Journal of the Scholarship of Teaching and Learning, Vol. 24, No. 4, December 2024, pp..174-193
doi: 10.14434/josotl.v24i4.35566

Resilience, Confidence-Building, and Performance: What a Case Study of Adaptive Digital Learning Can Tell Us

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Abstract: Adaptive digital learning courseware is becoming part of the instructor tool kit to support student performance and ultimately reduce DFWI rates. However, past studies of the effectiveness of adaptive digital learning platforms in elevating student performance on summative assessment have shown promising yet at times mixed reviews (e.g. Yarnall et al., 2016). This case study integrates adaptive digital learning to address the challenge of promoting reading and concept application outside of class and analyzes its impacts on students' engagement in class, perceived learning, and performance on summative assessment. Such an analysis, which considers mediating factors not previously analyzed together in adaptive digital learning studies, such as individual rather than aggregate performance, digital learning platform design differences, resiliency factors, and in-class activities, is an important step in clarifying some of the previously mixed results. Drawing on data collected in two sections of the same general education social science course taught by the same instructor in the same semester, this study illustrates the varying potential of adaptive digital learning to increase student confidence in the material and how it can translate into increased student performance if aligned and coupled in certain ways with in-class active learning. This study also provides evidence that illustrates how digital learning that is designed for greater degrees of editability by faculty can maximize learning benefits for students. (220 words)

Keywords: adaptive digital learning, digital learning, online learning, courseware design, stereotype threat, resilience, Scale of Protective Factors, confidence, GRIT, scaffolding, undergraduate, general education, flipped classroom, student engagement, reading comprehension, application, Bloom's taxonomy

General education courses are an important component of an undergraduate student's education and often play a key initial role in supporting undergraduate students in obtaining their college goals. Reaching these goals involves, in part, nurturing out-of-class engagement in the course material that will hopefully lead to engagement in class activities and lectures and translate into obtaining learning objectives and ultimately graduating. Yet, for a variety of reasons, students may not always complete assigned textbook readings or practice concepts on their own prior to class, which in turn can impact their engagement in other class exercises, their academic performance, their ability to graduate as projected and ultimately DFWI rates.

Digital learning courseware, and adaptive digital learning courseware in particular, are increasingly being offered as one means to address the challenge of supporting student engagement outside of class, such as completing textbook readings and practicing the course material. Digital learning courseware is typically defined as an education-focused electronic platform that structures engagement in the course material through practice activities and accompanying assessment or feedback, which is often given in real-time, to foster learning (O'Sullivan, 2020b). One type of digital learning is adaptive digital learning. What distinguishes adaptive digital learning from other types of digital learning is that adaptive digital learning presents each student with questions and/or feedback that is based on that student's previous performance within the platform (Dziuban et al., 2016). This

is in contrast to other types of digital learning that utilize the same questions for every student or randomly draw on a set of questions from a question bank each time a user engages with it.

This case study used both adaptive and non-adaptive digital learning courseware to address the challenge of promoting reading and practicing the application of concepts outside of class. Based on past scholarship (e.g. Yarnall et al., 2016) that shows mixed yet promising results of adaptive digital learning courseware for supporting student success and retention, this case study investigates the degree to which the use of adaptive digital learning influences student engagement with in-class activities, their understanding of lecture, their completion of course readings, and students' performance on specific exam questions. Unlike past studies, it compares how engagement with adaptive and non-adaptive digital learning affected students' perceived confidence in the material and learning and investigates the mediating role that in-class activities can play on adaptive digital learning's effectiveness. This case study also expands the demographic and contextual focus of past studies of adaptive digital learning to begin to address how certain factors linked to resilience, such as students' social support as well as planning, social, and cognitive skills, are associated with student preferences and performances using adaptive digital learning.

This case study, which includes various impacting factors on student performance that have not previously been considered together, can help instructors better understand the mixed results of past adaptive digital learning studies and ultimately how to approach selecting and/or combining different types of digital learning platforms with their existing pedagogical approaches. It can also assist software developers in designing digital learning platforms. Results of this study illustrate the potential of adaptive and digital learning courseware to increase student confidence in the material and positively influence student performance if aligned and coupled with in-class active learning in certain ways. The results also suggest that digital learning courseware design that give instructors flexibility in content creation can potentially result in a higher impact across a broader range of students than adaptive digital learning with more restricted content customization.

Literature Review: Adaptive Digital Learning Courseware

Recent studies of the effectiveness of adaptive digital learning courseware in elevating student performance on summative assessments have shown promising yet at times mixed results (e.g., Griff & Matter, 2013, Hagerty & Smith, 2005, Murray & Pérez, 2015, Yarnall et al., 2016).

Part of the complicating factor is that some of the past studies tended to be meta-analyses that encompassed different disciplines, courses, and adaptive digital learning platforms that used their own algorithms. For example, nine different adaptive digital learning courseware were part of the Adaptive Learning Market Acceleration Program (ALMAP), which involved 14 different higher education institutions from summer 2013 through winter 2015 (Yarnall et al., 2016). The subsequent meta-analysis revealed a statistically significant difference in course grades for 5 out of 15 courses, with 4 showing positive impacts, 1 showing negative, and the remaining 10 being neutral (Yarnall et al., 2016).

