Do Adaptive Lessons for Pre-class Experience Improve Flipped Learning?

Dr. Renee M. Clark, University of Pittsburgh

Renee M. Clark serves as research assistant professor focusing on assessment and evaluation within the University of Pittsburgh's Swanson School of Engineering and its Engineering Education Research Center (EERC), where her interests center on active and experiential learning. She has 25 years of experience as an engineer and analyst, having worked most recently for Walgreens and General Motors/Delphi Automotive in the areas of data analysis, IT, and manufacturing. She received her PhD in Industrial Engineering from the University of Pittsburgh and her MS in Mechanical Engineering from Case Western while working for Delphi. She completed her postdoctoral studies in engineering education at the University of Pittsburgh.

Prof. Autar Kaw, University of South Florida

Autar Kaw is a professor of mechanical engineering at the University of South Florida. He is a recipient of the 2012 U.S. Professor of the Year Award from the Council for Advancement and Support of Education and Carnegie Foundation for Advancement of Teaching. The award is the only national program to recognize excellence in undergraduate education.

Professor Kaw received his BE Honors degree in Mechanical Engineering from Birla Institute of Technology and Science (BITS) India in 1981, and his degrees of Ph.D. in 1987 and M.S. in 1984, both in Engineering Mechanics from Clemson University, SC. He joined the University of South Florida in 1987.

Professor Kaw's main scholarly interests are in engineering education research, adaptive learning, open courseware development, bascule bridge design, fracture mechanics, composite materials, and the state and future of higher education.

Funded by National Science Foundation (2002-16), under Professor Kaw's leadership, he and his colleagues from around the nation have developed, implemented, refined and assessed online resources for an open courseware in Numerical Methods (http://nm.MathForCollege.com). This courseware annually receives 1,000,000+ page views, 2,000,000+ views of the YouTube lectures, and 90,000+ visitors to the "numerical methods guy" blog.

Professor Kaw has written more than 85 refereed technical papers and his opinion editorials have appeared in the Tampa Bay Times, Tampa Tribune and Chronicle Vitae. His work has been covered/cited/quoted in many media outlets including Chronicle of Higher Education, Inside Higher Education, U.S. Congressional Record, Florida Senate Resolution, ASEE Prism, and Voice of America.

Eleonora Delgado, University of South Florida

Eleonora Delgado is a master's student in the Department of Mechanical Engineering at the University of South Florida. She graduated magna cum laude from the University of South Florida with a B.S. in Mechanical Engineering. Her areas of interest include vibrations and machine design.

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Abstract

In a meta-study of STEM courses, use of active learning over traditional lecturing indicated an increase of 0.47 standard deviations on exams and concept inventories. One pedagogy that uses active learning is the flipped classroom, where the initial exposure to the content is obtained outside the classroom via videos, text, online discussion, and assessment. During class time, active learning techniques such as peer-to-peer instruction and solving of applied problems are used.

In a prior NSF grant involving a combined dataset from three engineering schools, the authors found that the differences in the cognitive and affective outcomes for blended and flipped formats in a numerical methods course were not statistically significant. The effect sizes measured via Cohen's *d* were also negligible to small for these two outcomes. One of the known challenges with the flipped format is the pre-class expectations for the students. Currently for pre-class learning in most flipped courses, instructors assign lecture videos or reading assignments. To ensure that such assignments are done, they are either followed by an online quiz or an in-class quiz at the start of class. However, this approach is the same for all students and does not address the differential needs of students.

To improve the quality of the pre-class activities for his numerical methods flipped classroom, the second author developed adaptive lessons using the Smart Sparrow platform under a current NSF grant. By doing so, students had a personalized path for preparation that involved multiple representations such as lecture videos, text, questions, and simulations. The students' learning was assessed in real time, and depending on their responses, they were taken on alternate paths in the lesson. An analysis of the various metrics available to the instructor from the Smart Sparrow platform demonstrated that the students were actively using the platform.

