several of the focus groups, members did not feel their courseware was truly adaptive because they were fed the same practice questions despite mastering them in previous attempts. Students reported that exam questions were

often exactly the same as those on the practice test, that there were no just-in-time resources to help them learn from incorrect responses, and that there was no summary of the learning objectives that they had mastered and that they had not mastered. Additionally, students stated they wished instructors would check the platform in student mode before students used it. Specifically, they wanted faculty members to be alert for system glitches, errors, and limitations.

Interestingly, students did not value adaptivity as much as features that allowed for learner autonomy. Participants in the Biology I focus group and the Accounting focus group both explicitly stated their courseware systems were not adaptive. Biology I students explained that the homework tool randomly assigned each student five questions from each lesson to complete, providing, as one student put it, "a randomized learning experience" instead of a personalized learning experience. On the other hand, some students reported finding adaptive features in their courseware. For the Engineering students, the system provided corrective and helpful feedback when they made an error. The Sociology focus group did not like how the courseware asked before each practice question how sure they were of the answer, relating that they simply clicked through those types of questions without giving them too much thought. In contrast to members of the College Algebra focus group, students in some humanities classes disliked the adaptive feature that let them skip material when they demonstrated mastery on a pre-quiz. These students told us they would prefer not to skip content, and thought that one quiz was not a good measure of what they did and did not know, particularly because often they guessed the correct response.

Overall, students found the learner autonomy features of the courseware more beneficial than the adaptive features. These include the ability to retake quizzes, opportunities to practice and self-remediate, search engines within the textbook, the ability to check why answers are incorrect, and progress measures. For example, one student appreciated a report in the Accounting courseware on how average time spent in the system correlated with students' grades. This report inspired the student to spend more time in the system to improve his grade. Another student in the Engineering focus group explained that the corrective feedback in the courseware – specifically pop-up messages invoked when a user makes a mistake-- was very helpful. The student attributed this helpfulness to the fact that the instructor had written the messages. Since this instructor knew common mistakes students would likely make, these messages were thoughtfully generated, well-integrated, and useful.

Alignment of Courseware with Course Content

Misalignment of courseware content with other course content was a key concern of students in all of the focus groups. Misalignment seems to fall in one of two categories that are not mutually exclusive: generic courseware and instructor-specific lecture notes.

Some misalignment arises from the use of generic courseware. Although many instructors and course directors choose courseware tied to a particular textbook title, oftentimes the courseware content itself is designed to work with a variety of titles in a particular discipline. One student in the General Chemistry focus group noted how she had used the same courseware three years consecutively because it was part of her high school curriculum, and at the university, in a first-year Introduction to Chemistry course and then again in the General Chemistry sequence. According to this student, there had been no significant changes in the courseware system's content, practice examples, or mastery questions from the first time she used it to the third time. This student wondered why a mass-produced product being used so widely was still so expensive. In addition, because the product is used so widely and does not seem to be updated every year, students in focus groups explained how they were able to easily find answers to mastery questions with a simple Internet browser search.

A second category of misalignment concerns instructor-specific lecture notes. Students in our focus groups noted a disconnect between the content delivered through courseware and the content presented in class by their instructors. One student commented that she felt as if she were taking two separate classes on the same topic: one in person and one online. Other students lamented how time spent practicing in the courseware did not prepare them for instructor-written high stakes exams. They gave three reasons for this lack of preparation: the content was not aligned, the problem sets were formatted differently, and the mastery levels assessed in the courseware were much lower than those assessed on in-class exams.

In sum, students expressed frustration that courseware is not customized to a departmental or course curriculum despite the high price tag, and that their work in the courseware is not preparing them for instructor-developed high-stakes exams.

Focus group participants who had recently graduated from high school expressed concern about a shift to learning through the courseware rather than learning in-class. They commented that they perceived a trend toward learning online rather than learning in the classroom and expressed unease over that trend, calling it 'self-teaching.' Students with more years of university, and particularly those in professional and STEM programs, did not share the concern over self-teaching.

In several focus groups, students disliked how the instructor did not review or discuss in class the homework they did in the courseware system, leading them to feel they were completing the courseware quizzes just for the sake of homework points instead of as a tool for understanding. On the other hand, the Engineering focus group members reported the most alignment between the courseware and the class content. Students in that focus group believed this successful alignment was due to the instructor himself having created the content on the courseware platform. Students reported that the instructor could answer adequately all of their questions on material from the courseware and that the courseware quizzes prepared them for the lectures that were given in class. Students in this focus group appreciated the alignment and noted the instructor's investment in the effectiveness of the software.