Subsequent studies of adaptive digital learning, such as Dziuban et al.'s (2016) study of an online psychological course and Gebhardt's (2018) study of an undergraduate economics course, demonstrate the potential that a focus on a single course and adaptive digital learning courseware can have on understanding more specific yet still generalizable impacts on learning. However, these studies do not drill down to whether completing a particular adaptive digital learning exercise translated into getting correct the exam questions with the targeted concepts/skills. For example, Dziuban et al. (2016) provided important insights into how students who were successful vs. unsuccessful in the course had differing engagement patterns with the adaptive digital learning courseware. In addition, Gebhardt (2018) used the mean scores on exams for the groups that completed vs. not completed the adaptive digital learning exercises and found that completion of all or part of the adaptive digital

learning corresponded with increased performance on exam questions that targeted skills lower on Bloom's taxonomy, but called for more research that investigates the association at the individual level. Other studies have focused more on student perceptions of the adaptive digital learning platform, such as Buchan et al. (2020), Clark et al. (2018), Liu et al. (2017), O'Sullivan et al. (2020a), and Sun et al. (2017). For example, Sun et al. (2017) found that adaptive digital learning courseware increased students' perceived competence or command of the material in undergraduate marketing and management courses but did not evaluate how that translated into individual course grade/exam performance.

This case study builds on these past studies by investigating if and how the use of adaptive digital learning outside of class corresponds with an increase in individual engagement, such as the completion of reading materials and participation in in-class activities, perceived confidence in the material, and ultimately individual performance on specific exam questions. To encourage reading completion and preparation for in-class lectures, activities, and exams, the course used an adaptive digital learning game, which came with the textbook and included more recall and understanding-focused questions but uses past responses to generate proximate questions, and a digital learning practice quiz, which used instructor-created real-life scenarios that involved application-focused questions. The results are compared with a separate section of the course that was taught by the same instructor in the same semester but did not use the adaptive digital learning game and included the digital learning practice quiz as an option. By analyzing the use of adaptive and non-adaptive digital learning and drilling down to its impacts on individual student performance and engagement, this study can help unpack some of the mixed results of past studies of adaptive digital learning and provide insight into the impacts of digital learning platform designs on student learning.

The two selected digital learning platforms in this study share certain design features, such as allowing multiple attempts, that in past studies students reported as helpful (O'Sullivan et al., 2020a, 2020b). Yet, they also differ in other design features that students in past studies rated as beneficial. For example, the digital learning practice quiz allows the most flexibility for instructor alterations as the questions and responses are created by the instructor whereas the adaptive digital learning game associated with the textbook allows the instructor to select what chapter sections of pre-created questions to include but does not allow the instructor to alter the questions or exclude certain questions in a particular section. Past studies have shown that students perceive questions and the accompanying feedback that are written by their instructors as more beneficial than pre-packaged digital learning, with minimum or no options for instructor customization and creation of practice exercises (O'Sullivan et al., 2020a). Similarly, some faculty also favored more design editability because they can adapt the content and targeted skills to better fit their learning objectives (Buchan et al., 2020, 32). Perceived lack of "fit" was one reason why some students in previous studies had a less than positive perception of adaptive digital learning platforms (i.e. O'Sullivan et al., 2020a). This case study takes these previous studies further through evaluating the impacts on student performance for two digital learning courseware with differing degrees of flexibility in customization.

The influence of design on student engagement and performance is not limited to the courseware interface itself but also involves the instructional design context that the digital learning is integrated into. For example, Van Leusen et al. (2020) argues that adaptive digital learning needs to be combined with active learning; pointing out how adaptive digital learning that targets more entry-level elements of Bloom's taxonomy can serve as a basis to build on by using active learning activities that target more challenging elements of Bloom's taxonomy. Similarly, Gebhardt (2018) and O'Sullivan et al. (2020b) point out that adaptive digital learning should be conceptualized as one piece of the larger puzzle that targets specific skills and content best suited for a given adaptive digital learning platform. Although these and other studies, such as Liu et al. (2017) and Buchan et al. (2020), discuss instructional design and scaffolding, they do not focus on investigating how students' engagement

with the adaptive digital learning courseware affected their perceived engagement in in-class activities, which is particularly important for active learning and more discussion-based courses. Dziuban et al.'s (2016) study revealed that students reported a perceived decrease in engagement with their peers after the integration of adaptive digital learning into an online introductory psychological course. This case study expands these past studies by investigating adaptive digital learning's impact on students' perceived engagement in in-person class discussions and understanding of lecture as well as the mediating impact that in-class activities can have on the efficacy of adaptive digital learning.

The case study's focus on a general education introductory cultural anthropology course also helps expand in various ways the very limited scholarship on the role of adaptive digital learning in social science and humanities courses, which are commonly discussion-based. Many studies of adaptive digital learning are STEM focused, and psychology, economics, history, and English more commonly represent the social sciences and humanities although in lower proportions than STEM.

Resilience

As the authors of the ALMAP study and subsequent studies have pointed out, there are various factors besides design that can influence student engagement and performance in a course (Yarnall et al., 2016). Although previous studies have looked at GPA, Pell-Grant status, race and ethnicity, gender, and first-generation college student status among other demographics like major and year in school, this study expands the focus to other dimensions of a student's life. Individuals can encounter a variety of daily and unexpected challenges outside of the curriculum design that can impede their abilities to complete coursework. Although these challenges are often and largely outside the control of the individual, past scholarship suggests that certain protective factors exist that may support rather than further compound an individual's ability to persist through difficulty (Ponce-Garcia, Madewell, & Kennison 2015). These factors include the "social-interpersonal", such as "social skills, social support, and the quality of familiar relationships" (Reich et al., 2010 as cited in Ponce-Garcia, Madewell, & Kennison 2015, 736) as well as the "cognitive-individual", such as "self-regulation, planning, executive functioning, problem-solving skills, and self-efficacy" (Ponce-Garcia, Madewell, & Kennison 2015, 736). Conversely, structural factors, such as inequalities related to a person's social identities, are barriers to success.