We implemented these adaptive pre-class lessons in the fall 2017 and spring 2018 semesters and discuss preliminary results from the fall 2017 semester in this paper. The results compare three methods – 1) blended instruction 2) flipped instruction *without* adaptive lessons and 3) flipped instruction *with* adaptive lessons. The comparisons are based on direct assessment of learning (i.e., final examination), as well as indirect assessments (i.e., student surveys and focus groups).

Introduction and Relevant Literature

Adaptive learning courseware provides a means of individualized, personalized learning and feedback for students. A "one-size-fits-all" approach is not optimal given individual preferences, interests, needs, and aptitudes, and "Advance Personalized Learning" has been identified as one of the 14 Grand Challenges for Engineering in the 21st Century (National Academy of Engineering). Gartner, a leading IT consulting firm, ranked adaptive learning first on its list of strategic technologies impacting education in 2015, although they stated "A lot of real-world testing remains" (Schaffhauser, 2015). Using computer algorithms, adaptive online courseware analyzes performance data, which is collected as the student utilizes the online learning

environment. Based on this, the adaptive courseware determines recommended content or learning activities for the student, provides personalized feedback, and displays real-time progress via dashboards for both the student and instructor. With our prior flipped classroom research with numerical methods coursework, we identified the lack of a personalized approach with the pre-class aspect, where students are expected to learn foundational content before class (via videos or textbooks) prior to the application during class. This served as a motivation for our use of adaptive lessons.

In a recent Gates Foundation program with higher education institutions – the Adaptive Learning Market Acceleration program (ALMAP) – modest positive learning results were found with the adaptive implementations in general (Yarnall et al., 2016). In student surveys, 51% of bachelors-degree students reported positive learning gains with adaptive courseware, although only 33% reported satisfaction with the experience. This recent grant program strongly called for future research in the area of blended classroom implementations of adaptive courseware. Another recent article also called for more research on adaptive learning, after uncovering no significant differences in exam scores between adaptive learning and traditional sections of a course (Murray & Perez, 2015). This makes our current study a needed contribution to the literature. However, there are also recent studies on adaptive tutorials for engineering mechanics courses that point to student satisfaction as well as enhanced outcomes (Prusty & Russell, 2011; Prusty et al., 2011). One study uncovered a reduction in failure rates, an increase in student satisfaction, and highly positive student comments related to the use of the tutorials (Prusty & Russell, 2011). In another study involving an adaptive tutorial on free-body-diagrams, the total number of student comments that identified the tutorial as effective (versus not) was approximately 2:1, with the top reasons for effectiveness given as *engaging, immediate feedback,* and *understanding of concepts*. In contrast, the top reasons for ineffectiveness were stated as *prefer other methods, confusing or hard to understand*, and *not enough feedback* (Prusty et al., 2011). Thus, results from the literature on adaptive learning outcomes are both minimal and mixed. Given this, our research questions are as follows:

1) Are there achievement differences in a numerical methods course when different methods of instruction are used – a) blended, b) flipped, and c) flipped with adaptive lessons? Are differences evident for underrepresented minorities, females, community college transfers, and Pell Grant recipients?

2) Do students' perceptions of the classroom environment differ when using these different instructional methods for numerical methods? What are students' perceptions of flipped-classroom adaptive learning, and are there differences by demographic groups?

Methods

To enhance the pre-class preparation needed for the flipped classroom, the instructor developed adaptive lessons using the Smart Sparrow software platform for a course in numerical methods. With Smart Sparrow, students had a personalized preparation path that involved multiple representations and resources, including lecture videos, text, questions, and simulations. The objective of the pre-class "lecture" and questions in the adaptive platform is to promote participation and engagement during the in-class activities. Prior to implementation of the

adaptive lessons, students completed a reading or watched a YouTube lecture video before class. They also completed a pre-class online quiz through the university LMS. With the adaptive lessons, all of these components were combined into one platform, and the student was adaptively taken down various paths depending on his/her responses to assessments in the lesson. For example, for the Newton Raphson method of finding roots of nonlinear equations, students watched a video lecture about the derivation, viewed an example of the Newton-Raphson method, and completed a three-question online quiz (with three possible attempts) prior to the use of adaptive learning. With adaptive learning, students covered the same content, but within the Smart Sparrow platform. Within this platform, students answered a series of questions after the video. If a student failed to answer the questions, he/she was directed to the text format of the video (i.e., textbook form). If the student still failed to answer all of the questions after this, he/she was sent to a pre-requisite lesson on the relationship between derivatives, tangent slopes, and the point at which the tangent crosses the abscissa.