Instructor use of courseware

A final concern expressed by focus group participants was how instructors were utilizing courseware, namely their underutilization of courseware analytics. When we asked students if they had received individual messages from instructors based on their performance in the courseware, the majority of them said they had not. What we were looking for in this prompt was whether or not faculty are using the learning analytics provided on the instructor dashboard to identify struggling students and to reach out to those students to offer help, suggest tutoring, or simply even to warn students they are in danger of failing the class. Student responses to this question indicated that faculty were not using learning analytics in this manner. However, it is possible that none of the focus group students performed on the courseware in such a way as to prompt a faculty intervention, that faculty interventions were conducted more informally during class time, or that students in need of assistance initiated a help session by attending faculty office hours, thus precluding the need for a faculty-initiated intervention.

In addition to the question about personal messages from instructors, we asked focus group students if faculty members had ever mentioned in class or in a class-wide announcement that they were adjusting a lecture, activity, or assessment based the class's performance reported in courseware learning analytics. None of the students reported having heard faculty say they were adjusting the course based on learning analytics, but again, it could be that these students were taking courses in which adapting a teaching method or assessment was unnecessary, or that the instructor did not explicitly tell students about a change made to course design based on learning analytics.

While it is unclear from the focus group sessions why students were not receiving personalized messages from faculty and why students did not perceive faculty to be tailoring instruction in the class based on learning analytics, we have included this student concern in our report as a means of raising awareness of a

possible issue with faculty underutilization of learning analytics tools. While students understand the difficulties for faculty teaching high-enrollment classes to track individual student progress and conduct personalized interventions, they stated they would welcome personalized messages from faculty. Students in the focus groups expressed a clear desire to form relationships with faculty members, and stated they preferred learning directly from a faculty member to learning from a courseware system.

Students told us they value the effectiveness of an organized, knowledgeable, and available instructor over a good courseware system. Students also appreciated opportunities to talk with instructors about questions they had regarding the course and the courseware. Many students mentioned that a lesson delivered on courseware should not be a replacement for a well-organized lecture or class activity. However, some students mentioned that if they found themselves with an instructor who was ineffective, the courseware became "a back-up teacher". Students talked about prior experiences with instructors in which they used the courseware as a "lifeline" to supplement their lack of learning in the classroom. However, this seemed to be a last resort, and while some students wavered on the effectiveness of adaptive courseware systems, all the focus group students recognized the importance of effective instructors.

CONCLUSIONS

In both the focus groups and the surveys, more students had positive views than had negative views of digital learning platforms. The courseware features students found helpful were generally those that supported learner autonomy, which they valued more than algorithmic adaptability. Specific examples of these features included 'due by' dates rather than one specific due date, multiple attempts for practice and low-stakes assessments, instant feedback on how to solve problem sets, as well as feedback that identified students' knowledge gaps. The surprising take-away from student responses is that students did not find most courseware systems adaptable. However, while the machines are not adapting to student inputs to provide personalized learning experiences, students are adapting their learning behaviors to both maximize and streamline their learning.

Despite students' overall positive view of digital learning platforms, they weighed the value of them against two key factors: how well they were integrated into their courses, and how much they cost. When courseware is implemented into a course solely as an add-on for homework practice and quizzing, the content in the system is often misaligned with lecture content, and the systems do not prepare students for high-stakes exams. An equally important consideration for students determining the value of courseware was the cost of access. Students do not wish to purchase products at any price point if those products do not significantly add

value to the learning experience, as for example, when the work students perform in the courseware counts little toward their final grade or does not prepare them for high-stakes exams.

One of the original promises of adaptive courseware is that it will disproportionately benefit underserved students. While our study does not include quantitative data on achievement outcomes, student survey respondents who self-identify as racially minoritized, Pell-eligible, and first-generation reported increasing levels of benefit to their final grade from Fall 2017 to Spring 2019. However, within that time period, there was fluctuation in the percentage of minoritized and first-generation students who believed their final grade was higher due to the courseware. In the Fall 2017 and Spring 2019 surveys, students who were not underserved reported a lower benefit to their final grade than underserved students. In the Spring 2018 survey, it was first-generation students who reported the courseware positively affected their final grade, and in Fall 2018 survey, students who were not underserved reported the greatest benefit to their final grade.

While some of these data are encouraging, they cannot be considered conclusive for three reasons: the data were collected over only four semesters, the numbers fluctuated from semester to semester, and the increasing adoptions of adaptive courseware may have influenced the response rates for any particular survey or focus group question.

Students see value in adaptive learning courseware systems when they are reasonably priced, well-aligned with other course content, and utilized by faculty to respond to student needs. However, students do not view courseware as a substitute for what they value more in their learning: authentic relationships with skilled and caring instructors.