Drawing from past scholars' work on resilience, or relatedly GRIT and 'academic perseverance' (Duckworth et al., 2007; Farrington et al., 2012, p20 as cited in Sottilare et al., 2014), this study investigates the influence of social support, social skills sets, goal efficacy, and planning prioritizing behavior following Ponce-Garcia, Madewell, and Kennison's (2015) Scale of Protective Factors, which assesses resilience based on these four areas. Although defining resilience itself and across cultural groups is complicated, Ponce-Garcia, Madewell, and Kennison (2015) point out that some of these protective factors have been noted across some cultural groups (Friborg et al., 2009 and Johnson-Powell, Yamamoto, Wyatt, & Arroyo, 1997 as cited in Ponce-Garcia, Madewell, & Kennison, 2015, 736*)*. Their Scale of Protective Factors survey, which at the time of this study contained 25 validated items, was developed to assess two social-interpersonal and two cognitive-individual protective factors associated with resilience (Ponce-Garcia, Madewell, & Kennison, 2015). The Scale of Protective Factors survey contains 4 subscales; the goal efficacy and planning prioritize behavior subscales represents cognitive-individual protective factors while the social skills set and social support subscales represent social-interpersonal protective factors (Ponce-Garcia, Madewell, & Kennison, 2015). The goal efficacy scale asks individuals to rate their confidence in various factors, such as problem-solving, in-the-moment assessment and action, planning, making decisions, and meeting goals (Ponce-Garcia, Madewell, & Kennison, 2015). Such skills can influence if and how students schedule in time for reading, studying, and practicing material on their own outside of class.

This case study uses the survey developed by Ponce-Garcia, Madewell, and Kennison (2015) to explore associations among strengths in these protective factors, the use of adaptive digital learning, and student performance and perceptions on understanding and engagement in the course material.

Overall, this case study builds on and expands past evaluations of adaptive digital learning by investigating five components that had not previously been considered together: adaptive digital learning's impact on students' self-reported engagement and understanding of lecture and course material for in-person classes, student performance on specific exam questions, the mediating roles of outside influencing factors in students' lives, specifically resiliency factors, the active learning class exercises that are coupled with the digital learning, and the degree of instructor customizability in a digital learning platform. Such a comprehensive approach will help both instructors and software developers in designing pedagogical and digital experiences that can best support a wide range of students, including those with varying degrees of different social support and social, planning, and cognitive skill sets, including those who are at-risk for leaving the university before graduation.

Methods

This IRB-approved case study was conducted at a Midwestern four-year university. It took place in two sections of the same in-person general education cultural anthropology course that were taught by the same instructor during the same semester. Each section met on the same days but at different times. Students self-selected into either section, and neither section was identified in student-facing course descriptions as containing digital or adaptive digital courseware. At the time of the study, the adaptive digital learning game was included in the cost of the new textbook, but a student using a borrowed or used book would need to purchase a license for the game if it had already been activated by another student.

For one of the sections (Section 2), the intervention involved integrating the adaptive digital learning game as a low-stakes set of assignments that accompanied six textbook chapters and a digital learning practice quiz targeting kinship terms associated with another chapter. The kinship section of the course is the most term heavy and involves multiple concepts that can easily be confused. Students in Section 1 were only assigned the digital learning practice quiz targeting kinship terms as extra credit. The practice quiz consisted of the same seven multiple-choice questions that required students to apply kinship concepts to a chart based on a real-life Hollywood family.[1] To receive full credit on the digital learning practice quiz, students needed to continue playing until they received 100% in the same online session. For each session, both the questions and options were presented in a different order. Instructor-created feedback was automatically generated based on the multiple-choice selection. For an incorrect response, the feedback was a hint rather than the correct answer. For the adaptive digital learning game, if students selected the correct option, the automatic feedback was an explanation of why it was correct, and if the selected answer was wrong, the feedback was a hint with the page number in the textbook where the answer could be found. Prior to answering the question in the adaptive digital learning game, students could increase or decrease the amount of points they were wagering for each question. If they got several questions correct in a row, feedback appeared encouraging them to wager more on the next question, and if several responses in a row were incorrect, the feedback encouraged the student to take a short break and was accompanied by background instrumental music. Students could stop and start and keep playing the adaptive digital learning game as much as they needed until they achieved the targeted number of points and questions, which was set at a minimum of 13 questions. The due date was the start of class on the day the material would be discussed. Both

[1] The kinship activity was inspired by Torsch (2006).

sections of the course contained the same lectures, small group in-class active learning exercises, and in-class TopHat questions.

A few specific questions were placed on the exams in both sections that targeted the same concepts from the textbook or lecture that were featured in the adaptive digital learning game (exam 1 and final) and the digital learning practice quiz (exam 2). These exam questions targeted remembering, understanding, and application skills. In order to help isolate out the impact of completing the adaptive digital learning game, one concept that was not discussed in class lecture or in-class active learning but was discussed in the textbook and appeared in the adaptive digital learning game was placed on exam 1 (polyvocality) and on the final (flexible accumulation). In addition, another set of shared exam questions across both groups involved a case study (Nacirema) and several concepts (subsistence strategies and cultural capital) that appeared in the adaptive digital learning game as more understanding/recall-level engagement and was incorporated into lecture to varying degrees, ranging from TopHat questions that closely aligned with the types of questions asked in the adaptive digital learning game in the case of the subsistence strategies, to an in-class active learning game that expanded the engagement from recall to application in the case of cultural capital. This latter inclusion of an in-class game is intended to investigate, in part, the role of scaffolding other in-class active learning exercises with digital learning.

IRB-approved surveys were administered to students in both sections; the survey contained closed-ended questions about students' experiences using the associated adaptive and/or digital learning courseware, demographic questions, and an open-ended question about challenges encountered in keeping up with course material, studying, and completing assignments. As part of the study, students in both groups were also asked to complete the Scale of Protective Factors survey.