Learning and performance were assessed in real time, and each student was subsequently sent down a different path, as the software could adapt to his/her knowledge and skills. Analytics from the software informed the instructor of metrics such as median time spent per lesson, the average percentage of questions answered correctly per lesson, and percent of students completing each lesson. These metrics provided feedback to the instructor in areas where the students were struggling as well as the amount of time spent by students, including those cases where too much time was being spent. The instructor viewed the metrics after each lesson to monitor progress.

As discussed above, with previous flipped classroom implementations, students watched the lecture videos, read the online textbook, and took pre-class quizzes prior to working actively during class. With previous blended implementations of the course (Kaw et al., 2012), the students had access to online videos for their learning, although the in-class time was primarily dedicated to lecturing with active learning exercises. For the study described in this paper, the blended approach was used during two semesters of the course (spring 2014 and spring 2015), the flipped approach *without* adaptive learning was used during two semesters (fall 2014 and fall 2015), and the flipped approach *with* adaptive learning was used during one semester (fall 2017). Four numerical methods course topics were made available in Smart Sparrow for this initial implementation - nonlinear equations, simultaneous linear equations, regression, and integration. Not available in Smart Sparrow were lessons for topics of scientific computing, differentiation, interpolation, and ordinary differential equations.

In designing the assessment plan for this study, we adapted the approach used in our prior NSF-funded research on comparing blended versus flipped classrooms for numerical methods (Clark et al., 2016; Clark et al., 2018). In particular, we used a mixed-methods approach consisting of surveys, student focus groups, instructor interviews, and final exam comparisons. Our surveys, which enabled indirect assessment of learning and student perspectives, consisted of the College and University Classroom Environment Inventory (CUCEI) (Fraser & Treagust, 1986), a flipped classroom evaluation survey, and a demographics survey, which enabled assessment of particular demographic groups of interest, including females, under-represented minorities (URM), community college transfers with associates degrees, and Pell grant recipients. In the evaluation

survey, we added survey questions used by the ALMAP program (discussed in the Background section) so that we could compare our results regarding satisfaction and engagement to those from another study (Yarnall et al., 2016). In our evaluation survey, students were also asked to compare and contrast their learning of the topics available in Smart Sparrow versus those not available in Smart Sparrow. This provided a means for students to compare their learning and effort expended with and without the adaptive platform. Data from our evaluation survey were triangulated with qualitative data collected from the student focus groups and instructor interviews, since the questions aligned. We conducted two focus groups with different demographic groups – 1) white males and 2) students who were not white males – to investigate potential differences in perspective based on demographic background. The assessment analyst for the project (i.e., the first author) and an upper-level undergraduate student performed a content analysis of the focus group data. They each independently coded the data and then discussed their responses to achieve consensus; thus, the focus group data were double-coded. Nonetheless, their first-time inter-rater reliability was Cohen's $\kappa = 0.72$, showing good agreement beyond chance (Norusis, 2005).

Results

Direct Assessment of Learning

To directly assess learning associated with the three instructional methods (i.e., our first research question), we compared the multiple-choice and free-response results on the final exam using an analysis of covariance, with pre-requisite-course GPA as the control variable. This was done for all students as well as demographic groups of interest, as shown in Table 1. Overall, we had demographic and exam data from 74% of the enrolled students for this analysis, with 75% associated with the flipped instruction, 73% with blended, and 77% with flipped instruction with adaptive learning. Given the smaller sample sizes associated with some of the demographic groups, we report the results from the non-parametric version of the analysis of covariance test (i.e., Quade's Test) (Quade, 1967; Lawson, 1983). However, the *p*-values from the parametric and non-parametric tests were in agreement with respect to decisions regarding significance. We also calculated the Cohen's *d* effect size as a measure of practical significance for each pair of means within a demographic group and reported the effect size with the greatest absolute value within each group in Table 1 (Sullivan & Feinn, 2012; Kotrlik et al., 2011). Effect sizes for all pairs of averages are given in the Appendix in Table 6. The blended method is considered the reference (i.e., control) group when comparing it to either the flipped or flipped with adaptive methods. When comparing the flipped versus the flipped with adaptive methods, the flipped method is the reference category.