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APPENDIX A: END-OF-SEMESTER SURVEY

Start of Block: Student Demographics

Q1 What is your academic status?
- ❏ First year undergraduate
- ❏ Sophomore
- ❏ Junior
- ❏ Senior
- ❏ Other

Q2 What is your gender?

- ❏ Male
- ❏ Female
- ❏ Non binary
- ❏ Prefer not to respond

Q3 Which ethnic or racial category best describes you?

- ❏ African American or Black
- ❏ African
- ❏ Asian
- ❏ Hispanic or Latino
- ❏ Native American or Alaskan Native
- ❏ Native Hawaiian or other Pacific Islander
- ❏ Two or more ethnic/racial categories
- ❏ White
- ❏ Other

Q4 Are you the first in your immediate family to be on track to complete a 4-year university degree?
- ❏ Yes
- ❏ No
- ❏ Not sure

Q5 Do you qualify for Federal tuition grants or loans such as the Pell Grant? (you don't have to have accepted the grants or loans to answer yes)

- ❏ Yes
- ❏ No
- ❏ Not sure

Q6 Which courseware did you use this semester?

- ❏ Pearson MyStatsLab (Math 115)
- ❏ McGraw Hill ALEKS (Math 121)
- ❏ Pearson MyMathLab (Math 123)
- ❏ McGraw Hill Connect (MIS 309)
- ❏ Pearson Mastering (Chem 101)
- ❏ MyChemLab (Chem 105/106)
- ❏ WileyPlus (Chem 221/222)
- ❏ Lumen Waymaker (Writ 100/101)
- ❏ Lumen Waymaker (EDHE 101)
- ❏ MindTap (Econ 202)
- ❏ MyEconLab (Econ 202)
- ❏ MyStatsLab (Econ 302)
- ❏ McGraw Hill Learn Smart with Connect (Bisc 102/104)
- ❏ Macmillan LaunchPad (Bisc 160/162)
- ❏ Pearson's Mastering A&P (Bisc 206/207)
- ❏ MindTap Physiology (Bisc 330)
- ❏ MySpanishLab (Span 111/211)
- ❏ Cengage Open Now (Soc 101)
- ❏ Realizeit Learning (Phad 395)
- ❏ Pearson Mastering Physics (Phys 213/214)
- ❏ Smart Sparrow (ENGR 323)

Q7 Which functions of the courseware did you find MOST USEFUL in helping you to learn? Check all that apply.

- ❏ The progress tool that told me how much of the lesson I'd completed
- ❏ The learning path or map which showed me what content and activities were in each lesson
- ❏ The multiple ways to learn including video, reading, and interactive tools
- ❏ The way the lessons were broken into small chunks rather than all in one big chapter
- ❏ When the system asked me how well I knew something or how sure I was about an answer
- ❏ Being able to take quizzes more than once
- ❏ Being able to view solutions to problem sets after submitting answers
- ❏ The messages I got from the system telling me "Well done" or "Try again"
- ❏ The ability to choose what I would work on next rather than being forced into a particular learning path
- ❏ The tutorials that broke down concepts step by step
- ❏ The review quizzes
- ❏ The homework practice
- ❏ The instant feedback I got that helped me see what I got right and what I needed to work on
- ❏ The reminders about upcoming homework or quizzes
- ❏ Links to learn more about a topic

Q8 Which functions of the courseware did you find LEAST USEFUL in helping you to learn? Check all that apply.

- ❏ The progress tool that told me how much of the lesson I'd completed
- ❏ The learning path or map which showed me what content and activities were in each lesson
- ❏ The multiple ways to learn including video, reading, and interactive tools
- ❏ The way the lessons were broken into small chunks rather than all in one big chapter
- ❏ When the system asked me how well I knew something or how sure I was about an answer
- ❏ Being able to take quizzes more than once
- ❏ Being able to view solutions to problem sets after submitting answers
- ❏ The messages I got from the system telling me "Well done" or "Try again"

- ❏ The ability to choose what I would work on next rather than being forced into a particular learning path
- ❏ The tutorials that broke down concepts step by step
- ❏ The review quizzes
- ❏ The homework practice
- ❏ The instant feedback I got that helped me see what I got right and what I needed to work on
- ❏ The reminders about upcoming homework or quizzes
- ❏ Links to learn more about a topic

Q9 How would you rate the courseware's effect on your final grade in this class?

- ❏ My grade is lower than it would have been without using adaptive courseware.
- ❏ My grade is about the same as it would have been without using adaptive courseware.
- ❏ My grade is better than it would have been without using adaptive courseware.

Q10 How much does your performance in the courseware count toward your final grade?