Statistical analysis using SPSS was performed in order to identify and construct a profile of any associations among individual students' use and perceptions of the two types of digital learning courseware, their performances on the exam questions that targeted info covered in the digital learning, their perceived ability to engage in class and understand lectures and concepts, their scores on the four subscales for resilience, and demographic characteristics.

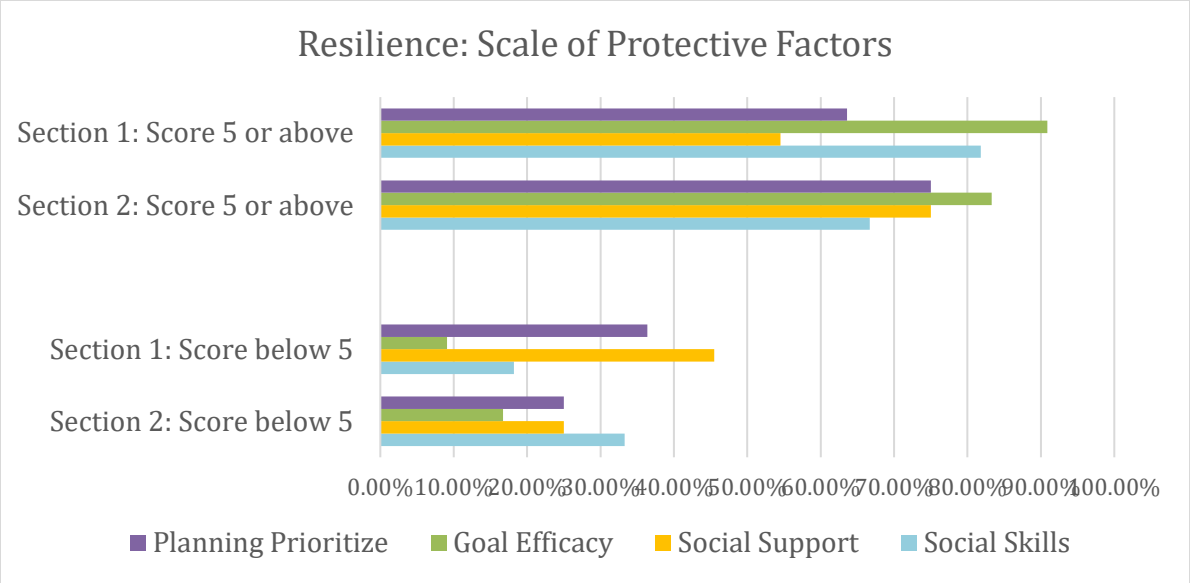
Results

For Section 2, which involved both the adaptive digital learning game and digital learning quiz, 56% of students completed the surveys. Similarly, for Section 1, which only involved the digital learning quiz, 54% of students completed the surveys. Table 1's display of the demographic composition for those from each section who participated in the surveys reveal that age, first-generation status, and gender distributions were very similar across respondents in both sections, and participants from both sections represented STEM and non-STEM majors. However, Section 2 respondents included more students with previous college experience, from historically marginalized groups, and who self-identified across a wider range of social class categories although the percentages of Pell Grant recipients were similar across both sections. The average GPA for those in Section 1 and those in Section 2 who participated in the study were similar, but Section 1 was somewhat higher.

Table 1. Participants

Demographic Background	Section 1 with Digital Learning Practice Quiz	Section 2 with Digital Learning Practice Quiz and Adaptive Digital Learning
Age	Majority of participants were 18 to 21 years old; mode = 18 years	Majority of participants were 18 to 21 years old; mode = 19 years
Year in School	64% First-year 36% Sophomore	32% First-year 42% Sophomore 10% Junior 16% Senior
First-Generation	9.1%	10.5 %
Gender	36% Men 64% Women	39% Men 61% Women
Race/Ethnicity	9% identified with MENA (Middle East or North Africa) 91% identified as white	24% identified as Black, Asian, or Hispanic/Latinx 76% identified as white
Social Class	Self-identified as: 0% Below the Poverty level 18% Working class 82% Middle class 0% Upper class Pell Grant recipient 27%	Self-identified as: 11% Below the Poverty level 17% Working class 67% Middle class 6% Upper class Pell Grant recipient 21%
Majors	Both STEM and non-STEM	Both STEM and non-STEM

Graph 1 contains the profile of the Scale of Protective Factors for each section's participants. According to Ponce-Garcia, Madewell, and Kennison (2015), a score of 5 or above in any subscale indicates a strength in that protective factor. Following this cut off, about one-third of students from Section 2 scored less than 5 as it related to the social skills category and one-quarter of students in Section 2 scored less than 5 as it related to the social support and planning prioritizing categories. When compared to Section 1, Section 2 had a higher percentage of respondents with lower scores related to social skill sets and goal efficacy.



Graph 1. Results of the Scale of Protective Factors Survey

Student Perceptions of Digital Learning Courseware's Usefulness for Understanding Course Material:

Overall, students perceived both the adaptive digital learning game and digital learning practice quiz as beneficial for understanding course content. As Table 2 indicates, 78.3% of students who answered the survey agreed that the adaptive digital learning game helped them understand the concepts better than reading the chapter only, and 69.6% agreed that it helped them better isolate out what was important in the chapter. Considering that increasingly students are entering college from high school with a semester or more of college credits, responses from first-year and sophomore-year students were combined and compared with a combined group of respondents in their junior and senior years. The results revealed that over 70% of those in their first two years of college agreed that the adaptive digital learning game helped them better understand the concepts and isolate out what was important from the readings compared to 60% of those in their junior or senior year. None of the students in their first two years of college disagreed about the adaptive digital learning game helping them isolate out important points in the reading; however, some of the students in their junior and senior years did.

Table 2. Adaptive Digital Learning Game and Understanding Course Material: Section 2 Student Perceptions.