For all demographic groups except females, the average percentage for the flipped method exceeded that for the other methods on the multiple choice questions, although the differences were not statistically significant, and the effect sizes were small, as shown by the values for *p* and *d* in Table 1. Unfortunately, the sample sizes for some of the demographic groups were small, influencing our power to detect statistically significant differences.

Table 1: Three Methods: Multiple-Choice Questions Comparison

Dem Group	Blended	Flip	Flip w/ Adaptive	*Quade's Test* *p*	*Effect Size* *d* *	Blended	Flip	Flip w/ Adaptive
	Average Percentage (Adjusted) (*s*)					Sample Size		
All	63.0 *(16.1)*	65.1 *(16.1)*	63.5 *(16.1)*	0.949	0.13	126	88	83
Female	65.5 *(17.7)*	60.5 *(17.8)*	61.2 *(18.4)*	0.513	-0.29	20	15	13
CC Trans	57.5 *(17.9)*	61.4 *(17.7)*	58.5 *(17.6)*	0.855	0.23	48	32	20
URM	62.7 *(15.5)*	65.5 *(15.5)*	64.6 *(15.5)*	0.937	0.19	25	33	23
Pell	62.6 *(16.6)*	66.4 *(16.5)*	64.0 *(16.5)*	0.748	0.23	46	29	27

* Value of *d* with the maximum absolute within each demographic group is reported.

However, different patterns were observed with the free response results of the final exam. Although there were no statistically significant differences among the three instructional methods for any of the groups, the mean associated with the flipped method was always the smallest among the three, which differs from the multiple choice results. However, the most interesting finding was for the underrepresented minority (URM) and Pell grant students, for whom the adaptive software potentially enhanced learning in the flipped classroom.

Table 2: Three Methods: Free-Response Questions Comparison

Dem Group	Blended	Flip	Flip w/ Adaptive	*Quade's Test* *p*	*Effect Size* *d* *	Blended	Flip	Flip w/ Adaptive
	Average Percentage (Adjusted) (*s*)					Sample Size		
All	39.9 *(20.7)*	37.3 *(20.6)*	42.6 *(20.6)*	0.204	0.26	126	88	83
Female	46.1 *(19.6)*	42.4 *(19.8)*	46.6 *(20.4)*	0.558	0.21	20	15	13
CC Trans	33.5 *(19.2)*	28.2 *(19.1)*	30.1 *(19.0)*	0.629	-0.28	48	32	20
URM	41.1 *(21.6)*	36.9 *(21.6)*	45.5 *(21.6)*	0.254	0.40	25	33	23
Pell	40.0 *(21.7)*	35.3 *(21.7)*	46.0 *(21.6)*	0.132	0.50	46	29	27

* Value of *d* with the maximum absolute within each demographic group is reported.

Classroom Environment

Specifically, the average percentages for the flipped method *without* adaptive learning were approximately 36.9 and 35.3 for the URM and Pell groups, respectively, and 45.5 and 46.0 for the flipped method *with* adaptive lessons. For the Pell grant group, the effect size associated with this difference was medium ($d = 0.50$). Effect sizes for all pairs of averages are given in the Appendix in Table 7.