- ❏ I am not sure
- ❏ It does not count toward our final grade in the class.
- ❏ It counts less than 10%
- ❏ It counts between 10% and 15%
- ❏ It counts between 15% and 20%
- ❏ It counts between 20% and 25%
- ❏ It counts more than 25%

Q11 Did the courseware change how you learned the material? Check all that apply.
- ❏ I was able to do classwork using a mobile device.
- ❏ I had more flexibility for when I submitted homework and quizzes.
- ❏ I had more flexibility for how I learned and practiced course concepts.
- ❏ I was able to revise lessons for a higher grade.
- ❏ I was able to access alternate materials that helped me understand course concepts.
- ❏ I spent more time practicing course concepts the courseware showed me I was weak in.
- ❏ I was able to skip content I already knew.

Q12 How did your instructor integrate the courseware into your course? Check all that apply.

- ❏ We used the courseware during class time to practice new concepts.
- ❏ We used the courseware during class time to collaborate on projects.
- ❏ We used the courseware during class time to take quizzes.
- ❏ The courseware replaced the textbook.
- ❏ Using the courseware was optional for students who wanted or needed extra help.
- ❏ We used the courseware outside of class to complete assignments.
- ❏ We used the courseware outside of class to collaborate on projects.
- ❏ We used the courseware outside of class to take quizzes.

Q13 Does your instructor discuss your progress or the class's progress in the courseware during class or in an email?

- ❏ Yes
- ❏ No
- ❏ Not sure

Q14 On which device did you most often use the courseware?

- ❏ In a lab, using a university-owned computer
- ❏ On a tablet such as an iPad
- ❏ On my laptop
- ❏ On my desktop
- ❏ On my smartphone such as an iPhone or Android

Q15 How much did your access code cost?

- ❏ More than $150.00
- ❏ Between $100.00 - $150.00
- ❏ Between $75.00 - $100.00
- ❏ Between $50.00 - $75.00
- ❏ Under $50.00
- ❏ It was free
- ❏ I do not know

Q16 How do you feel about the cost of the access code?

- ❏ It was overpriced.
- ❏ It was priced about right.
- ❏ It was underpriced.

Q17 Where did you buy your access code?

- ❏ At the official Ole Miss Bookstore (Barnes & Noble)
- ❏ A bookstore other than the official Ole Miss Bookstore such as Rebel Bookstore or Campus Book Mart
- ❏ Online and directly from the publisher
- ❏ Online from a third party such as Amazon, Chegg Books, or another online store.

Q18 Did you purchase a physical book along with the access code?

- ❏ Yes
- ❏ No

Q19 If you bought a physical book, why did you do so?

- ❏ It was a required purchase.
- ❏ It came with the access code.
- ❏ I wanted the physical book.
- ❏ I did not purchase a physical textbook.

Q20 If you purchased a physical textbook, how often have you used it for class?

- ❏ I use it at least once weekly.
- ❏ I use it less than once weekly.
- ❏ I never use the physical textbook.
- ❏ I did not purchase a physical textbook.

APPENDIX B: FOCUS GROUP QUESTIONS

- How has your instructor instructed you to use the courseware? For example, do you only use it to prepare for exams, or use it for homework completion, or is the courseware a replacement for your textbook?
- When you use the courseware, how long does it take you to complete the required lessons?
- Do you feel you spend more time or less on studying/homework/lessons than in classes in which you don't use adaptive courseware?
- Are you more likely to do readings, quizzes, and practice modules when you know a computer system is recording your use?
- Has your instructor ever sent you an email, text, or verbal communication regarding your use of the courseware?
- Do you feel the adaptive features of the courseware are helping you learn the course content? If yes, why do you think that is? If no, how do you prefer to learn course content?
- Have you noticed any difference in your grades in classes in which you use adaptive courseware versus classes in which you don't use adaptive courseware?
- What would you want your instructors to know about the courseware that you feel they don't already know?
- What would you want the university administration to know about adaptive courseware?
- If you had the choice to take a class next semester with or without adaptive courseware, which would you choose? Why would you make that choice?

Three-way overlap of Minoritized, Pell-eligible, and First-generation college students

Fall 2017 survey: 7%
Spring 2018 survey: 8%
Fall 2018 survey: 8%
Spring 2019 survey: 7%

Two-way overlaps among pairings of Minoritized, Pell-eligible, and First-generation college students

Fall 2017 survey
First gen and minority   9%
First gen and Pell =   15%
Minority and Pell =   17%

Spring 2018 survey
First gen and minority   9%
First gen and Pell   18%
Minority and Pell   17%

Fall 2018 survey
First gen and minority   10%
First gen and Pell   15%
Minority and Pell   16%

Spring 2019 survey
First gen and minority   8%
First gen and Pell   15%
Minority and Pell   13%