Survey Question	Strongly agreed/agreed/somewhat agreed	Neither Agree nor Disagree	Somewhat disagree/Strongly Disagree
The adaptive digital learning game helped me *better understand the concepts* than when I read the chapter only.	78.3%	13%	8.7%

The questions in the adaptive digital learning game helped me *better understand the lecture material* than when I read the chapter only.	69.6%	26.1%	4.3%
The adaptive digital learning game helped me *isolate out what was important in each chapter* than just reading by myself.	69.6%%	21.7%	8.7%

As Table 3 illustrates, the degree of perceived usefulness for the digital learning practice quiz was even higher and spanned across students of varying demographic backgrounds with zero students in both sections disagreeing about its usefulness. 90.5% of respondents in Section 2 and 100% of respondents in Section 1 who used the digital learning kinship quiz agreed it helped them learn the kinship terms.

Table 3. Digital Learning Practice Quiz: Sections 1 and 2 Student Perceptions.

The digital learning practice quiz helped me learn the kinship terms.			
	Strongly agreed/agreed/somewhat agreed	Neither Agree nor Disagree	Somewhat disagree/Strongly Disagree
Section 2	90.5%	9.5%	0%
Section 1	100%	0%	0%

The number of participants in Section 2 who identified as first-generation, Pell Grant recipients, and/or members of a racialized minority group were small, and more participants were needed to determine statistical significance as it relates to the impact of doing the adaptive digital learning game. Previous research suggests that individuals from underrepresented minority groups and Pell Grant students report positive results from adaptive digital learning (Clark et al., 2018). More research is needed to identify the impact adaptive digital learning games have for these different demographic groups.

Adaptive Digital Learning Courseware's Influence on Completing Textbook Readings

The results suggest that students used the adaptive digital learning game more as a guide for identifying what is important to read in each chapter. Although students were encouraged to read the chapter before completing the associated adaptive digital learning game, 72% of students reported having read little to none of the chapter prior to starting it. However, 48% of students reported that the adaptive

digital learning game helped them complete more of the required textbook readings compared to other readings in the class with no associated adaptive digital learning game. A comparison of how much students reported reading before and after using the adaptive digital learning game in two other questions further supported the conclusions that it helped almost 50% of students read more of the textbook considering that 52% of students who started out having read none or very little of the chapter reported having read at least "a little" to a "moderate amount" or even "a lot" after completing the adaptive digital learning game. Only 21% of students surveyed reported having read none of the chapter prior to and after doing the adaptive digital learning game. These results suggest that many students went back and either read the suggested pages from the game feedback or went back and read some sections of the chapter as they went through the game. For those in Section 2 who participated in the survey, the percentage of students who on average read 0-25% of the book was slightly lower (33.3%) than those in Section 1 (38.5%); however, there was not a statistically significant association between being in either class and what percentage of the required reading was completed.

In terms of the protective factors, there did not appear to be any statistically significant associations between whether a person's score was less than 5 for either the goal efficacy, planning prioritizing, social skills, or social support subscales and whether they had indicated that the adaptive digital learning game helped them read more of the chapter. However, the sample size of respondents was small and resulted in cell counts below the minimum.

Considering that the first years of college can be a transitional period, responses from students in their first two years were compared to those in their junior and senior years to see if the adaptive digital learning had influence over how much they read. The results revealed no statistically significant association. However, the group of first and second-year students were a bit more divided, with 36% agreeing, 43% being neutral, and the remaining disagreeing that the adaptive digital learning game impacted how much of the textbook they read.

Adaptive Digital Learning's Influence on Performance

To help evaluate the association between completing the adaptive digital learning game and students' performances on summative assessments, the results from the shared multiple choice exam questions were compared based on students' completion of the adaptive digital learning game. The results in Table 4 illustrate that adaptive digital learning has the potential to possibly assist in recall-oriented exam questions. However, there are several mediating factors at play, including if and how the concepts were approached during class lecture and in-class activities.

Table 4. Impacts on Summative Assessment: Adaptive Digital Learning Courseware WITH accompanying Lecture and In-class Activities.

Exam	Question Type/Content	Groups Compared	Percent of students who answered correctly	Pearson chi square p-value	Fisher's exact test	phi
Final	Recall/Subsistence	Students in Section 2 who used the assoc. adaptive digital learning game Students in Section 1 and those from Section 2 who did not use the assoc. adaptive digital learning game	87.5% 69.2%	.227 (several cells below expected count minimums)	.364	.224
Exam 1	Understanding/ Nacirema	Student in Section 2 who used the assoc. adaptive digital learning game Students in Section 1 and those from Section 2 who did not use the assoc. adaptive digital learning game	78.6% 93.3%	.249 (several cells below expected count minimums)	.330	-.214
Final Exam	Application/cultural capital	Student in Section 2 who used the assoc. adaptive digital learning game Students in Section 1 and those from Section 2 who did not use the assoc. adaptive digital learning game	92.3% 87.5%	.672 (several cells below expected count minimums)	1.000	.079

For example, in both Section 1 and Section 2, the instructor integrated a TopHat question about connections between particular subsistence systems and specific forms of political organization. This TopHat question was a recall-oriented question based on the textbook reading (and a similar recall-oriented question in the adaptive digital learning game) and the reasons behind the connections were unpacked in class through a discussion activity. The subsequent exam question was also a recall-oriented question about the connection among particular subsistence strategies and forms of political organization. A higher percentage of students who used the associated adaptive digital learning game

answered the subsistence exam question correctly compared to students who did not use the adaptive digital learning game. In addition, the in-class repetition combined with assessment at the same level of Bloom's taxonomy across the different forms of engagement and the exam question may help explain why the association is not statistically stronger.