To investigate our second research question about the perceived learning environments with the three types of instruction, we used the College and University Classroom Environment Inventory (CUCEI). We obtained an overall CUCEI response rate of 68% of enrolled students, with 75% associated with the flipped instruction, 71% with blended, and 55% with flipped instruction with adaptive learning. To compare the three instructional methods, we ran an analysis of variance, and in particular Welch's test due to unequal variances in the groups (Norusis, 2005). We examined Tamhane's T2 post-hoc tests (which don't assume equal variances) to pinpoint the specific means that differed. We also calculated effect sizes for the pairs of means that differed significantly (Sullivan & Feinn, 2012; Kotrlik et al., 2011). One of the most pleasing differences was with the *Individualization* dimension, which measures individual or differential treatment. This was significantly higher with medium effect sizes for adaptive learning (average of 2.80) versus the other two methods, as shown in Table 3. This might be expected given the goals of adaptive learning. However, for most of the other CUCEI dimensions, the blended classroom scored highest. Relatively noteworthy differences for blended instruction included the following: 1) *Innovation*, for which the blended method scored significantly higher than the other two methods, with medium effect sizes, and 2) *Satisfaction*, for which the blended classroom scored significantly higher than the flipped classroom, with a medium effect size. With *Personalization* and *Task Orientation*, the blended and flipped w/adaptive methods scored significantly higher than the flipped method without adaptive learning, all with medium effect sizes. Thus, from an overall, general perspective, the flipped method without adaptive learning appeared to be associated with the least favorable classroom environment.

Table 3: Classroom Environment Results

CUCEI Dimension		**Blended (B)**	**Flip (F)**	**Flip w/ Adaptive (A)**	***ANOVA Welch test***	***Tamhane Post Hoc test***	***Cohen's Effect Size***
		Dimension Mean (1-5 scale)			***p***	***(significant differences)***	***d***
Cohesiveness	Students know & help one another	3.06	2.77	3.12	0.012	0.030 (F&B) 0.027 (F&A)	-0.36 0.44
Individualization	Treated individually/ differentially or allowed to make decisions	2.41	2.43	2.80	0.002	0.010 (F&A) 0.002 (B&A)	0.50 0.60
Innovation	Novel class activities, teaching techniques, or assignments	3.29	2.94	2.90	<0.0005	<0.0005 (F&B) <0.0005 (B&A)	-0.56 -0.66
Involvement	Active student participation in class discussions and activities	3.41	3.18	3.33	0.032	0.025 (F&B)	-0.38
Personalization	Interaction w/ instructor	4.17	3.74	4.14	<0.0005	<0.0005 (F&B) 0.003 (F&A)	-0.62 0.53
Satisfaction	Enjoyment of classes	3.69	3.11	3.37	<0.0005	<0.0005 (F&B)	-0.63
Task Orientation	Organization and clarity of class activities	4.26	3.84	4.22	<0.0005	<0.0005 (F&B) 0.002 (F&A)	-0.74 0.57
	Sample Size	123	89	59			

Note: The blended method is the reference (i.e., control) when comparing it to the flipped or flipped with adaptive methods. When comparing the flipped versus flipped with adaptive methods, the flipped method is the reference category.

Flipped Classroom Evaluation Survey

We received responses to the evaluation survey from 56% of students enrolled in the fall 2017 adaptive-learning section of the flipped course. In addition, we administered the evaluation survey to students in the prior flipped sections of the course without adaptive learning (71% response rate), enabling a comparison of the two methods. In Table 4, we present findings that compare learning with and without the use of adaptive lessons in the fall 2017 flipped classroom, as adaptive lessons were not available for all course topics. As shown in Table 4, students indicated their learning gains were nearly equivalent with and without the use of adaptive lessons in the fall 2017 flipped classroom, as measured using a 1-5 scale from strongly disagree to strongly agree. However, when adaptive learning was not used at all in the previous flipped semesters (fall 2014 & fall 2015), the students rated this question at 2.77 on the 5-point scale. Interestingly, students' average free-response score on the exam was highest during the flipped semester *with the adaptive-lessons* (i.e., Table 2), being nearly one point higher than during the prior flipped semesters without any adaptive learning at all.

Table 4: Evaluation Survey Results: Learning Gains

I had greater learning gains with the flipped classroom vs. usual methods of instruction.	
Topics with adaptive lessons	3.41
Topics without adaptive lessons	3.39

*1-5 scale: strongly disagree to strongly agree.