The potential mediating impact of in-class activities on the effectiveness of adaptive digital learning is also evident when comparing results of the subsistence exam question with the Nacirema case study exam question. The negative phi value for the Nacirema case study question suggests a possible inverse relationship between completing the game and getting this question correct. Completing the adaptive digital learning game could have caused some confusion in this case. This may have been due to the fact that there was not a direct mirroring of the Nacirema case study across the adaptive digital learning game, class discussion, textbook, and exam like there was for the subsistence question. The Nacirema case study was presented in the adaptive digital learning game as not being related to ethically studying other cultural practices, but in lecture it was part of a larger week discussion on how to appropriately approach the study of cultural diversity, which involves ethics as did the associated textbook chapter.

The results for the cultural capital question further illustrate the potential impact of in-class active learning and lecture on the effectiveness of adaptive digital learning and how certain in-class application games can potentially be similarly beneficial to learning, especially in transitioning from recall to application. In this case, both Sections 1 and 2 did an application-oriented in-class activity related to different forms of capital, including cultural capital. On the associated exam, there was a higher percentage of students across both sections who answered the cultural capital question correctly.

In contrast with the cultural capital concept, subsistence concepts, and Nacirema case study, there was not an in-class activity associated with the polyvocality and flexible accumulation concepts nor did they appear in lecture; however, these concepts were listed on the study guide and appeared as vocabulary terms in the textbook. The results in Table 5 reveal how the percentage of students who completed the adaptive digital learning game and answered correctly the application question about polyvocality was about the same as the students who did not use the adaptive digital learning game. The percentage of students who correctly answered the application-oriented flexible accumulation question was a little higher for those who did the adaptive digital learning game. However, the percentage of students who answered correctly the associated exam question remained lower compared to the other application question about cultural capital, which had an in-class application activity associated with it.

Table 5: Impacts on Summative Assessment: Adaptive Digital Learning Courseware WITHOUT accompanying Lecture and Active Learning.

Exam	Question Type/Content	Groups Compared	Percentage of students who answered correctly	Pearson chi square p-value	Fisher's exact test	phi
Exam 1	Application/ Polyvocality	Student in Section 2 who used the assoc. adaptive digital learning game Students in Section 1 and those from Section 2 who did not use the assoc. adaptive digital learning game	73.3% 71.4%	.909 (several cells below expected count minimums)	1.000	.021
Final	Application/ Flexible Accumulation	Student in Section 2 who used the assoc. adaptive digital learning game Students in Section 1 and those from Section 2 who did not use the assoc. adaptive digital game	56.3% 46.2%	.588	.715	.100

For the digital learning practice quiz, the lecture in both classes involved some TopHat application questions related to some of the kinship terms. The majority of the respondents in both sections completed the digital learning practice quiz on kinship and correctly answered the associated application questions on the exam, which used a different kinship chart and set of questions than the TopHat and digital learning practice quiz. However, the sample size of respondents who had not completed the digital learning practice quiz was too low to statistical compare the exam results based on completion of the digital learning. Overall, the data in this section suggests the importance of pairing more recall or understanding-oriented digital learning with in-class activities or another digital learning that specifically focuses on application and more in-depth engagement to help students transition their knowledge use.

Adaptive Digital Learning Courseware's Influence on Class Engagement

According to the survey, students reported that the adaptive digital learning game enhanced what they got out of and contributed to class activities and discussions. Approximately 56.5% of students reported that the adaptive digital learning game helped them either understand or engage more in class activities and discussions than reading the chapter alone, and 70% of students who responded to the survey indicated that the adaptive digital learning game helped them better understand the lecture. No

statistically significant associations with gender, year in school, or at-risk factors were found, but this could be due to the small sample size. For students who scored below 5 in the social skills resilience subcategory, the numbers were too small to determine statistical significance and were very similar to the expected count.

Resilience and Adaptive Digital Learning Courseware

64% of students agreed that the feedback and advice in the adaptive digital learning game was helpful for continuing and completing the assignment and thus played a role in their ability to persist and complete the assignment. The crosstab and chi-square results of whether students agreed, disagreed, or were neutral on the helpfulness of the adaptive digital learning game's feedback and whether their score was below 5 or 5 and higher for the subscales on the resilience survey revealed a possible association or link between social support and goal efficacy scores and feedback being helpful; however the sample size was too small to be conclusive. The p-value for the Pearson Chi-square for social support was .018 and the phi was .592 and the p-value for the Pearson Chi-square for goal efficacy was .021 and the phi was .578, but the results should be interpreted with caution due to small cell counts. Although the hypothesis was that students who were less confident in their goal-setting and goal-reaching abilities or who didn't have sufficient social support might perceive the advice and affirmations present in the adaptive digital learning game feedback as helpful in completing the assignment, a closer look at the actual and expected counts for these two subscales revealed that more students who scored under 5 were neutral or disagreed with the feedback being helpful and less agreed that it was helpful than the expected count and the reverse was true for those who scored 5 or higher. One possible explanation for the differences in expected and actual counts may have been outside pressures/factors that impeded completion of the assignment and that could not be addressed or mediated by the feedback.

There were three common challenges to completing coursework that students reported on the survey: family responsibilities, motivation, and work/lack of free time. All three to some degree involve time demands, such as needing to help family or to work to pay for living expenses and school, that compete with demands to study, practice, and read. While motivation was explicitly listed, other individuals described it in terms of staying focused to complete assignments after a long day of work or with mental health challenges, such as depression. Other challenges mentioned, such as commuting and competing work in other courses, only highlight how limited available time was a central factor for various students. When asked to list the class activities or instructor support that helped them deal with some of these challenges and better understand the course material, students listed course design features, such as thorough lectures and in-class activities, extensions on due dates, and reminders sent on the course management system. In addition, one student who reported challenges related to work and family listed the adaptive digital learning game that was associated with six of the chapters. Another student suggested more in-class time for homework and practice.

Building Confidence with Digital Learning Courseware

Confidence in one's abilities is a re-occurring theme in the goal efficacy subscale for resilience, and a reduction in confidence in turn can stem from outside pressures, such as stereotype threat, that can affect students' performance on summative assessment (Steele, Spencer, & Aronson, 2002 cited in Murphy & Zirkel, 2015). The results of the survey revealed that 78% of students reported that the adaptive digital learning game increased their confidence in the reading material compared to readings without the adaptive digital learning game. When this data was compared by gender, at-risk status, and year in school, it revealed a statistically significant association with gender (p=.034; Fisher's Exact =

.056; phi = -.441) with women agreeing more than men about the positive impact on confidence. The results should be interpreted with caution due to small cell counts. Overall, 93% of women compared to 56% of men strongly agreed to somewhat agreed that the adaptive digital learning game helped increase their confidence in the material. No students disagreed or strongly disagreed about the adaptive digital learning game having a positive impact on their confidence.

The crosstab and chi-square results of whether students' confidence increased as a result of completing the adaptive digital learning game and whether they scored below 5 or 5 or above for each subscale on the resilience Scale of Protective Factors revealed an association between the confidence building potential of adaptive digital learning and the goal efficacy score. The association though may be due to the fact that confidence is a theme running through the goal efficacy questions and considering that the phi value was -.592, the Pearson Chi-square was .004 (with several cells below expected count minimums), and the Fisher's Exact test was .021. Although it was expected that more students scoring under 5 for goal efficacy might agree that the adaptive digital learning game helped build their confidence, there was an inverse association as the negative phi value suggests, with the majority of such students neither agreeing nor disagreeing, and more students with scores of 5 or higher agreeing than expected.

For the digital learning practice quiz on kinship, 94% of students across both sections reported that the digital learning practice quiz increased their confidence levels. When comparing the survey responses for the two sections, 100% of students in Section 1 (without adaptive digital learning) agreed that the digital learning practice quiz on kinship increased their confidence compared to 91% of students in Section 2 (with adaptive digital learning). No students disagreed that the digital learning practice quiz increased their confidence in the concepts. The results suggest that the confidence building potential of this type of digital learning tends to be strong across all levels of resilience.

Discussion and Reflection

The goal of the intervention in this general education social science course was to help students prepare outside of class for in-class engagement and summative assessments, with such preparation involving reading the textbook and practicing concepts. The results revealed that the adaptive digital learning game associated with the textbook was successful in increasing how much of the assigned reading students completed. The fact that the feedback included a list of the associated page numbers in the textbook most likely facilitated this. In addition, students reported that the adaptive digital learning game helped them understand and engage in the lecture and in-class active learning exercises better than reading the chapter alone. Such increased engagement in an in-person learning environment is an important finding. It illustrates how the impacts of adaptive digital learning on class engagement can differ across instruction formats. In an online psychology course that integrated adaptive digital learning, Dziuban et al. (2016) found that 75% of students reported a perceived decrease in engagement with their peers. Although Dziuban et al. (2016, p. 91) reports that 52% of students in this online psychology course "preferred little to no interaction with students in their classes," Ricke (2019, p. 7) found that 74% of students taking an in-person introductory social science course "strongly agreed/agreed that 'seeing what other students think about a topic or question in this class was helpful to my learning' and "63% of students strongly agreed/agreed that 'sharing my ideas was important to me in this class.'" Thus, in addition to the use of learning technologies in the classroom, such as the image-sharing projection software discussed in Ricke (2019), the integration of digital learning courseware *outside of* in-class meetings can further support students' abilities to engage with their peers in in-class exercises.

In addition to supporting engagement with others and course readings, both the digital and adaptive digital learning courseware showed promise in supporting students' confidence in the

material, with the more application-focused digital learning practice quiz having the greatest impact on the most students, with 94% reporting an increase in confidence. This higher impact may be due in part to its closer alignment to the type of skills and questions on the exam than the adaptive digital learning courseware. In addition, the results suggest the potential of adaptive digital learning to help mediate in part certain aspects of some stereotype threats in social science and STEM courses, given the difference in responses between women and men, with more women agreeing that the adaptive digital learning game increased their self-confidence in the material.

Building confidence is related to building resilience. The challenges that individual students reported overlapped somewhat with the Scale of Protective Factors, such as a lower score in social support and reporting family dynamics or family responsibilities as a challenge to finishing coursework. Part of resilience involves having the resources and support to persist through challenges. Of the students who described a challenge in the survey and scored lower than 5 in one of the subscales, 33.3% agreed or strongly agree that adaptive digital learning helped them complete more of the course reading. In general, student survey responses point to a tension between the time needed outside of class to complete homework and time needed for work, family, and health maintenance. While adding an additional activity outside of class could compound the issue, students' responses indicated that the adaptive digital learning game increased the amount of reading they completed outside of class. These results suggest that one strategy to promote engagement outside of class, such as reading the textbook or practicing concepts, involves reconceptualizing it as a low-stakes assignment that can be repeated. Such findings align with Gebhurdt's (2018) recommendation. Although adaptive digital learning and digital learning in general cannot solve the demands on time, it can help students complete readings, giving them a time frame and multiple attempts to complete associated low-stakes assignments in case family or work demands interrupt their progress. Moreover, this study showed that the targeted feedback from the adaptive digital learning game helped students persist in and complete the assignment. While this study is a start, more research is needed to better understand resilience as a factor in interpreting how combining different types of digital learning with in-class active learning could have mediating effects for those with different degrees of protective factors.