We also asked students about the helpfulness of the adaptive lessons and their engagement and interest in them. We compared these results with those from a previous Gates Foundation study to provide an external comparison (Yarnall et al., 2016). For the Gates' study, we used results from the BS-degree students taking general education courses (i.e., psychology, biology, business, marketing, and economics). Thus, our course differed from those in the study. The question scale ranged from 1 to 4, with the following values: not true, sometimes true, mostly true, and always true. Positive responses were those rated as mostly true or always true, as confirmed with researchers from the Gates' study. As shown in Table 5, 72% of our students rated the helpfulness of the adaptive lessons positively (i.e., mostly or always true response), compared to 33% in the other study. The Gates' study identified this question as a measure of satisfaction. Forty percent (40%) of our students rated their engagement or interest with the adaptive lessons positively, compared to 25% in the other study.

Table 5: Evaluation Survey Results: Helpfulness, Interest, and Engagement

	Positive Response (Mostly or Always True)	
Question	Our implementation	Gates Foundation program (ALMAP)
The adaptive lessons were helpful to me.	72%	33%
The adaptive lessons were interesting and engaging.	40%	25%

*1-4 scale: Not true, sometimes true, mostly true, and always true.

Smart Sparrow Metrics

An analysis of the various metrics available from Smart Sparrow demonstrated that the students were actively using the platform. For example, based on 91 students participating in the research, the average degree of lesson completion was 92%. This means that across the 17 Smart

Sparrow lessons, the average amount of the lesson that was completed was 92% (s=4.6%), which demonstrated utilization of the platform by students. Students had four chances to get the full points for each lesson by watching the videos and answering all the quiz questions correctly. They could go through the lesson as many times as they wanted. Across the 17 lessons, the average percentage points earned was 88% (s=5%), again demonstrating the effectiveness of the platform relative to student use and achievement of performance expectations.

Focus Group Perspectives

We present results from the focus group questions posed to two demographic groups of students enrolled in the fall 2017 flipped classroom with adaptive learning. Seven (7) students participated in the white males group, who represent the majority among engineering students, and five (5) students participated in the group consisting of students who were *not* white males (i.e., non-white-males). We present sample results, which are from two of the focus-group questions, in which we do a comparison of responses from the two demographic groups. These results respond to our second research question and demonstrate more favorable perspectives towards the adaptive software by the non-white-male students.

Question 1: *Did the Smart Sparrow adaptive platform impact your learning or understanding more so than other methods for studying, learning, or reviewing content? Why do you feel this was the case?*

The non-white-males had a more positive perspective towards their learning with the adaptive platform, with two *yes* and just one *no* response (out of five students) to this question. Conversely, the white males had four *no* responses to the question (out of seven students). All remaining responses for both groups were classified as *mixed,* with mixed responses typically consisting of both positive and negative supporting statements. The (more-positive) non-white-males identified lecture preparation and understanding as well as quiz questions intermixed with the video content as adaptive-learning features helpful to their learning or understanding. They identified lecture preparation/understanding (3 responses) and quiz questions (3 responses) more frequently than the white males did. The white males discussed only the lecture preparation/understanding feature of the adaptive lessons as a positive feature (2 responses). One non-white-male student said, *"Smart Sparrow did impact learning more than the typical approach. I had to pay attention and take notes when watching the video, and it helped me to understand better. I liked watching a video and then answering a set of questions right away."*

Question 2: *Discuss your satisfaction with the Smart Sparrow adaptive software and reasons for it.*

Similarly, the non-white-males expressed more satisfaction with the adaptive software than the white males did. For the non-white-males, all four responses were coded as *positive*, versus just one for the white males. The remainder of the responses for the white males were coded as either negative or mixed. In relation to their satisfaction, the non-white-males discussed the convenience and simplicity of the adaptive platform, including the availability of all resources from the same website and the ability to work at one's own pace (4 responses). In his interview, the instructor also identified the availability of all resources as an advantage. The non-white-males also discussed the quiz questions intermixed with the video content, which enabled them

to obtain, confirm, or reinforce their understanding (2 responses). With the white males, although they discussed the benefits of lecture preparation, quiz questions, and convenience, they also discussed dissatisfaction with the degree of specificity of the software's feedback (3 responses) as well as the fact that the video was not available on the same page when working the problem (2 responses).