Although the adaptive digital learning increased confidence across different demographic groups, it did not translate into statistically significant differences in performance on exams. Nevertheless, the adaptive digital learning game and digital learning in general offers one mode through which to encourage repetitious engagement with the material. Although not sufficient, such repetition, especially when carefully combined and aligned with in-class engagement, can help foster learning and the transition from recall to application. Indeed, some type of applied practice, such as an in-class active learning exercise or instructor-designed digital learning quiz can help some students know how to take that knowledge and build on it or use it in new ways. Such practice can also help model for students how to study effectively on their own, which is a key strategy for promoting growth mindset and with it, resilience (Dweck, 2017).

This study of the adaptive digital learning game and digital learning practice quiz provides data that confirms the importance of instructors being able to edit questions themselves in digital learning courseware. Although Gebhardt's (2018) analysis of the impact of adaptive digital learning discussed how the lecture was purposely designed to closely follow the adaptive digital learning, these prior studies had not included data to evaluate the association between such alignment and student performance on associated summative assessment. Currently, some adaptive digital learning courseware is set up so that instructors need to follow its content and its approaches to the content closely rather than allowing instructors flexibility in identifying central content and how to approach it. Although adaptive digital learning cannot allow too many alterations in number of questions, types of questions as it relates to difficulty and level on Bloom's taxonomy, and their pathways, some

adaptive digital learning platforms that currently accompany textbooks could allow edits to clarify or substitute in similar questions as it relates to content and the targeted skill sets on Bloom's taxonomy, similar to some OER textbooks. This could take the format of setting up a shell in which instructors can plug in their own questions and/or choose from a set of pre-created questions that fit with the content and level on Bloom's taxonomy needed for the adaptive digital learning pathways to respond and give the appropriate next question based on each user's past performance. In the case of the digital learning practice quiz, which had more flexibility in design setup, more students reported its benefit.

Such alignment can only occur if courseware engineers and designers build in sufficient flexibility to the program design. This study of individual student engagement, perceptions of two types of digital learning platforms, and student performance on summative assessment highlight how more flexible editing features that allow customization of content is key for increasing digital learning's impact. Such editing opportunities is a design feature that both instructors and students in previous studies in other disciplines, like engineering, reported to be an important component, but it is not always available in different adaptive digital learning platforms, including those for the social sciences (i.e. O'Sullivan et al., 2020a; Buchan et al., 2020; Wynants & Dennis, 2022). Moreover, past studies reveal that students are less likely to perceive the digital learning assignments as "busywork" if the targeted content or skills align with that of the summative assessment or class discussions (O'Sullivan et al., 2020a).

The cost of integrating digital learning courseware, whether that be in terms of finances and/or time, is also a factor related to student and instructor resilience. While textbook costs vary widely across disciplines, at the time of this study, the adaptive digital learning game was included in the cost of a new textbook. Once the option became available, the e-book and accompanying adaptive digital learning game featured in this study was later preloaded together into the learning management system at a discounted price, which was folded into tuition to help reduce student cost and increase equity in access. The digital learning practice quiz tool is freely available to faculty and students; however, the cost in terms of time for the faculty member was greater considering that a set of scenario questions, responses, and feedback needed to be created and loaded into the tool by the instructor. Yet, the investment in time and money can result in increasing students' engagement with the course material inside and outside of class.

One limitation to the study was the small sample size. Plans to expand the study were interrupted by COVID-19 and the switch to online learning and open-note and open-book online exams, which have continued through the pandemic. Although the smaller sample size complicates statistical analysis, it points to the potential of future research to identify ways that faculty and institutions can adjust the integration of digital learning as well as course design to support students, particularly those who have different levels of protective factors. Furthermore, to assist in evaluating how the integration of adaptive digital learning can support performance for students of different demographic backgrounds and with access to differing levels of resiliency factors, a longitudinal study that involves students taking the Scale of Protective Factors survey over the course of one academic year and comparing the confidence ratings, performance, and alignment with active learning can provide additional insights as could a semester-long study that looks at students taking simultaneously comparable courses in terms of difficulty, one using adaptive digital learning and the other not, and comparing their results from the Scale of Protective Factors survey, the confidence ratings, performance, and alignment with active learning. With the advent of COVID-19, the use of online instructional materials and concerns about equity in course design have amplified. Thus, it is increasingly important to understand the ways in which different digital learning tools can be integrated into courses to maximize student support.

Conclusion

This case study of adaptive and non-adaptive digital learning highlights how a customizable design and the scaffolding of digital learning with in-class activities that follow Bloom's taxonomy and course learning objectives are key factors in digital learning courseware's ability to effectively support student learning. Unlike standard quiz assessments, adaptive and certain other forms of digital learning offer the potential to shift the focus from points to practice by allowing students multiple attempts to engage with the material, with each attempt being a different experience and accompanied by automatically generated feedback. In turn, such engagement can help foster student confidence and resilience. The adaptive digital learning game that accompanied the textbook increased the amount that students read outside of class while the digital learning practice quiz with instructor-created content supported more application-level skills. In turn, both the adaptive and digital learning courseware helped build students' perceived confidence level in the material. While this did not consistently and directly translate into higher performance on related exam questions, this increased engagement in the material prior to class did enhance what students reported they got out of and contributed to in-class activities and lectures. When the adaptive digital learning's approach to the material is aligned and combined with other active learning exercises and lectures, a symbiotic scaffolding of support can be created to foster student learning.

Acknowledgements

I am grateful to the IUPUI Digital Faculty Fellows Program and IUPUI School of Liberal Arts Langsam-Belle Fellowship for their funding support. In addition, I would like to thank the IUPUI Center for Teaching and Learning and IRDS for providing advice and guidance during different phases of this project. I am also grateful to the IUPUI Role of Reflection in SoTL Community of Practice for their insights related to resiliency studies, the writing group I was in and the anonymous reviewers for all of their advice, support, and time, and the students who also generously gave of their time to participate in this study.

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