Discussion and Conclusions

Personalized adaptive lessons were implemented within a numerical methods course in the fall 2017 to enhance the pre-class experience associated with the flipped classroom. A preliminary direct comparison of the adaptive instruction with two other methods used to teach this course previously (i.e., blended instruction and flipped instruction *without* adaptive learning) showed no significant differences in exam scores and small effect sizes. The most promising finding was in the free-response exam results of the URM and Pell grant students, for whom adaptive learning potentially enhanced their learning in the flipped classroom. With the classroom environment survey, one of the most pleasing differences was in the *Individualization* dimension, which measures individual or differential treatment. This was significantly higher with medium effect sizes for flipped with adaptive learning versus the other two methods. However, for most of the other CUCEI dimensions, the blended classroom scored highest. Compared to the white male students, the non-white-males generally had more favorable perspectives (during the focus group) towards the adaptive software with regards to their learning and satisfaction with the platform and its content. The student feedback from the focus groups and surveys is also being used formatively to improve the adaptive lessons. The instructor is currently working on including simulations of numerical methods, and he has improved feedback from the lessons by offering appropriate hints.

Based on the instructor's assessment, the students, in general, liked the adaptive platform, with many indicating they wanted all course topics to be covered in the Smart Sparrow platform. However, from the instructor's perspective, there was a fair degree of challenge and effort required on his part to program the platform for his needs, in addition to having the content ready for deployment. However, given the many advantages, he plans to continue using the adaptive platform in his numerical methods course going forward, including possibly for post-class lessons in a blended classroom.

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Appendix

Table 6: Multiple-Choice Question Results: Cohen's Effect Sizes for All Pairs of Means

	Blended	**Flip**	**Effect Size**
	Average Percentage (Adjusted)		***d***
All	63.0	65.1	0.13
Female	65.5	60.5	-0.29
CC Trans	57.5	61.4	0.23
URM	62.7	65.5	0.19
Pell	62.6	66.4	0.23
	Flip	**Flip w/ Adaptive**	**Effect Size**
	Average Percentage (Adjusted)		***d***
All	65.1	63.5	-0.10
Female	60.5	61.2	0.04
CC Trans	61.4	58.5	-0.17
URM	65.5	64.6	-0.06
Pell	66.4	64.0	-0.15
	Blended	**Flip w/ Adaptive**	**Effect Size**
	Average Percentage (Adjusted)		***d***
All	63.0	63.5	0.03
Female	65.5	61.2	-0.24
CC Trans	57.5	58.5	0.06
URM	62.7	64.6	0.12
Pell	62.6	64.0	0.09

Note: Leftmost instructional method in the table represents the reference, or control, category.

Table 7: Free-Response Question Results: Cohen's Effect Sizes for All Pairs of Means

	Blended	**Flip**	**Effect Size**
	Average Percentage (Adjusted)		***d***
All	39.9	37.3	-0.13
Female	46.1	42.4	-0.19
CC Trans	33.5	28.2	-0.28
URM	41.1	36.9	-0.19
Pell	40.0	35.3	-0.22
	Flip	**Flip w/ Adaptive**	**Effect Size**
	Average Percentage (Adjusted)		***d***
All	37.3	42.6	0.26
Female	42.4	46.6	0.21
CC Trans	28.2	30.1	0.10
URM	36.9	45.5	0.40
Pell	35.3	46.0	0.50
	Blended	**Flip w/ Adaptive**	**Effect Size**
	Average Percentage (Adjusted)		***d***
All	39.9	42.6	0.13
Female	46.1	46.6	0.02
CC Trans	33.5	30.1	-0.18
URM	41.1	45.5	0.20
Pell	40.0	46.0	0.28

Note: Leftmost instructional method in the table represents the reference, or control, category.

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